NASA

Aeronautical Engineering
A Continuing Bibliography with Indexes

NASA SP-7037(215)
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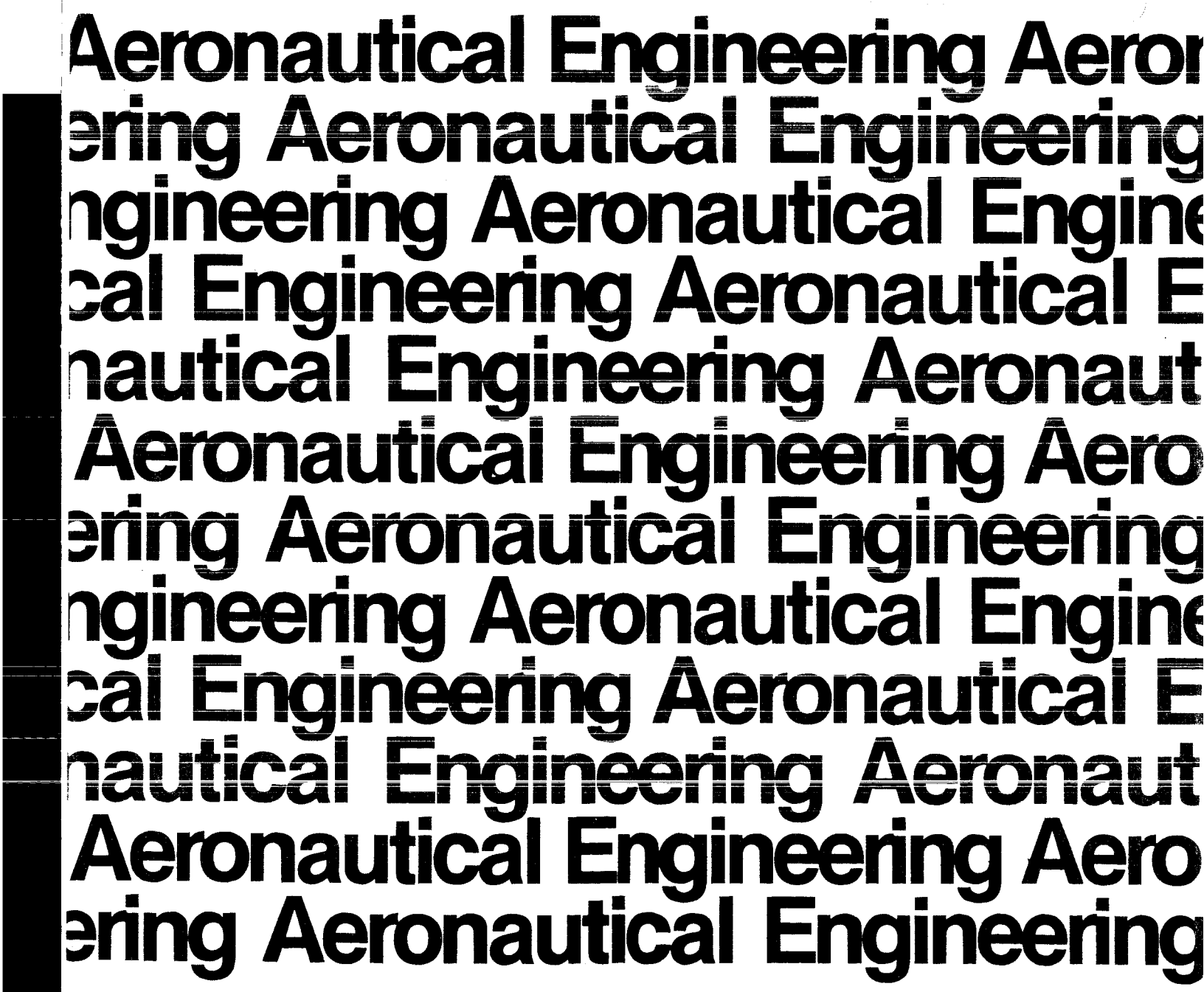

ACCESSION NUMBER RANGES

Accession numbers cited in this Supplement fall within the following ranges.

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NASA SP-7037(215)

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 215)

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in June 1987 in

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

NASA Scientific and Technical Information Office 1987
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Washington, DC

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INTRODUCTION

This issue of *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 425 reports, journal articles and other documents originally announced in June 1987 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA).*

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the bibliography consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by the first nine *STAR* specific categories and the remaining *STAR* major categories. This arrangement offers the user the most advantageous breakdown for individual objectives. The citations include the original accession numbers from the respective announcement journals. The *IAA* items will precede the *STAR* items within each category

Seven indexes -- subject, personal author, corporate source, foreign technology, contract number, report number, and accession number -- are included.

An annual cummulative index will be published.

Information on the availability of cited publications including addresses of organizations and NTIS price schedules is located at the back of this bibliography.

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Category 09	**Research and Support Facilities (Air)** Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.	**375**
Category 10	**Astronautics** Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; space communications, spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.	**378**
Category 11	**Chemistry and Materials** Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; propellants and fuels; and materials processing.	**378**

Category 12 Engineering 380
Includes engineering (general); communications and radar; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

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Includes geosciences (general); earth resources and remote sensing; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

Category 14 Life Sciences 394
Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and space biology.

Category 15 Mathematical and Computer Sciences 394
Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

Category 16 Physics 397
Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

Category 17 Social Sciences 398
Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law, political science, and space policy; and urban technology and transportation.

Category 18 Space Sciences N.A.
Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.

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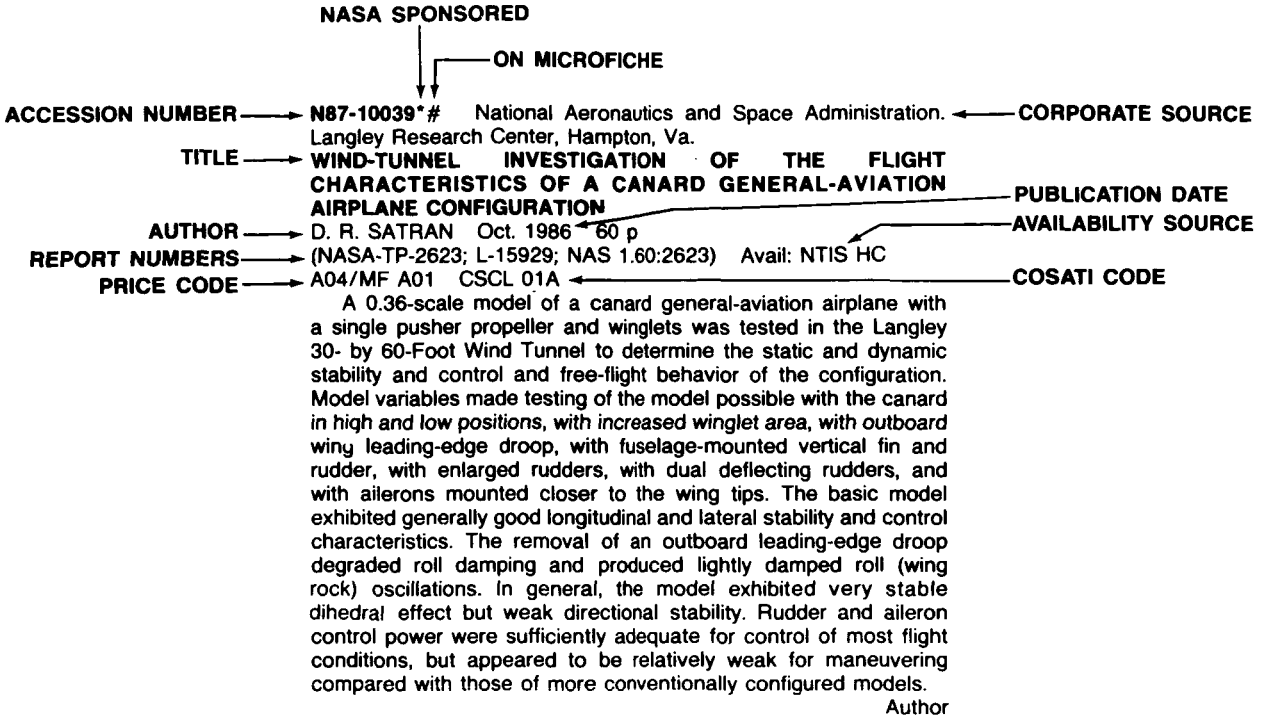
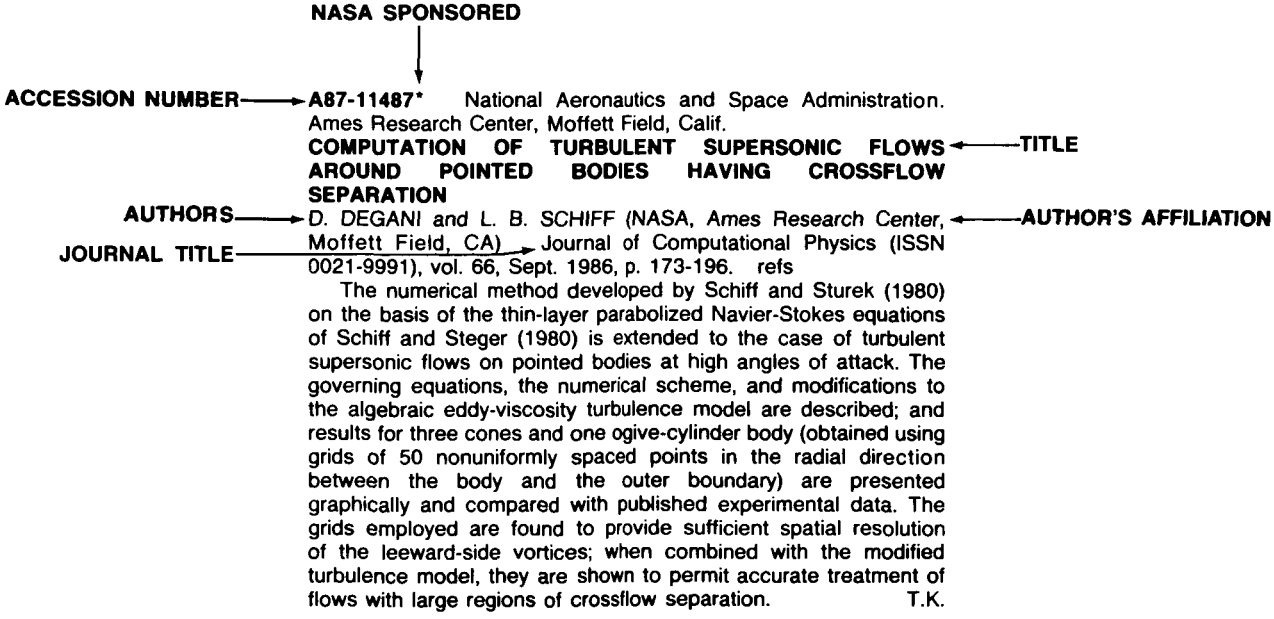
TYPICAL REPORT CITATION AND ABSTRACT



TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT



AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 215)

JULY 1987

01

AERONAUTICS (GENERAL)

A87-27698
CROSSED WINGS FLY FASTER
GEORGE MARSH New Scientist (ISSN 0028-6664), vol. 112, Dec. 11, 1986, p. 42-45.

The aerodynamic problem of how to exceed the speed of conventional helicopters while retaining helicopter ascent and descent capabilities is examined. The 'transition aircraft' or 'convertiplane' is being considered as an answer. Several such aircraft are discussed: the Bell-Boeing V22 Osprey, an X-wing mounted on a Rotor Systems Research Aircraft, and an ABC (advancing blade concept) aircraft with contrarotating rotors of graphite and glass fiber composition. The latest is the X-wing, having four stiff blades which form a rotor for vertical flight; for cruising the blades lock into a fixed 'X' position, with each blade at 45 degrees to the fuselage. Key factors in the construction and operation of an X-wing aircraft include the use of blowing and suction via slots near the leading and trailing edges, new rigid materials (graphite fiber composites, adhesives, titanium, etc.) and a flight control computer at the heart of a digital system that controls the machine's complex Coanda-effect. D.H.

A87-27814
STOL TECHNOLOGY TO BOOST TACTICAL AIRLIFTERS
BRIAN WANSTALL Interavia (ISSN 0020-5168), vol. 41, Dec. 1986, p. 1394-1396.

An evaluation is made of the design features and technology readiness status of configurational concepts currently under consideration in the U.S. and Western Europe with a view to the replacement of such tactical airlifters as the C-130. Emphasis is being given to the greatest possible reduction of takeoff and landing distances through the incorporation of powered lift and multielement wing high lift devices. Attention is given to the range of technology demonstration modifications currently undergoing tests in the form of a C-130 High Technology Testbed; the modifications encompass high lift systems, advanced flight controls, advanced graphic cockpit displays, precision navigation, and terminal guidance systems. O.C.

A87-28613
WILL THE AEROSPACE PLANE WORK?
STEPHEN W. KORTHALS-ALTES Technology Review (ISSN 0040-1692), vol. 90, Jan. 1987, p. 42-51.

The NASA National Aerospace Plane, proposed in 1986 as a hypersonic transport/single-stage-to-orbit vehicle that would be able to reduce launch costs from $2000/lb to $20/lb on the basis of a straightforward integration of already-existing technology, is presently scrutinized with attention to its most critical component, an airbreathing propulsion system. Primary airbreathing propulsion candidates are supersonic combustion ramjets and air turboramjets. Both civilian and military operational costs are assessed; it is judged that cost improvements over current launchers will at best amount to an order-of-magnitude reduction, rather than the two orders of magnitude initially claimed. The aerospace plane, furthermore, is held to be uneconomical as an air defense system. O.C.

A87-29276#
MILITARY DEVELOPMENTS IN AERONAUTICS - THE NEXT THIRTY YEARS
D. C. WHITTLEY (de Havilland Aircraft Company of Canada, Ltd., Downsview) (CASI, Annual General Meeting, 33rd, Vancouver, Canada, May 12, 1986) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 32, Dec. 1986, p. 276-287.

The present evaluation of technological prospects for military aircraft evolution notes that the complex combination of several major technological advances, entailing substantial risks, which is required to achieve a quantum jump in performance and effectiveness calls for a 'technology integration demonstrator' approach to the management of technological development. Attention is presently given to four examples of this approach: the British Experimental Aircraft Program, the U.S. Air Force's STOL and Maneuver technology program (employing an F-15), the Canadian Advanced STOL Transport Program, and the DRIE/DND/NASA STOVL fighter program. O.C.

A87-29639
THE AV-8B GOES ABOARD - TACAIR OPERATIONS FROM THE LHD 1
PETER S. GINGRAS, JOHN P. HACKETT (Ingalls (A.L.), Ann Arbor, MI), and DWIGHT B. CALDWELL (McDonnell Douglas Corp., Saint Louis, MO) IN: V/STOL/STOVL; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 59-80.
(SAE PAPER 861632)

The 1800-troop-carrying LHD 1-class Multipurpose Amphibious Ship, which is to be delivered in early 1989, is specifically designed to serve as a platform for AV-8B V/STOL aircraft operation in support of amphibious missions. Technical support and weapons stowage/handling facilities are tailored to operate the AV-8B in an autonomous role. Attention is given to the design features, performance capabilities, and weapons carriage capacity of the state-of-the-art AV-8B Harrier variant, as well as to its profiles for interdiction, antiship, interception, surveillance, and long range ferry missions. Armaments that can be incorporated encompass a 25-mm gun, Sidewinder missiles, laser-guided bombs, Maverick missiles, cluster bombs, general purpose bombs, fuel tanks, and jammer pods. O.C.

A87-29640
NEW MATERIALS IN CIVIL AVIATION; PROCEEDINGS OF THE AEROSPACE TECHNOLOGY CONFERENCE AND EXPOSITION, LONG BEACH, CA, OCT. 13-16, 1986
Conference and Exposition sponsored by SAE. Warrendale, PA, Society of Automotive Engineers, Inc. (SAE SP-682), 1986, 70 p. For individual items see A87-29641 to A87-29645.
(SAE SP-682)

The present conference discusses an evaluation of the Bell 206L and Sikorsky S-76 helicopters' composite components, the application of advanced composites to civil aircraft primary structures, and the experiences obtained over the course of a decade with the DC-10's composite rudders. Also discussed are the lessons learned in the DC-10 carbon/epoxy rudder

development program and the cost effectiveness of weight reduction measures involving advanced materials substitution. O.C.

A87-30002
HAS THE ORIENT EXPRESS BEEN MURDERED?
BILL SWEETMAN Interavia (ISSN 0020-5168), vol. 42, Jan. 1987, p. 27-29.

The technological development and economic feasibility factors that strategically affect the prospects for the 'Orient Express' hypersonic transport (HST) aircraft for trans-Pacific routes are discussed. A parallel study by the U.S. National Research Council has by contrast recommended consideration of a Mach 3 SST as well as a Mach 5-6 HST. Additional support for the economic and technological viability of an SST has emerged from both NASA and aerospace industry research efforts, which point to substantial airframe material weight reductions and 40-percent improvements in engine specific fuel consumption. O.C.

A87-30165
THE FUTURE OF HYDROGEN - AN ANALYSIS AT WORLD LEVEL WITH A SPECIAL LOOK AT AIR TRANSPORT
C. MARCHETTI (International Institute for Applied Systems Analysis, Laxenburg, Austria) (Hydrogen Industry Council, Hydrogen Link Conference, Montreal, Canada, Mar. 24-26, 1986) International Journal of Hydrogen Energy (ISSN 0360-3199), vol. 12, no. 2, 1987, p. 61-71.

A systems analysis is presented for the emergence of such elements of the hydrogen economy as a hydrogen-fueled air transportation system, in view of historical trends in technology development and economic growth. It is noted that the world commercial aircraft fleet has had 4000 aircraft since 1950 despite an 80-fold traffic increase since 1950. It is hypothesized that the dependence of aircraft powerplant output on size can be broken by means of airbreathing engine flow throughput increases of the kind promised by hydrogen-fueled hypersonic systems. This is projected to be able to yield a great improvement in productivity. O.C.

A87-30843
METHODS FOR MONITORING AND MAINTAINING MILITARY TURBOJETS [METHODES DE SURVEILLANCE ET DE MAINTENANCE DES TURBOREACTEURS MILITAIRES]
J. DARGEIN (SNECMA, Evry, France) (Societe Francaise des Mecaniciens, Journee d'Etudes sur les Machines Tournantes, Paris, France, June 10, 1986) Revue Francaise de Mecanique (ISSN 0373-6601), no. 4, 1986, p. 215-217. In French.

The evolution of military engine monitoring and maintenance practices is traced over the past quarter century. The engines normally experience a series of transitory states due to the nature of military missions, which exacerbate stresses on engines. Engine maintenance and repair is the province of the ground personnel. The job was, for awhile, partly ameliorated by limiting the allowable engine flight hours, after which the engines were pulled. Cost-savings have been realized with modular engine components, so that individual components have programmed lifetimes. Further economies are being gained by identifying inspection techniques which allow assessments of engine parts, which are not replaced or repaired until predefined deterioration thresholds are broached. M.S.K.

A87-30844
IN-SERVICE MONITORING AND MAINTENANCE OF ENGINES AT AIR FRANCE [ENTRETIEN ET SURVEILLANCE EN SERVICE DES REACTEURS A AIR FRANCE]
P. CHETAIL (Companie Nationale Air France, Orly, France) (Societe Francaise des Mecaniciens, Journee d'Etudes sur les Machines Tournantes, Paris, France, June 10, 1986) Revue Francaise de Mecanique (ISSN 0373-6601), no. 4, 1986, p. 219-226. In French.

Techniques used by Air France to optimize maintenance and inspection procedures for modular engine components to ensure flight safety while performing only economically justified repairs are described. Engine components are designed to permit rebuilding to tolerances close to that of new equipment. Tests are described which are used to obtain properly balanced rebuilt engines. Malfunctioning components are detected when engine performance varies beyond well-defined parameters contained in an extensive database developed from decades of flight operations. The engine parameters which are monitored in-flight for later analysis by ground personnel in assessing engine condition are summarized. M.S.K.

A87-30918
NEW COMMERCIAL AIRCRAFT PROMISE EFFICIENCY
T. A. HEPPENHEIMER High Technology (ISSN 0277-2981), vol. 7, Feb. 1987, p. 23-27.

Designs for the next generation of transport aircraft are being guided by costs to the purchaser. The various configurations of the propfan, the contrafan, and ducted and unducted turbofans that will be implemented to enhance fuel efficiency are described. Al-Li alloys and composite structures will lower the weight of the new aircraft, which will in nominal operating conditions be flown by flight management computers. Aerodynamic efficiency will be improved with supercritical wings and perforated wings, the latter ensuring continuous laminar flow. Both the propfan and perforated, laminar flow concepts were developed to a state of industrial readiness by NASA efforts. Finally, design concepts which may be used in a next-generation SST are outlined. M.S.K.

A87-31149#
ROBOTIC SYSTEMS FOR AIRCRAFT SERVICING/ MAINTENANCE
EDWIN R. SCHULTZ (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 1, Dec. 1986, p. 24-27.

The application of robotic systems to the servicing and maintenance of aircraft is studied. Automated systems for refueling and rearming tactical aircraft are proposed. Consideration is given to modular mechanical/avionics subsystems, airborne computer monitoring of subsystem performance, and robotic/airframe compatibility. The potential advantages of using automated systems for aircraft maintenance include: a reduction in manpower requirements for ground servicing, an increase in the sortie generation rate, and limiting the exposure of ground support personnel to biochemical hazards. I.F.

N87-18520*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
JOINT UNIVERSITY PROGRAM FOR AIR TRANSPORTATION RESEARCH, 1983
FREDERICK R. MORRELL, comp. Mar. 1987 80 p Conference held in Atlantic City, N.J., 16 Dec. 1983; sponsored by NASA and FAA
(NASA-CP-2451; L-16254; NAS 1.55:2451) Avail: NTIS HC A05/MF A01 CSCL 01B

The research conducted during 1983 under the NASA/FAA sponsored Joint University Program for Air Transportation Research is summarized. The material was presented at a conference held at the Federal Aviation Administration Technical Center, Altantic City, New Jersey, December 16, 1983. The Joint University Program is a coordinated set of three grants sponsored by NASA Langley Research Center and the Federal Aviation Administration, one each with the Massachusetts Institute of Technology, Ohio University, and Princeton University. Completed works, status reports, and bibliographies are presented for research topics, which include navigation, guidance, control, and display concepts. An overview of the year's activities for each of the universities is also presented.

N87-18532*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FULL-POTENTIAL MODELING OF BLADE-VORTEX INTERACTIONS
H. E. JONES and F. X. CARADONNA (Army Aviation Research and Development Command, Moffett Field, Calif.) Aug. 1986 30 p
(NASA-TM-88355; A-86395; NAS 1.15:88355; USAAVSCOM-TM-86-A-5) Avail: NTIS HC A03/MF A01 CSCL 01B

A comparison is made of four different models for predicting the unsteady loading induced by a vortex passing close to an airfoil. (1) The first model approximates the vortex effect as a change in the airfoil angle of attack. (2) The second model is related to the first but, instead of imposing only a constant velocity on the airfoil, the distributed effect of the vortex is computed and used. This is analogous to a lifting surface method. (3) The third model is to specify a branch cut discontinuity in the potential field. The vortex is modeled as a jump in potential across the branch cut, the edge of which represents the center of the vortex. (4) The fourth method models the vortex expressing the potential as the sum of a known potential due to the vortex and an unknown perturbation due to the airfoil. The purpose of the current study is to investigate the four vortex models described above and to determine their relative merits and suitability for use in large three-dimensional codes. Author

N87-19347# Universal Energy Systems, Inc., Dayton, Ohio.
V/STOL CONCEPTS AND DEVELOPED AIRCRAFT. VOLUME 1: A HISTORICAL REPORT (1940-1986) Final Report, 3 Sep. 1978 - 26 Jun. 1986
BERNARD LINDENBAUM 26 Jun. 1986 455 p
(Contract F33615-83-C-3000)
(AD-A175379; AFWAL-TR-86-3071-VOL-1) Avail: NTIS HC A20/MF A01 CSCL 01C

A comprehensive, in-depth review of the development of VTOL and V/STOL concepts and aircraft other than the helicopter is presented. The time period covered is from the beginning of organized government-sponsored activity in the late 1940's through the present. Conventional helicopters are not discussed. Included are V/STOL aircraft which do use rotors but are aimed at providing cruise speeds and aerodynamic efficiencies similar to those of conventional airplanes. Although not aircraft in the conventional sense, wingless VTOL vehicles which use direct thrust (rocket or turbojet/turbofan) for lift in all flight modes also are included since such machines do have a close relationship to some of the more commonly accepted forms of VTOL aircraft. This volume contains an introductory review of V/STOL aircraft concepts and the rationale behind them. The concepts are categorized by propulsion system. This volume contains definitive information and technical reviews of the rocket belt, turbojet/turbofan platform type (wingless) vehicles, and turbojet/turbofan vertical attitude takeoff and landing aircraft. GRA

N87-19348# Oak Ridge National Lab., Tenn.
METHOD FOR FORECASTING REPAIR AND REPLACEMENT NEEDS FOR NAVAL AIRCRAFT, PHASE 2
R. C. DELOZIER and V. K. WILKINSON Sep. 1986 51 p
(Contract DE-AC05-84OR-21400)
(DE87-001628; ORNL/TM-10179) Avail: NTIS HC A04/MF A01

This report describes the Phase 2 work performed on the development of repairs and replacements forecasting algorithms for Naval Aviation Logistics Center support. This new methodology is intended to improve the confidence level between actual and predicted spare parts requirements. Phase 2 refined the bivariate regression analysis, developed in the Phase 1 demonstration effort, and expanded the analyses to the multivariable level. This method assumes that the various steps along the parts' supply line that are required to support the Navy under various operations can be modeled based on historical data, or educated assumptions can be input where data are unavailable or inadequate. To demonstrate the feasibility of the method, the P-3 aircraft was selected, and four recent years of maintenance data were studied. The data covered system and parts replacements and other maintenance actions. Two P-3 component data were examined in search of correlations that might exist between various parameters (e.g., flight-hours and time). The results of this phase of the study show that a methodology in which a systematic analysis of historical data coupled with input from maintenance experts results in improved predictive ability. The improvement in estimated needs for spare parts vs actual needs can produce significant cost savings. DOE

02

AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

A87-27937*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
WIDE-FIELD SHADOWGRAPHY OF TIP VORTICES FROM A HELICOPTER ROTOR
S. P. PARTHASARATHY, Y. I. CHO, and L. H. BACK (California Institute of Technology, Jet Propulsion Laboratory, Pasadena) AIAA Journal (ISSN 0001-1452), vol. 25, Jan. 1987, p. 64-70. Previously cited in issue 19, p. 2736, Accession no. A85-40682. refs
(Contract NAS7-918)

A87-27938#
COMPUTATION OF TRANSONIC FLOWS IN TURBOMACHINES USING THE RUNGE-KUTTA INTEGRATION SCHEME
S. V. SUBRAMANIAN and R. BOZZOLA (Textron, Inc., AVCO Lycoming Textron, Stratford, CT) AIAA Journal (ISSN 0001-1452), vol. 25, Jan. 1987, p. 71, 72. Abridged. Previously cited in issue 18, p. 2611, Accession no. A85-39728. refs

A87-27957#
CONICAL, SEPARATED FLOWS WITH SHOCK AND SHED VORTICITY
F. MARCONI (Grumman Corporate Research Center, Bethpage, NY) AIAA Journal (ISSN 0001-1452), vol. 25, Jan. 1987, p. 173-175. refs
(Contract F49620-84-C-0056)

An investigation of the relationship between shock vorticityand shed vorticity-produced separation is conducted by numerically evaluating Euler solutions for the flow about a 5-deg cone, varying the specified separation point location. The importance of both sources is inferred from the fact that the vorticity shed goes smoothly to zero as the shock vorticity separation point location is approached. Separation due to shock vorticity alone can be considered a limiting solution of the solution set in which vorticity is shed from the surface. O.C.

A87-27958*# Washington Univ., Seattle.
SUPERSONIC LAMINAR FLOW DEVELOPMENT IN A SQUARE DUCT
D. O. DAVIS, F. B. GESSNER (Washington, University, Seattle), and G. D. KERLICK (NASA, Ames Research Center; Informatics General Corp., Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 25, Jan. 1987, p. 175-177. refs
(Contract NCA2-IR-850-401)

Supersonic laminar flow development in a constant-area square duct exhibits as one of its distinguishing features the formation of two contrarotating secondary flow vortices centered about the corner bisector. This phenomenon does not occur in unbounded corner flow. The secondary flow causes an outward bulging of total pressure contours in the vicinity of the corner bisector for wholly attached flow conditions. O.C.

A87-27962#
NUMERICAL SOLUTIONS OF VISCOUS TRANSONIC FLOW IN TURBOMACHINERY CASCADES
V. IYER and E. VON LAVANTE (Texas A & M University, College Station) AIAA Journal (ISSN 0001-1452), vol. 25, Jan. 1987, p. 184-186. Previously cited in issue 07, p. 835, Accession no. A85-19454. refs

A87-27981#
EULER SOLUTIONS FOR HIGHLY LOADED TURBINE CASCADES
B. N. SRIVASTAVA (Avco Everett Research Laboratory, Inc., MA) and R. BOZZOLA (Avco Corp., Avco Lycoming Div., Stratford, CT) Journal of Propulsion and Power (ISSN 0748-4658), vol. 3, Jan.-Feb. 1987, p. 39-45. Research supported by Avco Corp. refs

This paper discusses the numerical formulation aspects of computing flowfields in several highly loaded turbine cascades. The theoretical formulation for the integration of the Euler equations utilizes a generalized transformed body-fitted coordinate system and an unsplit explicit MacCormack's scheme (based on central flux balancing) to achieve steady-state solutions. Computational results have been generated for subsonic and transonic flows in several high-turning-angle and high-solidity turbine cascades that are representative of advanced turbine technology. The results of the computational simulations have been favorably compared with measured surface pressure data, outflow angles, and outflow Mach numbers for C- and H-grid topologies. Author

A87-27983#
AFTERBODY FLOWFIELD COMPUTATIONS AT TRANSONIC AND SUPERSONIC MACH NUMBERS
URIEL C. GOLDBERG, JOSEPH J. GORSKI, and SUKUMAR R. CHAKRAVARTHY (Rockwell International Science Center, Thousand Oaks, CA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 3, Jan.-Feb. 1987, p. 56-62. Previously cited in issue 01, p. 5, Accession no. A86-11044. refs

A87-27984*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
BOUNDARY-LAYER EFFECTS ON THE FLOWFIELD ABOUT ISOLATED FLOW-THROUGH NACELLES
WILLIAM B. COMPTON, III (NASA, Langley Research Center, Hampton, VA) and JOHN L. WHITESIDES (NASA, Langley Research Center; Joint Institute for Advancement of Flight Sciences, Hampton, WA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 3, Jan.-Feb. 1987, p. 63-70. Previously cited in issue 19, p. 2739, Accession no. A85-40729. refs

A87-28067#
INVERSE AERODYNAMIC DESIGN METHOD FOR AIRCRAFT COMPONENTS
J. B. MALONE, J. VADYAK (Lockheed-Georgia Co., Flight Sciences Div., Marietta), and L. N. SANKAR (Georgia Institute of Technology, Atlanta) Journal of Aircraft (ISSN 0021-8669), vol. 24, Jan. 1987, p. 8, 9. Abridged. Previously cited in issue 01, p. 6, Accession no. A86-11054.

A87-28068#
EULER SOLUTIONS FOR TRANSONIC FLOW PAST A FIGHTER WING
L. N. SANKAR (Georgia Institute of Technology, Atlanta), J. B. MALONE, and D. SCHUSTER (Lockheed-Georgia Co., Marietta) Journal of Aircraft (ISSN 0021-8669), vol. 24, Jan. 1987, p. 10-16. Research supported by the Lockheed-Georgia Independent Research and Development Program. Previously cited in issue 01, p. 4, Accession no. A86-11031. refs

A87-28069*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
TRANSONIC WING FLOWS USING AN EULER/NAVIER-STOKES ZONAL APPROACH
TERRY L. HOLST, KAREN L. GUNDY, JOLEN FLORES, NEAL M. CHADERJIAN (NASA, Ames Research Center, Moffett Field, CA), UNVER KAYNAK (Stanford University, CA) et al. Journal of Aircraft (ISSN 0021-8669), vol. 24, Jan. 1987, p. 17-24. Previously cited in issue 19, p. 2739, Accession no. A85-40742. refs
(Contract NCA2-OR-745-309)

A87-28071*# Continuum Dynamics, Inc., Princeton, N. J.
SCALING LAWS FOR TESTING AIRFOILS UNDER HEAVY RAINFALL
ALAN J. BILANIN (Continuum Dynamics, Inc., Princeton, NJ) Journal of Aircraft (ISSN 0021-8669), vol. 24, Jan. 1987, p. 31-37. Previously cited in issue 07, p. 841, Accession no. A85-19617. refs
(Contract NASA ORDER L-71488-B)

A87-28072#
SECTION CHARACTERISTICS OF A FINITE, SWEPT CIRCULATION CONTROL AIRFOIL
N. J. WOOD (Stanford University, CA) Journal of Aircraft (ISSN 0021-8669), vol. 24, Jan. 1987, p. 38-44. Previously cited in issue 17, p. 2463, Accession no. A86-37836. refs

A87-28073#
NONPLANAR, SUPERSONIC, THREE-DIMENSIONAL, OSCILLATORY, PIECEWISE CONTINUOUS-KERNEL FUNCTION METHOD
I. LOTTATI and E. NISSIM (Technion - Israel Institute of Technology, Haifa) Journal of Aircraft (ISSN 0021-8669), vol. 24, Jan. 1987, p. 45-54. refs

The three-dimensional, supersonic, piecewise continuous-kernel function method formulated for studying oscillatory and steady flows is hereby extended to cope with nonplanar configurations in the supersonic region. This work treats problems associated with the computation of the kernel function for the nonplanar supersonic case and the anomalies associated with almost adjoining lifting surfaces. Interference aerodynamic forces as computed by the present method are compared with results obtained using other numerical methods. The reverse flow theorem is also used to indicate the accuracy of the computed results. Author

A87-28074#
NOISE FROM A CIRCULATION CONTROL WING WITH UPPER SURFACE BLOWING
M. SALIKUDDIN, W. H. BROWN, and K. K. AHUJA (Lockheed-Georgia Co., Marietta) Journal of Aircraft (ISSN 0021-8669), vol. 24, Jan. 1987, p. 55-64. Research supported by Lockheed Independent Research and Development Program. Previously cited in issue 01, p. 3, Accession no. A86-10939. refs

A87-28334#
A GENERAL FAMILY OF GENERALIZED VARIATIONAL PRINCIPLES FOR 2-D UNSTEADY FULLY POTENTIAL TRANSONIC FLOW WITH SHOCKS AROUND OSCILLATING AIRFOILS
GAOLIAN LIU (Shanghai Institute of Mechanical Engineering, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 4, Dec. 1986, p. 361-369. In Chinese, with abstract in English. refs

In this paper, a two-parameter family of generalized variational principles (VPs), together with its derived subgeneralized VP series, is established for two-dimensional, unsteady, fully potential transonic flow with shocks around oscillating airfoils. Two powerful methods, variations with variable domains and natural boundary conditions, are used to convert almost all boundary conditions and matching conditions across unknown oscillating shocks and free trailing vortex sheets into natural ones. Suction and/or blowing along wind surfaces are accounted for. The results provide an

extensive and sound theoretical basis for the FEM and other variational methods in unsteady transonic aerodynamics, and can be generalized further to three-dimensional wings and to two-dimensional and three-dimensional bladings of turbomachinery. C.D.

A87-28335#
AN INTRODUCTION OF HYBRID DIFFERENCE SCHEME SUITABLE FOR COMPUTATION OF TRANSONIC FLOWS
YIYUN WANG (Beijing Institute of Aerodynamics, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 4, Dec. 1986, p. 370-379. In Chinese, with abstract in English.

A combination of a MacCormack scheme and an upwind one is presented. It is suitable for computation of transonic flows. As an example, the transonic flow around a circular airfoil was calculated; the process and results are described in detail. Author

A87-28337#
CALCULATION OF SUPERSONIC STEADY AXISYMMETRIC NOZZLE AND JET
JIANGPENG CAI (Chinese Aerodynamic Establishment, Institute of Computing Technology, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 4, Dec. 1986, p. 389-397. In Chinese, with abstract in English. refs

This paper presents a numerical method to calculate the supersonic internal flow and the supersonic jet for a given axisymmetric nozzle. The interior points of the nozzle are calculated by the two-step MacCormack finite difference scheme and added artificial viscosity. The boundary points are calculated by a two-order accuracy scheme deduced from the characteristic relation. The Prandtl-Meyer flow formula is used at the nozzle exits. The boundary of the jet is determined by an iterative procedure. Numerical results from three nozzles are given. C.D.

A87-28338#
CALCULATION OF AERODYNAMIC HEAT TRANSFER ON BLUNT-NOSED THIN WINGS AT ANGLES OF ATTACK
SHUXUAN XU (University of Science and Technology of China, Hefei, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 4, Dec. 1986, p. 398-405. In Chinese, with abstract in English. refs

A method for calculating aerodynamic heat transfer on thin wings at angles of attack is provided, based on the assumption of small cross flow and the calculation of an infinite cylinder. It is valid in the range of supersonic and low hypersonic speeds. The method does not require calculation of the details of the stream lines and can be used for various swept wings at moderate angle of attack or yaw angle. A comparation between the theoretical and the experimental results is given. Author

A87-28341#
THE OBSERVATION OF TRANSITION IN SHOCK WIND TUNNEL
JINGMEI LI (Chinese Academy of Sciences, Institute of Mechanics, Beijing, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 4, Dec. 1986, p. 430-435. In Chinese, with abstract in English. refs

The observation of burst during transition on a flat plate and 9 deg cone is made in a shock wind tunnel at free stream Mach number (FSMN) of 5.2, free stream Reynolds number (FSRN) of 2.3 x 10 to the 7th/m in one case and FSMN of 5.3 and FSRN of 3 x 10 to the 7th/m in another case. The burst is compared with hairpin eddies at low speed. The mechanism is the same for both burst and hairpin, and the speeds of the two eddies equals the one of the critical layer. The eddies' frequency increases with Reynolds number at low speed, but hardly changes in the supersonic and hypersonic regions. The breakdown of the burst results in turbulence. C.D.

A87-28342#
NUMERICAL CALCULATIONS FOR THE TWO-DIMENSIONAL TRANSONIC FLOWS OVER LIFTING AIRFOILS IN ORTHOGONAL STREAM-LINE COORDINATES
YU CHEN (Beijing Institute for System Engineering, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 4, Dec. 1986, p. 436-439. In Chinese, with abstract in English.

In this paper the stream-line iteration method is used for computing transonic flows past airfoils with an attack-angle in orthogonal stream-line coordinates. Using this method, flows over 6 percent bicircular-arc and NACA0012 airfoils at alpha = 1 deg were computed. The computed result is in good agreement with experiment data. Author

A87-28417
AERODYNAMIC RESEARCH INTO THE HIGH CAMBERED MCA-TYPE SUPERSONIC COMPRESSOR CASCADE
KAREL CELIKOVSKY and PAVEL SAFARIK Zprava VZLU, no. Z-49, 1986, p. 1-9. refs

The paper describes aerodynamic research on the behavior of a high-camber supersonic straight cascade carried out in an attempt to simulate the behavior of a supersonic rotor midspan section. A supersonic windtunnel is used and flow phenomena in the entrance region and cascade channel are analyzed. A cascade starting is shown to agree with the requirements placed on the annular-stage cascade. An analysis of flow around the airfoils operating under the periodic inlet and nonperiodic exit conditions is performed. K.K.

A87-28625*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FULL-SCALE GROUND EFFECTS OF TWIN IMPINGING JETS BENEATH A SUBSONIC TACTICAL V/STOL AIRCRAFT
MICHAEL R. DUDLEY, JAMES E. ESHLEMAN (NASA, Ames Research Center, Moffett Field, CA), and CHARLES J. SCHELL (Grumman Aerospace Corp., Bethpage, NY) AIAA, Aircraft System Design and Technology Meeting, Dayton, OH, Oct. 20-22, 1986. 15 p. refs
(AIAA PAPER 86-2704)

This paper presents a summary of an analysis of flow field characteristics about a large scale twin-tilt-nacelle V/STOL aircraft in close proximity to the ground. The analysis uses experimental data in the form of measurements of pressure distributions on the ground beneath the aircraft and on the undersurface of the aircraft's fuselage. The integrals of these distributions are compared with forces measured directly, for both the total model and isolated nacelles, (i.e., net thrust). The handling qualities of the vehicle were found to be influenced by flow field characteristic features, not present in simpler models. Lift increases and significant degradation in roll control occur at low heights for fuselage strake deflections of 30 degrees or more. Reductions in control effectiveness about the other axes were also observed. Author

A87-29085
AERODYNAMICS OF A VORTEX CHAMBER WITH GAS FLOW RATE ADJUSTMENT AT THE OUTLET [AERODINAMIKA VIKHREVOI KAMERY PRI REGULIROVANII RASKHODA GAZA NA VYKHODE]
E. P. VOLCHKOV, L. V. SERIKOV, and V. I. TEREKHOV (AN SSSR, Institut Teplofiziki, Novosibirsk, USSR) Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seriia Tekhnicheskie Nauki (ISSN 0002-3434), Oct. 1986, p. 45-51. In Russian. refs

The effect of gas flow rate redistribution on the aerodynamics of a vortex chamber is investigated experimentally using laser Doppler anemometry. It is shown that gas flow rate redistribution at the chamber outlet makes it possible to obtain practically any profile of the circular velocity component in the main volume of the vortex, the possible profiles ranging from a potential one to a quasi-solid one. It is also shown that, as the redistribution parameter is reduced from 1.0 to 0.6, the circular velocity remains practically constant, while the radial component changes substantially. The

results obtained are found to be in good agreement with theoretical predictions. V.L.

A87-29086
SOME FEATURES OF THE APPROXIMATE CALCULATION OF THE INTEGRAL AERODYNAMIC CHARACTERISTICS OF POLYGONAL LIFTING CONFIGURATIONS AT SUPERSONIC FLIGHT VELOCITIES [NEKOTORYE OSOBENNOSTI PRIBLIZHENNOGO RASCHETA SUMMARNYKH AERODINAMICHESKIKH KHARAKTERISTIK POLIGONAL'NYKH NESUSHCHIKH KONFIGURATSII PRI SVERKHZVUKOVYKH SKOROSTIAKH POLETA]
I. I. MAZHUL (AN SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seriia Tekhnicheskie Nauki (ISSN 0002-3434), Oct. 1986, p. 52-57. In Russian. refs

The use of approximation method for calculating the integral aerodynamic characteristics of polygonal lifting configurations is discussed with reference to problems related to the parametric analysis and aerodynamic optimization of flight vehicles. The application of the shock-expansion method to polygonal shapes is examined with allowance for experimentally determined structural characteristics of flow past these configurations. A quasi-two-dimensional approach based on the hypothesis of local two-dimensionality of hypersonic flow is shown to provide reasonably good agreement with experimental data for Mach 2-3 or greater in the case of polygonal lifting configurations. V.L.

A87-29262
EXTENSION OF HOT AIR BALLOON FLIGHT DURATION THROUGH ADAPTION OF BALLOON SURFACE CHARACTERISTICS
W. HALLMANN (Aachen, Fachhochschule, West Germany) Aeronautical Journal (ISSN 0001-9240), vol. 90, Dec. 1986, p. 385-392. Translation.

Solar insolation is explored as a means of extending balloon flight duration. The idea is to minimize thermal loss to the environment and maximize the absorption of energy through the balloon's skin. Models for buoyancy and thermodynamics of the heat balance between the inner and outer environments of a balloon are used to examine the relation between flight duration and balloon surface temperature. It is found that the emissivity of the surface is four times as important as the absorption capacity for flight duration. Less fuel is needed for hot air if the net heat loss from the balloon interior is supplemented by solar heating and heat loss is minimized. There is a maximum temperature that the internal gas can reach before emission increases and flight duration decreases. The performances of Ripstop and Mylar as balloon skin materials are compared. M.S.K.

A87-29564#
SUPERSONIC SOLUTION OF PROBLEMS INVOLVING ANALYSIS AND DESIGN CALCULATION BY STREAMLINE CURVATURE METHOD IN TURBOMACHINERY
FANGYUAN ZHU and XINHAI ZHOU Northwestern Polytechnical University, Journal (ISSN 1000-2753), vol. 5, Jan. 1987, p. 69-78. In Chinese, with abstract in English.

An eigenvalue analysis is performed for the time-dependent basic equations governing blade-to-blade flow in turbomachinery. It is found that a meridional Mach number Mm of less than 1.0 is required for a disturbance to propagate upstream in the turbomachine flowfield. A routine algorithm can provide solutions for the supersonic flowfield for relative Mach number of more than 1.0 and Mm of less than 1.0. A calculative example is given in which the computation of the transonic flowfield in the axial flow compressor stage with given airflow angle distributions is transformed into a design calculation with given circulation distributions. The results for these two types of calculations are shown to be in close agreement. C.D.

A87-29565#
ON PERFORMANCE OF A CASCADE WITH VARYING GEOMETRY CONVERGING PASSAGE
LIU BO and RUQUN YAN Northwestern Polytechnical University, Journal (ISSN 1000-2753), vol. 5, Jan. 1987, p. 79-86. In Chinese, with abstract in English.

A varying-geometry converging cascade passage whose geometric shape is similar to that of a real compressor is investigated. The theory of compressible turbulent boundary layers is utilized together with characteristic parameters and the assumption of a simple-power velocity distribution in the wake behind the cascade to derive a simplified equation for calculating the total pressure loss coefficient, the static pressure ratio, and the diffusion factor of a high subsonic converging cascade. This equation may be used to predict the performance parameters of inlet guide vanes and compressor stators for both design and off-design conditions. A correlation equation relating 'n' to intake flow conditions, cascade geometric parameters, and characteristics wake parameters is also derived. These equations are used to calculate total pressure losses, static pressure ratios, and diffusion factors for the studied compressor cascade under various conditions, and fairly good agreement with experimental data is obtained. C.D.

A87-29566#
THE PREDICTING METHOD FOR THE PERFORMANCE OF THE MODERN SUPERSONIC/TRANSONIC STAGE OF THE AXIAL-FLOW COMPRESSOR
WEIWEN LI and JINGYUE ZHOU Northwestern Polytechnical University, Journal (ISSN 1000-2753), vol. 5, Jan. 1987, p. 87-98. In Chinese, with abstract in English. refs

Procedures for calculating the modern supersonic/transonic stages of an axial-flow compressor with low hub-tip ratio and part-span dampers on the rotors are proposed. Experimental data on the blade rows with multiple circular arc airfoils and double circular arc airfoils for the modern stages are presented, and methods for calculating loss parameters and deviation angles are given. The performances of a transonic rotor and a compressor supersonic stage are calculated; the results are in satisfactory agreement with experimental data. C.D.

A87-29688* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
CONSTRUCTION OF EXPLICIT AND IMPLICIT SYMMETRIC TVD SCHEMES AND THEIR APPLICATIONS
H. C. YEE (NASA, Ames Research Center, Moffett Field, CA) Journal of Computational Physics (ISSN 0021-9991), vol. 68, Jan. 1987, p. 151-179. refs

A one-parameter family of explicit and implicit total variation diminishing (TVD) schemes is developed which permits incorporation of an expanded group of slope and flux limiters. The numerical technique is intended for use in calculations which include a time-differencing scheme and an optional Lax-Wendroff scheme. Methods of extending the TVD models to nonlinear scalar equations and systems of hyperbolic conservation equations are described. Sample results are presented from calculations of shocked flows around NACA 0012 and NACA 0018 airfoils. M.S.K.

A87-29859* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
A DIRECTIONAL ARRAY APPROACH FOR THE MEASUREMENT OF ROTOR NOISE SOURCE DISTRIBUTIONS WITH CONTROLLED SPATIAL RESOLUTION
T. F. BROOKS, M. A. MARCOLINI (NASA, Langley Research Center, Hampton, VA), and D. S. POPE (PRC Kentron, Inc., Hampton, VA) Journal of Sound and Vibration (ISSN 0022-460X), vol. 112, Jan. 8, 1987, p. 192-197.

A special array system has been designed to examine noise source distributions over a helicopter rotor model. The particular measurement environment is for a rotor operating in the open jet of an anechoic wind tunnel. An out-of-flow directional microphone element array is used with a directivity pattern whose major

directional lobe projects on the rotor disk. If significant contributions from extraneous tunnel noise sources in the direction of the side lobes are excluded, the dominant output from the array would be that noise emitted from the projected area on the rotor disk. The design incorporates an array element signal blending features which serves to control the spatial resolution of the size of the directional lobes. (Without blending, the resolution and side lobe size are very strong functions of frequency, which severely limits the array's usefulness). D.H.

A87-29893
SOLVABILITY OF SOME PROBLEMS CONCERNING SUPERSONIC FLOW PAST A WEDGE USING THE LAVRENT'EV-BITSADZE APPROXIMATION [O RAZRESHIMOSTI NEKOTORYKH ZADACH SVERKHZVUKOVOGO OBTEKANIIA KLINA V RAMKAKH PRIBLIZHENIIA LAVRENT'EVA-BITSADZE]
A. V. GRISHIN Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki (ISSN 0044-4669), vol. 26, Dec. 1986, p. 1868-1877. In Russian. refs

Boundary value problems corresponding to nonsymmetric supersonic jet flow past an infinite wedge and nonsymmetric infinite supersonic flow with a separated shock wave past a finite wedge are formulated and analyzed in the hodograph plane using the Lavrent'ev-Bitsadze approximation. An analysis is also made of the problem of symmetric supersonic flow past an infinite wedge. A class of problems is identified for which the uniqueness of the solution to the corresponding boundary value problem in the hodograph plane is the necessary condition of flow realizability in physical plane. V.L.

A87-30075
SECOND-ORDER BOUNDARY LAYERS FOR STEADY, INCOMPRESSIBLE, THREE-DIMENSIONAL STAGNATION POINT FLOWS
R. VASANTHA and G. NATH (Indian Institute of Science, Bangalore, India) International Journal of Heat and Mass Transfer (ISSN 0017-9310), vol. 29, Dec. 1986, p. 1993-1996. refs

The effects of Prandtl number and mass transfer on the second-order boundary layers in both nodal and saddle point regions of a three-dimensional flow were studied numerically. The governing equations were solved using an implicit finite-difference method. It was found that, as the injection rate increases, both skin friction and heat transfer decrease, whereas the effect of suction is opposite. As the Prandtl number increases, the heat transfer increases. I.S.

A87-30279*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
CONSERVATIVE FULL-POTENTIAL MODEL FOR UNSTEADY TRANSONIC ROTOR FLOWS
ROGER C. STRAWN and FRANCIS X. CARADONNA (NASA, Ames Research Center; U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 25, Feb. 1987, p. 193-198. Previously cited in issue 07, p. 829, Accession no. A86-19676. refs

A87-30406#
THE AERODYNAMIC CHARACTERISTICS OF AIRCRAFT WITH STRIP WING AND LIFTING FUSELAGE [CHARAKTERYSTYKI AERODYNAMICZNE SAMOLOTOW ZE SKRZYDLEM PASMOWYM I KADLUBEM WYTWARZAJACYM SILE NOSNA]
ADEL SULTAN MASSAUD ABUSAHMEN, KRZYSZTOF MAC, and WIESLAW SOBIERAJ (Wojskowa Akademia Techniczna, Warsaw, Poland) Technika Lotnicza i Astronautyczna (ISSN 0040-1145), Sept.-Oct. 1986, p. 3-7. In Polish.

The paper presents the characteristics and applications of strip wings used in operational military aircraft. The flow around the wing at various flight speeds is described, and the results of wind-tunnel tests performed on an aircraft with a wing of this type are discussed. K.K.

A87-30446
GUST RESPONSE OF A FLAT-PLATE AEROFOIL IN THE TIME DOMAIN
R. K. AMIET (United Technologies Research Center, East Hartford, CT) Quarterly Journal of Mechanics and Applied Mathematics (ISSN 0033-5614), vol. 39, Nov. 1986, p. 485-505. refs

The problem of a thin aerofoil subjected to a delta-function type of gust is solved by a technique previously used for the harmonic gust case. These two problems are Fourier transforms of one another, one being in the time domain and the other in the frequency domain, but the time-domain solution leads to simpler expressions. Also, the exact solution, at any given time, for the delta-function case can be expressed in a finite number of terms, whereas the exact solution for the harmonic gust requires an infinite number of terms. For the time-domain solution the appearance of the terms follows the natural temporal ordering of the problem in that new terms appear coincident with their appearance in the flow field. Similarity rules relating the skewed gust case to the nonskewed gust case, similar to those of Graham for the frequency domain, are derived for the time-domain solution. The first two terms of the time-domain solution are given as is the asymptotic solution for large time. The time-domain solution is well suited to the use of convolution and fast Fourier-transform techniques when the solution for a general gust is needed. Author

A87-30467
A STUDY OF WING-FUSELAGE INTERACTION
M. A. KHAN (University College, London, England) and T. CEBECI (Douglas Aircraft Co., Long Beach, CA) Journal of Engineering Mathematics (ISSN 0022-0833), vol. 20, no. 4, 1986, p. 367-379. refs

The problem addressed is that of the initial profile appropriate for the calculation of the boundary layer on the wing at a wing-body junction. The geometry considered is such that the fuselage boundary layer reaches the interaction region still attached and it is shown that when the wing has curvature the boundary-layer component of velocity normal to the wing is turned inviscidly through a right angle to provide a (in general) non-zero profile to initiate the wing calculation. Author

A87-31101*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
RECENT PROGRESS IN CIRCULATION CONTROL AERODYNAMICS
JACK N. NIELSEN (NASA, Ames Research Center, Moffett Field, CA) and JAMES C. BIGGERS (David W. Taylor Naval Ship Research and Development Center, Bethesda, MD) AIAA, Aerospace Sciences Meeting, 25th, Reno, NV, Jan. 12-15, 1987. 34 p. refs
(AIAA PAPER 87-0001)

A workshop on circulation control aerodynamics was held on February 19-21, 1986 at NASA Ames Research Center, Moffett Field, CA. The subjects covered were viscosity and turbulence of Coanda jets, circulation control airfoils, airfoil theory, circulation control airfoil and wing experiments, circulation control rotor theory, X-Wing technology, and fixed-wing technology. The unclassified papers of the Workshop are reviewed in this paper, and Workshop recommendations for future research and development on circulation control are presented. Author

A87-31104*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A STUDY OF A CIRCULATION CONTROL AIRFOIL WITH LEADING/TRAILING EDGE BLOWING
B. G. MCLACHLAN (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting, 25th, Reno, NV, Jan. 12-15, 1987. 10 p.
(AIAA PAPER 87-0157)

An experimental study of the flow past a two-dimensional circulation control airfoil under steady leading/trailing edge blowing was conducted. The effect of varying jet momentum on the flow field was determined through the use of flow visualization and airfoil force measurements. The flow patterns associated with

leading edge blowing, alone and simultaneously with trailing edge blowing, are described and correlated with the lift measurements. Author

A87-31106*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TWO- AND THREE-DIMENSIONAL VISCOUS COMPUTATIONS OF A HYPERSONIC INLET FLOW
WILLIAM G. KUNIK, THOMAS J. BENSON (NASA, Lewis Research Center, Cleveland, OH), WING-FAI NG, and ARTHUR TAYLOR (Virginia Polytechnic Institute and State University, Blacksburg) AIAA, Aerospace Sciences Meeting, 25th, Reno, NV, Jan. 12-15, 1987. 17 p. Previously announced in STAR as N87-15441. refs (AIAA PAPER 87-0283)

The three-dimensional parabolized Navier-Stokes code has been used to investigate the flow through a Mach 7.4 inlet. A two-dimensional parametric study of grid resolution, turbulence modeling and effect of gamma has been done and compared with experimental results. The results show that mesh resolution of the shock waves, real gas effects and turbulence length scaling are very important to get accurate results for hypersonic inlet flows. In addition a three-dimensional calculation of the Mach 7.4 inlet has been done on a straight sideplate configuration. The results show that the glancing shock/boundary layer interaction phenomena causes significant three-dimensional flow in the inlet. Author

A87-31127*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
NUMERICAL ANALYSIS OF FLOW THROUGH SCRAMJET ENGINE INLETS
AJAY KUMAR (NASA, Langley Research Center, Hampton, VA) NATO, AGARD, Symposium on Aerodynamics of Hypersonic Lifting Vehicles, Bristol, England, Apr. 6-9, 1987, Paper. 12 p. refs

A set of computer programs has been developed to analyze flow through supersonic combustion ramjet (scramjet) inlets. These programs solve either the two- or three-dimensional Euler/Navier-Stokes equations in full conservation form by MacCormack's explicit or explicit-implicit method. An algebraic two-layer eddy viscosity model is used for turbulent flow calculations. The programs are operational on Control Data CYBER-200 series vector-processing computer system and have been optimized to take maximum advantage of the vector processing capability of the system. Since their development, the programs have been extensively verified and used to analyze a number of very complex inlet configurations. In this paper, results are presented from two-dimensional, quasi-three-dimensional, and three-dimensional analyses of the inlet flow field to illustrate the use of the programs. Author

A87-31128*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
THE POTENTIAL INFLUENCE OF RAIN ON AIRFOIL PERFORMANCE
R. EARL DUNHAM, JR. (NASA, Langley Research Center, Hampton, VA) Institut von Karman de Dynamique des Fluides, Lecture Series on the Influence of Environmental Factors on Aircraft Wing Performance, Rhode-Saint-Genese, Belgium, Feb. 16-20, 1987, Paper. 14 p. refs

An overview of the most recent work conducted by NASA and others to study the potential influence of heavy rain on airfoil performance is presented. Previous analytical investigations are discussed, and some promising experimental methods for evaluating rain effects are examined. Special attention is given to the scaling analysis. Results from wind tunnel tests indicated that a conventional NACA 64-210 airfoil and an unflapped NACA 0012 airfoil have different sensitivities to a simulated rain spray. Very little effect was noted on the lift of the NACA 64-210 airfoil, while the NACA 0012 showed a considerable loss in maximum lift capability. With both airfoils in a flapped configuration, significant reductions in maximum lift capability were noted. For the NACA 64-210 airfoil, a reduction in the angle of attack for maximum lift was observed. For both airfoils, the effect of rain on lift occurred near the region of maximum lift; little effect was observed at lower angles of attack. I.S.

A87-31129*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SELECTED VORTEX-LIFT RESEARCH AT NASA LANGLEY RESEARCH CENTER
JAMES M. LUCKRING (NASA, Langley Research Center, Hampton, VA) International Vortex Flow Symposium on Euler Code Validation, Stockholm, Sweden, Oct. 1-3, 1986, Paper. 10 p. refs

A focused overview is presented of theoretical and experimental work underway at the NASA Langley Research Center pertinent to separation-induced vortex flows. The theoretical material selected for this review reflects the breadth of methodology in use and under development with limited discussion of details. The experimental discussion concentrates on planned testing of a delta wing in the NTF as well as other facilities. The historical perspective of this current work is also addressed. Author

A87-31151#
TRANSONIC AIRFOIL DESIGN PROCEDURE UTILIZING A NAVIER-STOKES ANALYSIS CODE
NAOKI HIROSE, SUSUMU TAKANASHI, and NOBUHIRO KAWAI (National Aerospace Laboratory, Tokyo, Japan) AIAA Journal (ISSN 0001-1452), vol. 25, March 1987, p. 353-359. Previously cited in issue 19, p. 2738, Accession no. A87-40708. refs

A87-31152#
TOTAL PRESSURE LOSS IN VORTICAL SOLUTIONS OF THE CONICAL EULER EQUATIONS
KENNETH G. POWELL, EARLL M. MURMAN, ERIC S. PEREZ, and JUDSON R. BARON (MIT, Cambridge, MA) AIAA Journal (ISSN 0001-1452), vol. 25, March 1987, p. 360-368. Previously cited in issue 19, p. 2741, Accession no. A85-40777. refs

A87-31153#
NAVIER-STOKES SIMULATIONS OF TRANSONIC FLOWS OVER A PRACTICAL WING CONFIGURATION
KOZO FUJII (National Aerospace Laboratory, Tokyo, Japan) and SHIGERU OBAYASHI AIAA Journal (ISSN 0001-1452), vol. 25, March 1987, p. 369, 370. Abridged. Previously cited in issue 07, p. 837, Accession no. A86-19922.

A87-31156#
ANALYSIS OF THREE-DIMENSIONAL SEPARATED FLOW WITH THE BOUNDARY-LAYER EQUATIONS
DAVID E. EDWARDS, JAMES E. CARTER (United Technologies Research Center, East Hartford, CT), and FRANK T. SMITH (University College, London, England) (Computational Fluid Dynamics Conference, 7th, Cincinnati, OH, July 15-17, 1985, Technical Papers, p. 99-107) AIAA Journal (ISSN 0001-1452), vol. 25, March 1987, p. 380-387. Previously cited in issue 19, p. 2802, Accession no. A85-40936. refs
(Contract N00014-81-C-0381)

A87-31158*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
EFFICIENT SIMULATION OF SEPARATED THREE-DIMENSIONAL VISCOUS FLOWS USING THE BOUNDARY-LAYER EQUATIONS
WILLIAM R. VAN DALSEM and JOSEPH L. STEGER AIAA Journal (ISSN 0001-1452), vol. 25, March 1987, p. 395-400. Previously cited in issue 03, p. 242, Accession no. A86-14452. refs

A87-31159#
HYBRID MACCORMACK AND IMPLICIT BEAM-WARMING ALGORITHMS FOR A SUPERSONIC COMPRESSION CORNER
C. ONG (Continuum Dynamics, Inc., Princeton, NJ) and D. KNIGHT (Rutgers University, New Brunswick, NJ) AIAA Journal (ISSN 0001-1452), vol. 25, March 1987, p. 401-407. Previously cited in issue 07, p. 830, Accession no. A86-19747. refs
(Contract AF-AFOSR-82-0040)

A87-31160#
COMPUTATION OF DYNAMIC STALL OF A NACA-0012 AIRFOIL
YOSHIFUMI SHIDA, KUNIO KUWAHARA, HIDEO TAKAMI (Tokyo, University, Japan), and KIYOAKI ONO (Nihon University, Tokyo, Japan) AIAA Journal (ISSN 0001-1452), vol. 25, March 1987, p. 408-413. Previously cited in issue 07, p. 829, Accession no. A86-19697. refs

A87-31162*# United Technologies Corp., East Hartford, Conn.
ANALYSIS OF TRANSITIONAL SEPARATION BUBBLES ON INFINITE SWEPT WINGS
R. L. DAVIS, J. E. CARTER (United Technologies Research Center, East Hartford, CT), and E. RESHOTKO (Case Western Reserve University, Cleveland, OH) AIAA Journal (ISSN 0001-1452), vol. 25, March 1987, p. 421-428. Previously cited in issue 19, p. 2741, Accession no. A85-40770. refs
(Contract NAS1-16585)

A87-31166#
SOLUTION OF INVERSE PROBLEM OF TRANSONIC FLOW ON S2 SURFACE USING AN ELLIPTIC ALGORITHM
HONGJI CHEN and CHUNG-HUA WU (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) AIAA Journal (ISSN 0001-1452), vol. 25, March 1987, p. 448-456. refs

The flow on an S2 surface with given V(theta) variation has been widely used in practice for direct and inverse problems of three-dimensional flows in turbomachines. The fact that the differential equations governing the flow remain elliptic as long as the meridional component of the absolute velocity is lower than the speed of sound, even in cases where the flow relative to the rotating blade is supersonic, is rigorously proved on the basis of the original system of first-order differential equations, as well as of the single second-order principal equations expressed in terms of the stream function. This provides a sound mathematical basis for solving the difficult transonic S2 surface flow, especially for the design problem, by a well-developed method for solving an elliptic equation. It is pointed out, however, that in so doing, it is important that the prescribed variation of V(theta) should have an appropriate abrupt change at the shock so that an accurate detailed flow variation throughout the rotor passage can be obtained. The preceding argument is illustrated by an example in which the transonic S(2,m) flow in a research axial-flow transonic compressor rotor is obtained by the use of a conventional method for solving the elliptic second-order partial differential equation for the stream function. Author

A87-31177*# National Aerospace Lab., Tokyo (Japan).
SELF-ADAPTIVE-GRID METHOD WITH APPLICATION TO AIRFOIL FLOW
KAZUHIRO NAKAHASHI (National Aerospace Laboratory, Tokyo, Japan) and GEORGE S. DEIWERT (NASA, Ames Research Center, Moffett Field, CA) (Computational Fluid Dynamics Conference, 7th, Cincinnati, OH, July 15-17, 1985, Technical Papers, p. 340-350) AIAA Journal (ISSN 0001-1452), vol. 25, April 1987, p. 513-520. Previously cited in issue 19, p. 2744, Accession no. A85-40957. refs

A87-31182*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
UPWIND NAVIER-STOKES SOLUTIONS FOR SEPARATED PERIODIC FLOWS
CHRISTOPHER L. RUMSEY, JAMES L. THOMAS, GARY P. WARREN, and GRACE C. LIU (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 25, April 1987, p. 535-541. Previously cited in issue 07, p. 831, Accession no. A86-19768. refs

A87-31195#
FORCE COEFFICIENTS FOR A NACA-0015 AIRFOIL UNDERGOING CONSTANT PITCH RATE MOTIONS
J. H. STRICKLAND (Sandia National Laboratories, Albuquerque, NM) and G. M. GRAHAM (Ohio University, Athens) AIAA Journal (ISSN 0001-1452), vol. 25, April 1987, p. 622-624. Previously cited in issue 07, p. 828, Accession no. A86-19631. refs
(Contract DE-AC04-76DP-00789)

A87-31196#
TRAILING-EDGE SEPARATION/STALL ALLEVIATION
M. J. WERLE, R. W. PATERSON, and W. M. PRESZ, JR. (United Technologies Research Center, East Hartford, CT) AIAA Journal (ISSN 0001-1452), vol. 25, April 1987, p. 624-626. refs

The three-dimensional relief mechanism presented for boundary layer avoidance of separation pressure rise employs a local contouring of the airfoil surface in the lateral direction in order to establish less unfavorable pressure gradients than the axial adverse pressure gradients that are encountered by the two-dimensional boundary layer. The local contouring takes the form of a rippled trailing edge geometry; it is shown by wind tunnel test results that higher maximum lift and/or lower drag at high lift are obtainable by these means. O.C.

A87-31197#
PRESSURE FLUCTUATION MEASUREMENTS WITH PASSIVE SHOCK/BOUNDARY-LAYER CONTROL
S. RAGHUNATHAN (Belfast, Queen's University, Northern Ireland) AIAA Journal (ISSN 0001-1452), vol. 25, April 1987, p. 626-628. SERC-supported research. refs

Attention is given to experimental results of pressure fluctuation measurements on a wall-mounted, circular-arc half-model in a transonic wind tunnel, with and without passive shock-wave/boundary-layer control, at Mach 1.3 and 1.37. It is established that the passive shock-wave/boundary-layer control effect in transonic flow can reduce pressure fluctuations in the region of shock/boundary-layer interaction to suppress buffeting. O.C.

A87-31285#
EXPERIMENTAL STUDY OF THE AERODYNAMICS OF INCIPIENT TORSIONAL STALL FLUTTER
F. O. CARTA and P. F. LORBER (United Technologies Research Center, East Hartford, CT) (Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2, p. 303-313) Journal of Propulsion and Power (ISSN 0748-4658), vol. 3, Mar.-Apr. 1987, p. 164-170. Research supported by the United Technologies Corp. Previously cited in issue 18, p. 2604, Accession no. A86-38912. refs

A87-31289#
EFFECT OF REYNOLDS NUMBER ON UPPER COWL FLOW SEPARATION
WERNER HOELMER, JAMES L. YOUNGHANS (General Electric Co., Cincinnati, OH), and JEAN CLAUDE RAYNAL (ONERA, LeFauga-Mauzac, France) (International Council of the Aeronautical Sciences, Congress, 14th, Toulouse, France, September 9-14, 1984, Proceedings. Volume 2, p. 1106-1115) Journal of Aircraft (ISSN 0021-8669), vol. 24, March 1987, p. 161-169. Previously cited in issue 22, p. 3174, Accession no. A84-45051. refs

A87-31290#
NUMERICAL SOLUTION OF THE DOWNWASH ASSOCIATED WITH A BLOWN-FLAP SYSTEM
ERIC LOTH and BARNES W. MCCORMICK (Pennsylvania State University, University Park) Journal of Aircraft (ISSN 0021-8669), vol. 24, March 1987, p. 170-175. Previously cited in issue 07, p. 835, Accession no. A86-19892. refs
(Contract N62269-84-C-0437)

A87-31291#
EFFECT OF SINK RATE ON GROUND EFFECT OF LOW-ASPECT-RATIO WINGS
RAY CHUNG CHANG (Aeronautical Research Laboratory, Taichung, Republic of China) and VINCENT U. MUIRHEAD (Kansas, University, Lawrence) Journal of Aircraft (ISSN 0021-8669), vol. 24, March 1987, p. 176-180. refs

An experimental investigation of dynamic ground effect has been conducted in the University of Kansas wind tunnel using delta wings of 60-, 70-, and 75-deg sweep, the XB-70 wing, and the F-104A wing. Both static and dynamic tests were made at a Reynolds number of 700,000. The investigation was restricted to conditions of constant sink rate (or flight path angle) and angle at attack. Test data have been compared to other test data, including dynamic flight test data of the XB-70 and F-104A. Limited flow visualization tests have been conducted. A significant dynamic effect was found for highly swept delta wings. Author

A87-31292#
PAN AIR ANALYSIS OF A TRANSPORT HIGH-LIFT CONFIGURATION
E. N. TINOCO, D. N. BALL, and F. A. RICE, II (Boeing Commercial Airplane Co., Seattle) Journal of Aircraft (ISSN 0021-8669), vol. 24, March 1987, p. 181-187. Previously cited in issue 17, p. 2462, Accession no. A86-37832. refs

A87-31293#
EULER SOLUTIONS FOR AIRCRAFT CONFIGURATIONS EMPLOYING UPPER-SURFACE BLOWING
ESSAM ATTA, SAAD RAGAB, and LARRY BIRCKELBAW (Lockheed-Georgia Co., Marietta) Journal of Aircraft (ISSN 0021-8669), vol. 24, March 1987, p. 188-194. Previously cited in issue 17, p. 2460, Accession no. A86-37805. refs

A87-31294#
VORTEX-INDUCED BENDING OSCILLATION OF A SWEPT WING
L. E. ERICSSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) Journal of Aircraft (ISSN 0021-8669), vol. 24, March 1987, p. 195-202. Previously cited in issue 17, p. 2460, Accession no. A86-37809. refs

A87-31295#
TRANSONIC WAVE DRAG ESTIMATION AND OPTIMIZATION USING THE NONLINEAR AREA RULE
N. MALMUTH (Rockwell International Corp., Thousand Oaks, CA), C. C. WU (California, University, Los Angeles), and J. D. COLE (Rensselaer Polytechnic Institute, Troy, NY) Journal of Aircraft (ISSN 0021-8669), vol. 24, March 1987, p. 203-210. Research supported by the Rockwell International Corp. Previously cited in issue 24, p. 3534, Accession no. A86-49582. refs

A87-31297*# Missouri Univ., Rolla.
FAST VISCOUS CORRECTION METHOD FOR FULL-POTENTIAL TRANSONIC WING ANALYSIS
SHEN C. LEE (Missouri-Rolla, University, Rolla), SCOTT D. THOMAS (Informatics General Corp., Palo Alto, CA), and TERRY L. HOLST (NASA, Ames Research Center, Moffett Field, CA) (International Council of the Aeronautical Sciences, Congress, 14th, Toulouse, France, September 9-14, 1984, Proceedings. Volume 1, p. 168-177) Journal of Aircraft (ISSN 0021-8669), vol. 24, March 1987, p. 218-220, abridged. Previously cited in issue 22, p. 3171, Accession no. A84-44946. refs
(Contract NAC2-OR-450-201)

A87-31298*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
VORTEX UNWINDING IN A TURBULENT BOUNDARY LAYER
CATHERINE B. MCGINLEY and GEORGE B. BEELER (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 24, March 1987, p. 221, 222. refs

The vortex unwinding method is used as a tool in performing vortex cancellation in a turbulent boundary layer. Sufficient reduction in the isotach variation was achieved to verify the usefulness of this technique, for the cases of both wall turbulence control and horseshoe vortex alleviation. More detailed measurements of vortex strength and position improve the optimization process and increase the amount of vortex unwinding. O.C.

A87-31299*#
SPANWISE PRESSURE DISTRIBUTION ON DELTA WING WITH LEADING-EDGE VORTEX FLAP
C. S. REDDY (New York, State University, Utica, NY) Journal of Aircraft (ISSN 0021-8669), vol. 24, March 1987, p. 222-224. refs
(Contract NSG-1561)

The aerodynamic characteristics of a highly swept planar delta wing employing conical leading edge flaps are numerically investigated, using a free vortex sheet method that is based on an advanced, three-dimensional inviscid flow panel method employing quadratic doublet distributions to represent the wing surface and the rolled-up vortex sheet and wake. Upward flap deflection shifts the negative pressure peak inboard of the basic wing and develops a significant suction pressure on the flap that then produces thrust component in the direction of flight; overall drag is thereby reduced. O.C.

N87-18533 Stanford Univ., Calif.
WIND TUNNEL RESONANCE BY THE FINITE ELEMENT METHOD Ph.D. Thesis
IN LEE 1986 123 p
Avail: Univ. Microfilms Order No. DA8619776

A finite element approach is developed for predicting the so-called resonant frequencies of subsonic wind tunnels with variously shaped cross sections. It is difficult to predict these frequencies analytically for an arbitrarily shaped cross section, especially in cases with transonic slots and a surrounding plenum chamber. In this case, the finite element method provides a useful numerical alternative. The resulting computer code has been applied to various wind tunnels including the NASA Ames Research Center 6' x 6' wind tunnel (rectangular cross section), and the NASA Langley Research Center 16' x 16' Transonic Dynamics Tunnel (octagonal cross section). The results are believed more accurate than theoretical values used in the past for an equivalent rectangular cross section. The effect of a plenum chamber on the resonance is examined in detail. Application of the finite element approach to the plenum chamber, as it interacts with the test section, gives more accurate results than what would be obtained by assuming an open tunnel. The typical transonic wind tunnel has very narrow slot openings. A method of including the viscosity effect on the resonant frequency is developed for this narrow slot case. Dissert. Abstr.

N87-18537*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
HELICOPTER BLADE-VORTEX INTERACTION LOCATIONS: SCALE-MODEL ACOUSTICS AND FREE-WAKE ANALYSIS RESULTS
DANNY R. HOAD Apr. 1987 106 p
(Contract DA PROJ. 1L1-62209-AH-76-A)
(NASA-TP-2658; L-16214; AVSCOM-TM-87-B-1; NAS 1.60:2658)
Avail: NTIS HC A06/MF A01 CSCL 01A

The results of a model rotor acoustic test in the Langley 4by 7-Meter Tunnel are used to evaluate a free-wake analytical technique. An acoustic triangulation technique is used to locate the position in the rotor disk where the blade-vortex interaction noise originates. These locations, along with results of the rotor free-wake analysis, are used to define the geometry of the blade-vortex interaction noise phenomena as well as to determine if the free-wake analysis is a capable diagnostic tool. Data from tests of two teetering rotor systems are used in these analyses. Author

N87-18538*# Grumman Aerospace Corp., Bethpage, N.Y.
AERODYNAMIC ANALYSIS FOR AIRCRAFT WITH NACELLES, PYLONS, AND WINGLETS AT TRANSONIC SPEEDS Final Report
CHARLES W. BOPPE Washington NASA Apr. 1987 148 p (Contract NAS1-14732)
(NASA-CR-4066; NAS 1.26:4066) Avail: NTIS HC A07/MF A01 CSCL 01A

A computational method has been developed to provide an analysis for complex realistic aircraft configurations at transonic speeds. Wing-fuselage configurations with various combinations of pods, pylons, nacelles, and winglets can be analyzed along with simpler shapes such as airfoils, isolated wings, and isolated bodies. The flexibility required for the treatment of such diverse geometries is obtained by using a multiple nested grid approach in the finite-difference relaxation scheme. Aircraft components (and their grid systems) can be added or removed as required. As a result, the computational method can be used in the same manner as a wind tunnel to study high-speed aerodynamic interference effects. The multiple grid approach also provides high boundary point density/cost ratio. High resolution pressure distributions can be obtained. Computed results are correlated with wind tunnel and flight data using four different transport configurations. Experimental/computational component interference effects are included for cases where data are available. The computer code used for these comparisons is described in the appendices. Author

N87-18539*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
SECONDARY STREAM AND EXCITATION EFFECTS ON TWO-DIMENSIONAL NOIZZLE PLUME CHARACTERISTICS
UWE H. VONGLAHN 1987 23 p Prepared for presentation at the 23rd Joint Propulsion Conference, San Diego, Calif., 29 Jun. - 2 Jul. 1987; sponsored in part by AIAA, SAE, ASME, and ASEE
(NASA-TM-89813; E-3457; NAS 1.15:89813; AIAA-87-2112)
Avail: NTIS HC A02/MF A01 CSCL 01A

In order to design two-dimensional nozzle/ejector systems for future high performance aircraft, the basic engine exhaust plume velocity and temperature decay as effected by the secondary stream (ejector) and decay augmentation means must be assessed. Included in the assessment of the plume decay characteristics are the effects of nozzle aspect ratio and nozzle/ejector flow conditions. Nozzle/ejector plume decay can be enhanced by suitable excitation of the plume shear layers. Correlation of these factors are developed in a manner similar to those previously developed for conic and dual-flow nozzle plumes. Author

N87-18540*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TWO-DIMENSIONAL NOZZLE PLUME CHARACTERISTICS
UWE H. VONGLAHN 1987 23 p Prepared for presentation at the 23rd Joint Propulsion Conference, San Diego, Calif., 29 Jun. - 2 Jul. 1987; sponsored in part by AIAA, SAE, ASME, and ASEE
(NASA-TM-89812; E-3456; NAS 1.15:89812; AIAA-87-2111)
Avail: NTIS HC A02/MF A01 CSCL 01A

Future high performance aircraft will likely feature asymmetric or two-dimensional nozzles with or without ejectors. In order to design two-dimensional nozzle/ejector systems of minimum size and weight, the plume decay and spreading characteristics of basic two-dimensional nozzles must first be established. The present work deals with the experimental analyses of these plume characteristics and includes the effects of nozzle aspect ratio and flow conditions (jet Mach number and temperature) on the plume decay and spreading of two-dimensional nozzles. Correlations including these variables are developed in a manner similar to those previously developed successfully for conic and dual-flow plumes. Author

N87-18543# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
COMPUTATIONAL DRAG ANALYSIS AND MINIMIZATION. MISSION IMPOSSIBLE?
J. W. SLOOFF 6 Nov. 1986 28 p Presented at the AGARD Special Course on Aircraft Drag Prediction and Reduction, Rhode-Saint-Genese, Belgium, 20-23 May 1985, and Hampton, Va., 5-8 Aug. 1985
(NLR-MP-85080-U; ETN-87-99295) Avail: NTIS HC A03/MF A01

Drag prediction, analysis, and minimization by computational fluid dynamics (CFD) techniques based on inviscid and viscous inviscid interaction flow models are discussed. Classical and computational means of distinguishing between various drag components; ways to obtain values of drag components from CFD codes and the problem of accuracy; examples of computational drag diagnostics; and computational drag minimization are included. The discussion is limited to sub/transonic transport (wing) aerodynamics, but should be applicable to sub/transonic aerodynamics of fighter aircraft. ESA

N87-18544# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
MULTICOMPONENT AIRCRAFT TRANSONIC INVISCID COMPUTATION SYSTEM (MATRICS) TRANSONIC POTENTIAL FLOW CALCULATIONS ABOUT TRANSPORT AIRCRAFT
J. VANDERVOOREN, A. J. VANDERWEES, and J. H. MEELKER 14 Mar. 1985 18 p Presented at the AGARD Symposium on Applications of Computational Fluid Dynamics in Aeronautics, Aix-en-Provence, France, 7-10 Apr. 1986
(Contract NIVR-311.1-1076)
(NLR-MP-86019-U; ETN-87-99303) Avail: NTIS HC A02/MF A01

A system under development for the calculation of (potential) flow about transport aircraft is outlined. Details of the full potential flow solver are given. Computer power required and informatics aspects are covered. Results of computations are discussed. ESA

N87-18545# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
METHODS FOR NUMERICAL SIMULATION OF LEADING-EDGE VORTEX FLOW
H. W. M. HOEIJMAKERS 20 Jun. 1984 45 p Presented at a Workshop on Vortex Dominated Flows, Hampton, Va., 9-10 Jul. 1985
(NLR-MP-85052-U; B8673827; ETN-87-99508) Avail: NTIS HC A03/MF A01

Computational methods to simulate the aerodynamics of configurations with leading-edge vortex flow are discussed with a view to three-dimensional steady flow applications. The strengths and weakness of the methods are indicated and results of different methods are compared. ESA

N87-18861*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
THE CASE FOR AERODYNAMIC SENSITIVITY ANALYSIS
JAROSLAW SOBIESZCZANSKI-SOBIESKI *In its* Sensitivity Analysis in Engineering p 77-96 Feb. 1987
Avail: NTIS HC A16/MF A01 CSCL 01A

No specific solutions are offered, nor verified by applications, for its subject problem which is sensitivity analysis in Computational Fluid Dynamics (CFD). Instead, a plea is made to the CFD community for extending their present capability to include sensitivity analysis. The plea is made from the viewpoint of an aeronautical engineer, not an expert in CFD methods, who needs the sensitivity information when working at the junction of aerodynamics, structures, active controls, and other disciplines whose inputs need to be integrated in aircraft design. Author

N87-19350*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NUMERICAL SIMULATION OF TRANSONIC PROPELLER FLOW USING A 3-DIMENSIONAL SMALL DISTURBANCE CODE EMPLOYING NOVEL HELICAL COORDINATES
AARON SNYDER 1987 23 p Prepared for presentation at the 8th Computational Fluid Dynamics Conference, Honolulu, Hawaii, 9-11 Jun. 1987; sponsored by AIAA
(NASA-TM-89826; E-3475; NAS 1.15:89826) Avail: NTIS HC A02/MF A01 CSCL 01A

The numerical simulation of three-dimensional transonic flow about propeller blades is discussed. The equations for the unsteady potential flow about propellers is given for an arbitrary coordinate system. From this the small disturbance form of the equation is derived for a new helical coordinate system. The new coordinate system is suited to propeller flow and allows cascade boundary conditions to be applied straightforward. A numerical scheme is employed which solves the steady flow as an asymptotic limit of unsteady flow. Solutions are presented for subsonic and transonic flow about a 5 percent thick bicircular arc blade of an eight bladed cascade. Both high and low advance ratio cases are given which include a lifting case as well as nonlifting cases. The nonlifting cases are compared to solutions from a Euler code. Author

N87-19355# Naval Postgraduate School, Monterey, Calif.
CONTROLLED DIFFUSION COMPRESSOR BLADE WAKE MEASUREMENTS M.S. Thesis
JOHN W. DREON, JR. Sep. 1986 139 p
(AD-A175141) Avail: NTIS HC A07/MF A01 CSCL 20D

A controlled-diffusion compressor stator blade-element design was re-tested in a subsonic cascade wind tunnel to obtain data with which to assess viscous computational prediction methods. Tests were conducted near design and toward stall conditions at Mach 0.28 and Reynolds number of 774000. Loss coefficient, diffusion factor and AVDR (Axial Velocity Density Ratio) were determined by mass averaging pneumatic pressure probe survey measurements. Wake velocity profiles were measured from 0.12 to 1.77 chordlengths downstream. Concentration was placed on the verifications of accuracy by careful calibration, multiplicity and exchange of survey probes. Cylindrical probes were found not to measure wake yaw angles as accurately as conical probes. Experimental results showed that losses were dependent on Reynolds number and that all blade-element performances were independent of the down stream axial location at which they were determined. GRA

N87-19356# Flow Research, Inc., Kent, Wash.
DEVELOPMENT OF A DEVICE FOR CONTROLLING THE LEADING EDGE VORTICES ON A DELTA WING Final Report, 1 Jul. - 31 Dec. 1985
MOHAMED GAD-EL-HAK Jan. 1986 86 p
(Contract F49620-85-C-0131)
(AD-A175207; FLOW-RR-357; AFOSR-86-2128TR) Avail: NTIS HC A05/MF A01 CSCL 20D

Recent experimental observations have shown that a leading edge vortex on a delta wing at constant angle of attack consists of a series of discrete smaller vortices. These vortices pair, much the same as in a free shear layer. A device is proposed to modulate the shedding and the pairing of the discrete vortices by mechanically or acoustically perturbing the leading edge of a delta wing. By applying the perturbation to both leading edges, the total lift of a wing will be altered; alternatively, by using the perturbation preferentially on only one side of the wing, the rolling moment around the axis of symmetry of the aircraft is controlled. The proposed device will enable the pilot of a fighter aircraft to achieve a previously unattained degree of maneuverability. During the first phase of this research, experiments were conducted in both a water towing tank and a high speed wind tunnel. Flow visualization, fast-response velocity probe surveys, as well as force measurements were conducted to assess the performance of the proposed vortex control device and, more importantly at this early stage of the research, to understand the complex flow field under consideration. GRA

N87-19358# National Aeronautical Establishment, Ottawa (Ontario).
FURTHER STUDIES ON THE 21% THICK, SUPERCRITICAL NLF AIRFOIL NAE (NATIONAL AERONAUTICAL ESTABLISHMENT) 68-060-21:1 Aeronautical Note
M. KHALID and D. J. JONES Sep. 1986 36 p
(AD-A175923; NAE-AN-41; NRC-26453) Avail: NTIS HC A03/MF A01 CSCL 01C

Further wind tunnel tests have been carried out on the NAE 10 in. chord supercritical NLF airfoil NAE 68-060-21:1. In previous tests, this airfoil showed very low drag levels when free transition was allowed on the model. In the main part of about 7, 9 and 13 million, transition was fixed at 7% and 15% on upper and lower surfaces respectively. It is observed that there is a substantial loss of lift under these conditions which appears to be associated with boundary layer thickening on the lower surface causing decambering near the trailing edge. Additional tests were also carried out under free transition at other Reynolds numbers than those previously used. The same drag bucket behavior near the design flow conditions was observed. GRA

N87-19363# Bristol Univ. (England). Dept. of Aeronautical Engineering.
THE PERFORMANCE OF AEROFOILS WITH LIFT DEVICES AT LOW REYNOLDS NUMBERS FOR USE ON RPV WINGS B.S. Thesis
S. T. KOHLER and P. PITHIYA Jun. 1985 57 p
(BU-332; ETN-87-99195) Avail: NTIS HC A04/MF A01

The effect of low Reynolds numbers upon the characteristics of simple high lift devices for operation on remotely piloted vehicle wings was tested. The wing section profiles and devices tested were: a NACA 23015 airfoil with a 30% chord plain flap, and a NACA 4415 airfoil with a 23% chord split flap, a 23% chord zap flap, a 20% chord Kruger flap, and a combination of the Kruger and zap flaps. Variations in lift, drag, and pitching moment of these devices were investigated over a Reynolds number range of 140,000 to 300,000. No serious deterioration in the capability of the devices is observed, however, reductions in lift which result in positive increments in pitching moments do occur as the Reynolds number is reduced. The relative merits of the combinations are unchanged as the Reynolds number is reduced, the greatest lift increase coupled with a smooth pitching moment being displayed by the Kruger and zap flap combination. ESA

N87-19364# Bristol Univ. (England). Dept. of Aeronautical Engineering.
LIFT-INTERFERENCE AND BLOCKAGE CORRECTIONS FOR A TWO-DIMENSIONAL AEROFOIL DURING A SUDDEN CHANGE OF INCIDENCE B.S. Thesis
S. C. LEACH and A. D. MACAULAY Jun. 1985 35 p
(BU-334; ETN-87-99197) Avail: NTIS HC A03/MF A01

The applicability of standard lift correction formulas to a two-dimensional NACA 0015 airfoil (chord 67 mm, span 100 mm) was demonstrated using a suction-type wind tunnel with variations from open-jet to fully-closed working sections, for velocities of up to 32.6 m/sec (Reynolds number 161,000). However, measurements of static pressures around the airfoil surface are unreliable, variations in the corrected value being an order of magnitude greater than the corrections themselves. Thus no detailed analysis of the pressures during a sudden change of incidence was possible, with no intermediate trend apparent. ESA

N87-19366# Bristol Univ. (England). Dept. of Aeronautical Engineering.
AN INVESTIGATION INTO THE STATIC PRESSURE DISTRIBUTION AND LIFT REDUCTION OVER AN AEROFOIL DUE TO A FORWARD SPOILER B.S. Thesis
M. NANRA and K. MART Jun. 1986 58 p
(BU-346; ETN-87-99208) Avail: NTIS HC A04/MF A01

The static behavior of a spoiler located farther forward toward the leading edge than is normal was studied. Upper and lower surface regions forward of $x/c = 0.3$ were examined by recording

static pressure data around the airfoil at mid-span. Various spoiler angles (relative to local airfoil surface) and spoiler sizes were used. All tests were performed on a 15% thick RAF 48 airfoil extending completely across a tunnel of width 3c. Spoiler hinge positions forward of x/c = 0.2 do not give very satisfactory results. Spoilers located on the under surface of the airfoil do not cause any great effect on the overall pressure distribution and hence do not give any significant reductions in lift. The region over the top surface of the airfoil around quarter-chord is seen to be the most feasible area in which to locate a leading edge spoiler. ESA

03

AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

A87-27935#
INTERACTION OF AIRCRAFT AND EXPLOSIVE ERUPTION CLOUDS - A VOLCANOLOGIST'S PERSPECTIVE
WILLIAM I. ROSE (Michigan Technological University, Houghton) AIAA Journal (ISSN 0001-1452), vol. 25, Jan. 1987, p. 52-58. refs

The dominant solid substance in volcanic eruption clouds is silicate glass, in the form of particles which, with a melting point in the 800-1200 C range, pose a significant hazard for aircraft gas turbine engines. Plinian eruptions, which derive their violent ejection energy from the explosion of previously dissolved gases, propel these silicate glass particles to altitudes of up to 60 km, from which they are dispersed over large areas by prevailing winds. It is suggested that satellite surveillance of potential eruption sites be increased, and that navigational maps showing the disposition of air routes to such volcanic sites should be distributed. O.C.

A87-28152
SEARCH STRATEGY FOR THE POTENTIAL COLLISION BETWEEN TWO AIRCRAFT [STRATEGICKE VYHLEDAVANI KONFLIKTU DVOJICE LETADEL]
KAREL HAVEL Zpravodaj VZLU (ISSN 0044-5355), no. 5, 1986, p. 249-259. In Czech.

An algorithm is developed for identifying the conflicting flight paths of two aircraft which may lead to a collision. An aircraft is approximated by a point, and its flight path is approximated by segments of a straight line, the number of the segments corresponding to the number of velocity vector changes. A search for a possible conflict is conducted for all combinations of the straight segments for the flight trajectory of each aircraft. A geographic filter and a time filter are used to facilitate the search. Details of the search procedure are briefly discussed. V.L.

A87-29584
WIND SHEAR; PROCEEDINGS OF THE AEROSPACE TECHNOLOGY CONFERENCE AND EXPOSITION, LONG BEACH, CA, OCT. 13-16, 1986
Conference and Exposition sponsored by SAE. Warrendale, PA, Society of Automotive Engineers, Inc. (SAE SP-681), 1986, 74 p. For individual items see A87-29585 to A87-29590.
(SAE SP-681)

The present conference considers the current record on windshear-related aircraft accidents and the prospects for their future prevention, the characteristics of aircraft performance and control in downburst wind shear phenomena, and the insights gained to date from the analysis of windshear-related accidents and incidents. Also discussed are piloting procedures that may be implemented during microburst phenomena, an overview of the FAA's integrated Wind Shear Program Plan, and the 'CLAWS' program experience at Denver, Colorado with respect to operational wind shear detection and warning. O.C.

A87-29585
SUMMARY OF WINDSHEAR ACCIDENTS AND VIEWS ABOUT PREVENTION
WILLIAM G. LAYNOR (National Transportation Safety Board, Washington, DC) IN: Wind shear; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 1-12. refs
(SAE PAPER 861697)

Since 1970, The U.S. National Transportation Safety Board has identified low altitude encounters with windshear as causes or contributing factors in 18 accidents involving transport category aircraft. Seven of the encounters were fatal and resulted in 575 deaths. Attention is presently given to the determinations arrived at by investigations of six specific accidents, as well as to the recommendations and implementations progress made since 1970 by the FAA, NASA, NOAA, and the airlines and aircraft manufacturers. O.C.

A87-29587
INSIGHT GAINED FROM ANALYSIS OF WINDSHEAR RELATED ACCIDENTS AND INCIDENTS
CHARLES R. HIGGINS and EDWARD L. BAKER (Boeing Commercial Airplane Co., Seattle, WA) IN: Wind shear; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 39-47.
(SAE PAPER 861699)

Piloted simulator recreations of accident scenarios furnish both crew perception/response-related and engineering factors-related accounts of windshear accidents and incidents encountered during takeoffs and landing approaches. It is inferred from analyses of crew and aircraft behavior in these simulations that windshear avoidance is the best defense; windshear strength exceeding any conceivable airliner's performance capability has been repeatedly measured. Windshear recognition, however, is difficult, and it is recommended that flight path be controlled through pitch attitude adjustments. The flight crew must be highly coordinated to recognize and respond to windshears. O.C.

A87-29589
OVERVIEW OF THE INTEGRATED FEDERAL AVIATION ADMINISTRATION (FAA) WIND SHEAR PROGRAM PLAN
GEORGE C. HAY (01FAA, Washington, DC) IN: Wind shear; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 61-64.
(SAE PAPER 861702)

Presented in this paper are efforts undertaken by the Federal Aviation Administration (FAA) to address the wind shear issue, as stated in the Integrated FAA Wind Shear Program Plan. Program elements include Education and Training, Ground Sensors, Airborne Sensors and Flight Guidance Systems, Terminal Information Systems and Low-Level Meteorological Hazard Characterization. The plan emphasizes how each program element operationally relates to the others and incrementally adds to the overall National Airspace Safety. Besides the FAA, other branches of the government, the industry, the aviation community and the academic sector are also involved in the development of this program.
Author

A87-29590* National Center for Atmospheric Research, Boulder, Colo.
OPERATIONAL WIND SHEAR DETECTION AND WARNING - THE 'CLAWS' EXPERIENCE AT DENVER AND FUTURE OBJECTIVES
JOHN MCCARTHY, JAMES W. WILSON, and MARK R. HJELMFELT (National Center for Atmospheric Research, Boulder, CO) IN: Wind shear; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 65-69. Research supported by the National Center for Atmospheric Research, NSF, and NOAA. refs
(Contract DOT-FA01-82-Y-10513; NASA ORDER H-59314-B)
(SAE PAPER 861847)

An operational wind shear detection and warning experiment was conducted at Denver's Stapleton International Airport in summer 1984. Based on meteorological interpretation of scope displays from a Doppler weather radar, warnings were transmitted to the air traffic control tower via voice radio. Analyses of results indicated real skill in daily microburst forecasts and very short-term (less than 5-min) warnings. Wind shift advisories with 15-30 min forecasts, permitted more efficient runway reconfigurations. Potential fuel savings were estimated at $875,000/yr at Stapleton. The philosophy of future development toward an automated, operational system is discussed. Author

A87-30003
ESCAPING FROM BURNING CABINS - ARE SMOKE HOODS THE ANSWER?
BRON REK Interavia (ISSN 0020-5168), vol. 42, Jan. 1987, p. 37, 38.

The production of dense smoke, toxic polymer-combustion gases, and carbon monoxide by airliner fires has prompted studies of the possibility of equipping passengers with smoke hoods or other emergency respiration equipment. Medical authorities recommend that the eyes should be protected from irritation by noxious fumes to facilitate cabin evacuation efforts. Attention is also given to the prospects for passenger injury from crash-dislodged cabin objects, including seats, and the question of how many emergency exits should be available on a B 747. O.C.

A87-31105#
IN-FLIGHT ICE ACCRETION CHARACTERISTICS OF ROTOR BLADE AIRFOIL SECTIONS
DAUMANTS BELTE (U.S. Army, Aviation Engineering Flight Activity, Edwards AFB, OH) AIAA, Aerospace Sciences Meeting, 25th, Reno, NV, Jan. 12-15, 1987. 11 p. refs
(AIAA PAPER 87-0176)

Airfoil sections representing the UH-1H and UH-60A helicopter rotor blades in three scale sizes were flown in both natural icing conditions and the artificial cloud produced by the Helicopter Icing Spray System. The testbed aircraft was a JU-21A with a structural framework over the left wing to hold two airfoil sections of 18-inch span simultaneously. Cameras sighted along the leading edge of each airfoil took timed sequence photographs against a background grid to show progressive stages of ice accumulation. Airfoil incidence angles were varied from 0 to 9 deg between icing immersions, which typically lasted from 10 to 20 minutes each. Ice profile tracings made from the photographs allowed the effects on ice accretions of natural and artificial cloud types, different temperatures, incidence angles, airfoil section types, and airfoil scale sizes to be compared. Limitations of this ice shape technique, included an airspeed gradient along the blade span, boundary layer effects against the outboard wall, observation angle parallax, and perspective view distortion along the leading edge. Analysis of the ice shape results indicated a lower than expected thickness accretion rate for artificial icing conditions, and showed that artificial ice formations begin to assume streamlined profile characteristics at temperatures 3 to 4 C warmer than for natural ice. Author

A87-31135#
CRASHWORTHINESS ANALYSIS OF TRANSPORT AIRCRAFT SEATS
D. H. LAANANEN (Arizona State University, Tempe) and A. O. BOLUKBASI (Simula, Inc., Phoenix, AZ) IN: Computers in engineering 1986; Proceedings of the International Conference and Exhibition, Chicago, IL, July 20-24, 1986. Volume 1. New York, American Society of Mechanical Engineers, 1986, p. 293-298. refs
(Contract DOT-FA03-83-C-00036)

A three-dimensional mathematical model of a seat, occupants, and restraint system has been developed for use in transport aircraft crashworthiness analyses. The finite element seat model can accommodate large displacements, nonlinear material behavior, and local buckling of tubular elements. Provision for simulation of floor warping has also been included. One, two, or three passengers can be simulated. The model of each passenger consists of twelve segments whose dimensions and inertial properties have been determined from studies of human body anthropometry and from measurements of anthropomorphic dummies. The dynamic test of a three-passenger seat, modified to include an energy-absorbing capability, is described, and test data are compared with computer simulation results. Author

N87-18521*# Massachusetts Inst. of Tech., Cambridge. Flight Transportation Lab.
INVESTIGATION OF AIR TRANSPORT TECHNOLOGY AT MASSACHUSETTS INSTITUTE OF TECHNOLOGY, 1983
ROBERT W. SIMPSON *In* NASA Langley Research Center Joint University Program for Air Transportation Research, 1983 p 3-9 Mar. 1987
Avail: NTIS HC A05/MF A01 CSCL 01C

The limitations in providing both centerline and altitude guidance for runways in good Loran-C signal coverage were determined. The high data rate (10/sec) and good repeatable accuracy of Loran-C indicate that it will be possible to provide the pilot with continuous, cross pointer display of guidance information similar to that provided by ILS/MLS, at least when good signal-to-noise ratios and good geometry from Loran-C Lines of Position (LOP) exist at the airport. B.G.

N87-18524*# Ohio Univ., Athens. Dept. of Electrical and Computer Engineering.
AIR TRANSPORTATION TECHNOLOGY PROGRAM AT OHIO UNIVERSITY, 1983
RICHARD H. MCFARLAND and JAMES D. NICKUM *In* NASA Langley Research Center Joint University Program for Air Transportation Research, 1983 p 23-25 Mar. 1987
Avail: NTIS HC A05/MF A01 CSCL 01C

The purpose is to provide a research tool, a receiver, such that engineers interested in examining Loran-C performance, usefulness, and other properties will have a flexible, modifiable, and well-known piece of receiving hardware. The significant improvements to the Loran-C receiver are summarized. B.G.

N87-18528*# Princeton Univ., N. J. Dept. of Mechanical and Aerospace Engineering.
INVESTIGATION OF AIR TRANSPORTATION TECHNOLOGY AT PRINCETON UNIVERSITY, 1983
ROBERT F. STENGEL *In* NASA Langley Research Center Joint University Program for Air Transportation Research, 1983 p 51-56 Mar. 1987
Avail: NTIS HC A05/MF A01 CSCL 01C

Progress is discussed for each of the following areas: voice recognition technology for flight control; guidance and control strategies for penetration of microbursts and wind shear; application of artificial intelligence in flight control systems; and computer-aided aircraft design. B.G.

N87-18531*# Princeton Univ., N. J. Dept. of Mechanical and Aerospace Engineering.
DEVELOPMENT OF CONTROL STRATEGIES FOR SAFE MICROBURST PENETRATION: A PROGRESS REPORT
MARK L. PSIAKI *In* NASA Langley Research Center Joint University Program for Air Transportation Research, 1983 p73-82 Mar. 1987
Avail: NTIS HC A05/MF A01 CSCL 01C

A single-engine, propeller-driven, general-aviation model was incorporated into the nonlinear simulation and into the linear analysis of root loci and frequency response. Full-scale wind tunnel data provided its aerodynamic model, and the thrust model included the airspeed dependent effects of power and propeller efficiency. Also, the parameters of the Jet Transport model were changed to correspond more closely to the Boeing 727. In order to study their effects on steady-state repsonse to vertical wind inputs, altitude and total specific energy (air-relative and inertial) feedback capabilities were added to the nonlinear and linear models. Multiloop system design goals were defined. Attempts were made to develop controllers which achieved these goals. B.G.

N87-18547*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
OPTIMIZATION OF AIRCRAFT INTERIOR PANELS
DEMETRIUS A. KOURTIDES and WILLARD D. ROPER (Hercules, Inc., Magna, Utah) Jul. 1986 43 p
(NASA-TM-88340; A-86209; NAS 1.15:88340; DOT/FAA-CT-86)
Avail: NTIS HC A03/MF A01 CSCL 01C

Eight different graphite composite panels were fabricated using four different resin matrices. The resin matrices included Hercules 71775, a blend of vinylpolystyrpyridine and bismaleimide, H795, a bismaleimide, Cycom 6162, a phenolic, and PSP 6022M, a polystyrylpyridine. Graphite panels were fabricated using fabric or unidirectional tape. This report describes the processes for preparing these panels and some of their mechanical, thermal and flammability properties. Panel properties are compared with state-of-the-art epoxy fiberglass composite panels. Author

N87-18548# Naval Safety Center, Norfolk, Va.
READINESS AND RETENTION. PILOT FLIGHT EXPERIENCE AND AIRCRAFT MISHAPS Final Report, 1977 - 1985
MICHAEL S. BOROWSKY 24 Jun. 1986 19 p
(AD-A173911) Avail: NTIS HC A02/MF A01 CSCL 01B

Budget constraints which yield reductions in flight hours per pilot imply an eventual shifting of the distribution of flight hours. Analyses show that the rate of pilot error mishaps tends to decrease as pilots' flight experience increase. These data suggest, therefore, that as the experience levels of naval aviators decline, the mishap rate will increase. The experience levels of Training Command/Fleet Readiness Squadron instructor pilots would also tend to decrease, thereby contributing both directly and indirectly to an increased mishap rate. The total effect will, of course, also depend upon aggregate flight hour reductions as well as pilot retention rates. GRA

N87-18549# Simula, Inc., Phoenix, Ariz.
DELETHALIZED CYCLIC CONTROL STICK Final Report, 27 Sep. 1984 - 8 Jul. 1986
C. N. WHITAKER and R. E. ZIMMERMAN Jul. 1986 90 p
(Contract DAAK51-84-C-0022; DA PROJ. 1L1-62209-AH-76)
(AD-A173931; TR-86408; USAAVSCOM-TR-86-D-5) Avail: NTIS HC A05/MF A01 CSCL 01D

In November 1983, the final report for the initial crashworthy cyclic control stick effort was published. The report detailed the development and testing of a purely mechanical self-contained crashworthy cyclic control stick equipped with load-limiting and separating joint. The joint was to limit impact loads transmitted to a crewmember. This report covers the additional development and testing of this concept by Simula Inc. to further delethalize the separating crashworthy cyclic control stick. Using an impact load-limiting grip pad and reduction of the moving mass to reduce the inertial forces, two configurations were subjected to static and dynamic pendululm testings. Additional destructive static testing was performed on both configurations, and one design was selected and tested in a full-scale dynamic test using an anthropomorphic dummy and a vertically stroking UH-60A Black Hawk crewseat. Testing demonstrated that the delethalized stick worked as intended when struck by the dummy. It also showed that the loads transmitted to the dummy were far less than with conventional sticks. GRA

N87-18550# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.
AIRCRAFT ACCIDENT REPORTS: BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION, ISSUE NUMBER 13, 1985 ACCIDENTS
25 Aug. 1986 398 p
(PB86-916927; NTSB-AAB-86-27) Avail: NTIS HC A17/MF A01; also available on subscription, North American Continent HC $185.00/year, all others write for quote CSCL 01B

The publication contains selected aircraft accident reports in Brief Formal occurring in U.S. civil and foreign aviation operations during Calendar Year 1985. Approximately 200 General Aviation and Air carrier accidents contained in the publication represent a random selection. The publication is issued irregularly, normally eighteen times each year. The Brief Format represents the facts, conditions, circumstances and probable cause(s) for each accident. GRA

N87-18551# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.
AIRCRAFT ACCIDENT REPORTS: BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION, ISSUE NUMBER 12, 1985 ACCIDENTS
5 Sep. 1986 392 p
(PB86-916926; NTSB-AAB-86-26-ISSUE-12) Avail: NTIS HC A17/MF A01; also available on subscription, North American Continent HC $185.00/year, all others write for quote CSCL 01B

The publication contains selected aircraft accident reports in Brief Format occurring in U.S. civil and foreign aviation operations during Calendar Year 1985. Approximately 200 General Aviation and Air Carrier accident reports in the publication represent a random selection. The publication is issued irregularly, normally eighteen times each year. The Brief Format represents the facts, conditions, circumstances and probable cause(s) for each accident. GRA

N87-18552# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.
AIRCRAFT ACCIDENT REPORTS: BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION, ISSUE NUMBER 10, 1985 ACCIDENTS
5 Sep. 1986 408 p
(PB86-916924; NTSB-AAB-86-24) Avail: NTIS HC A18/MF A01; also available on subscription, North American Continent HC $185.00/year, all others write for quote CSCL 01B

The publication contains selected aircraft accident reports in Brief Format occurring in U.S. civil and foreign aviation operations during Calendar Year 1985. Approximately 200 General Aviation and Air Carrier accidents contained in the publication represent a random selection. The publication is issued irregularly, normally eighteen times each year. The Brief Format represents the facts, conditions, circumstances and probable causes(s) for each accident. GRA

N87-18553# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.
AIRCRAFT ACCIDENT REPORTS: BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION, ISSUE NUMBER 9 OF 1985 ACCIDENTS
8 Aug. 1986 405 p
(PB86-916923; NTSB-AAB-86-23) Avail: NTIS HC A18/MF A01; also available on subscription, North American Continent HC $185.00/year, all others write for quote CSCL 01B

The publication contains selected aircraft accident reports in Brief Formation occurring in U.S. civil and foreign aviation operations during Calendar Year 1985. Approximately 200 General Aviation and Air Carrier accidents contained in the publication represent a random selection. The publication is issued irregularly, normally eighteen times each year. The Brief Format represents the facts, conditions, circumstances and probable cause(s) for each accident. GRA

N87-18554# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.
AIRCRAFT ACCIDENT REPORTS: BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION, ISSUE NUMBER 8, 1985 ACCIDENTS
15 Sep. 1986 396 p
(PB86-916922; NTSB-AAB-86-22) Avail: NTIS HC A17/MF A01; also avaiable on subscription, North American Continent HC $185.00/year, all others write for quote CSCL 01B

The publication contains selected aircraft accident reports in Brief Format occurring in U.S. civil and foreign aviation operations during Calendar Year 1985. Approximately 200 General Aviation and Air Carrier accidents contained in the publication represent a random selection. The publication is issued irregularly, normally eighteen times each year. The Brief Format represents the facts, conditions, circumstances and probable causes(s) for each accident. GRA

N87-18555# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.
AIRCRAFT ACCIDENT REPORTS: BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION, ISSUE NUMBER 17 OF 1984 ACCIDENTS
Jul. 1986 266 p
(PB86-916913; NTSB-AAB-86-13) Avail: NTIS HC A12/MF A01; also available on subscription, North American Continent HC $185.00/year, all others write for quote CSCL 01B

The publication contains selected aircraft accident reports in Brief Format occurring in U.S. civil and foreign aviation operations during Calendar Year 1984. Approximately 200 General Aviation and Air Carrier accidents contained in the publication represent a random selection. The publication is issued irregularly, normally eighteen times each year. The Brief Format represents the facts, conditions, circumstances and probable cause(s) for each accident. GRA

N87-18556# National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.
AIRCRAFT ACCIDENT REPORTS: BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION ISSUE NUMBER 16 OF 1984 ACCIDENTS
15 Jul. 1986 596 p
(PB86-916912; NTSB-AAB-86-12) Avail: NTIS HC A25/MF A01; also available on subscription, North American Continent HC $185.00/year, all others write for quote CSCL 01B

The publication contains selected aircraft accident reports in Brief Format occurring in U.S. civil and foreign aviation operations during Calendar Year 1984. Approximately 200 General Aviation and Air Carrier accidents contained in this publication represent a random selection. This publication is issued irregularly, normally eighteen times each year. The Brief Format represents the facts, conditions, circumstances and probable cause(s) for each accident. GRA

N87-19367# National Transportation Safety Board, Washington, D. C. Bureau of Safety Programs.
ANNUAL REVIEW OF AIRCRAFT ACCIDENT DATA US GENERAL AVIATION, CALENDAR YEAR 1983
8 Jan. 1987 252 p
(PB87-161915; NTSB-ARG-87-01) Avail: NTIS HC A12/MF A01

A statistical compilation and review of general aviation accidents which occurred in 1983 in the United States, its territories and possessions, and in international waters is presented. The accidents are all those involving U.S. registered aircraft not conducting air carrier revenue operations under 14 CFR 121, 14 CFR 125, 14 CFR 127, or 14 CFR 135. Each section (except for the All Operations section) presents a review of a subset of all general aviation accidents. Each subset represents aircraft of similar types or aircraft being operated for particular purposes. Several tables present accident parameters for 1983 only, and each section includes tabulations which present comparative statistics for 1983 and for the five year period 1978 to 1982. Author

N87-19368# Lockheed-California Co., Burbank.
KRASH ANALYSIS CORRELATION: TRANSPORT AIRPLANE CONTROLLED IMPACT DEMONSTRATION TEST Final Report, Feb. - Aug. 1985
GIL WITTLIN Dec. 1986 130 p
(Contract DTFA03-84-C-00004)
(DOT/FAA/CT-86/13; LR-30916) Avail: NTIS HC A07/MF A01

The analyses results of a transport airplane Controlled Impact Demonstration (CID) test using program KRASH are described. Pre-CID analyses, presented previously, are provided in summary form. The KRASH post CID correlation consists of modeling two sequences: a symmetrical impact of the fuselage with the ground (after engine loss at initial air-to-ground impact) and the unsymmetrical air-to-ground including initial engine ground contact and subsequent fuselage impact with the ground. The analyses and test results are compared with regard to floor acceleration responses, fuselage shear and bending moment distribution, structural failures, fuselage underside crush, and sequence of events. Author

N87-19369# Federal Aviation Administration, Atlantic City, N.J.
HALON EXTINGUISHMENT OF SMALL AIRCRAFT INSTRUMENT PANEL FIRES Final Report
G. R. SLUSHER, J. A. WRIGHT, and L. C. SPEITEL Dec. 1986 35 p
(DOT/FAA/CT-86/26) Avail: NTIS HC A03/MF A01

Hand-held Halon 1211 and 1301 fire extinguishers of 2.5 and 3.0 pound capacity, respectively, were discharged to determine their effectiveness on instrument panel fires in small aircraft. The fires consisted of aircraft wire insulation and hydraulic fluid located below and behind the instrument panel in a Piper Model PA-30 Twin Comanche fuselage. The extinguishers were discharged using two methods: by directing the agent upward under the instrument panel, and by directing the agent behind the instrument panel by discharging through fireports mounted on the instrument panel. Except for one test, the fires were extinguished rapidly upon discharge of the Halon fire extinguishers. The two methods of discharge were equally effective in extinguishing the fires. Extinguishers charged with Halon 1211 and 1301 were both effective for fire extinguishment. In the test where the fire was not extinguished, the fire was located under the instrument panel on the copilot's side and the extinguisher was discharged through a fireport located on the extreme opposite side. In this test, the fire was knocked down but continued to burn. Measurement of the decomposition products of the Halon agents demonstrated toxic gas concentrations significantly below levels considered dangerous. Author

N87-19370# Department of the Air Force, Washington, D.C.
CONTROLLABLE EJECTION SEAT CATAPULT Patent Application
J. A. CUEVAS, inventor (to Air Force) 19 Jun. 1986 20 p (AD-D012592; US-PATENT-APPL-SN-876585) Avail: NTIS HC A02/MF A01 CSCL 01E

A catapult seat ejection system for ejecting a pilot and seat from an aircraft is disclosed in which the thrust of the catapult is controlled to prevent injury to the pilot due to acceleration forces. The catapult comprises a main catapult tube; a piston within the tube driven by gas pressure from the burning of two solid propellant cartridges; and four shuttle vent valves powered by gas from a plurality of electrically ignited squibs controlled by an electronic control system. The catapult is initially driven by only one of the two solid propellant cartridges and the electronic controller continuously monitors acceleration. If acceleration is too great the controller fires squibs with a control signal to open the shuttle vent valves to vent the gasses from the catapult and thereby reduce the pressure and acceleration of the seat. If the acceleration is too low and the vent valves are closed, the sensor fires the second cartridge with a second control signal. GRA

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

A87-28353
AN EXAMINATION OF DISTRIBUTED PLANNING IN THE WORLD OF AIR TRAFFIC CONTROL
NICHOLAS V. FINDLER and RON LO (Arizona State University, Tempe) Journal of Parallel and Distributed Computing (ISSN 0743-7315), vol. 3, Sept. 1986, p. 411-431. refs
(Contract DOT-RS-5863-C-00001)

The present consideration of a distributed planning system network for ATC addresses the questions as to the way that individual processors should be interconnected to fully utilize their capabilities, as well as the manner of planning activity that those individual processors should engage in. Attention is presently given to results obtained with a location-center cooperative mode operation organizational architecture, which is demonstrated by a simulation-based planning process. The general goal of this system is the delegation of greater ATC responsibilities to computers. O.C.

A87-28917#
THE MINIMUM FOR GEOMETRIC DILUTION OF PRECISION IN GLOBAL POSITIONING SYSTEM NAVIGATION
BERTRAND T. FANG (Analytic Sciences Corp., McLean, VA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 10, Jan.-Feb. 1987, p. 116.

Fang (1981) has presented simple bounds to the GPS navigation performance index, designated the 'geometric dilution of precision' (GDOP) and projected to be greater than the sq rt of 2; a value as low as the sq rt of 2.5 was obtained for a completely symmetrical GPS configuration. It is presently shown that the sq rt of 2.5 value is indeed the GDOP minimum, through the construction of a completely symmetrical GPS configuration. O.C.

A87-29163
EPSILON ENTROPY OF TRAJECTORY INFORMATION [EPSILON-ENTROPIIA TRAEKTORNOI INFORMATSII]
A. I. VELICHKIN and S. N. GERASHCHENKO Radiotekhnika (ISSN 0033-8486), Oct. 1986, p. 51-54. In Russian.

An approach derived from Kolmogoroff's epsilon entropy theory is used to determine the dependence of the minimum rate of data transmission on the rms error of the reproduction of a flight trajectory. The results are of interest in connection with the control of flight vehicles, which often involves the necessity of transmitting vehicle location data over a digital channel. B.J.

A87-29632#
AN AIRSPACE-SURVEILLANCE AND COLLISION-AVOIDANCE SYSTEM BASED ON THE STANDARD COMMERCIAL-AVIATION DME [EIN LUFTRAUMUEBERWACHUNGS- UND KOLLISIONSSCHUTZ-SYSTEM AUF DER BASIS DES IN DER LUFTFAHRT EINGEFUEHRTEN STANDARD-DME]
A. BECKER and H. J. SCHNITTGER (DFVLR, Institut fuer Flugfuehrung, Braunschweig, West Germany) Ortung und Navigation (ISSN 0474-7550), vol. 27, no. 3, 1986, p. 419-428. In German. refs

Techniques for using a standard DME system (with appropriate additional hardware modules) as an integrated navigation, airspace-surveillance, and collision-avoidance system are discussed, summarizing the results of DFVLR development studies (Becker, 1980 and 1986; Ullrich, 1986; Schnittger, 1986). Integrated system configurations providing slant range, azimuth angle, geographic coordinates, and communication to the aircraft and slant range, azimuth angle, altitude, and recognition information to the ground station are outlined; onboard and ground measurement-acquisition rates of 11 and 2.5 Hz, respectively, are predicted for a 100-user system; and the use of the DME data in a collision-avoidance system is described. The obstacles to acceptance of such systems as ICAO standards are indicated, and special applications such as controlling helicopter traffic to offshore oil platforms are suggested. T.K.

A87-29633#
FLIGHT MEASUREMENT DATA [FLUGMESSDATEN]
HANS-JUERGEN WAGNER Ortung und Navigation (ISSN 0474-7550), vol. 27, no. 3, 1986, p. 430-439. In German.

The flight-measurement procedures used by the West German air force to evaluate the performance of ground radar installations are reviewed. Consideration is given to the complementary field and equipment measurements, the goals of flight measurement, the selection of flight routes and profiles, radiometeorological support, the acquisition of flight-measurement data, and evaluation techniques (correcting for false readings due to multiple propagation, determination of the altitude error and mean altitude error, construction of error histograms, and calculation of the cumulative frequency distribution). Diagrams and graphs are provided, and the capabilities and limitations of the methods employed are considered. T.K.

A87-29759
HOMOMORPHIC FILTERING FOR THE RESOLUTION OF RADIO-NAVIGATION SIGNALS AND REREFLECTIONS [GOMOMORFNAIA FIL'TRATSIIA DLIA RAZRESHENIIA RADIONAVIGATSIONNYKH SIGNALOV I PEREOTRAZHENII]
E. A. ARKHIPOV and A. K. BERNIUKOV Radiotekhnika (ISSN 0033-8486), Nov. 1986, p. 83-85. In Russian. refs

The effect of the frequency bandwidth and the input SNR on the resolving power of a cepstral analyzer is investigated. It is shown that the use of homomorphic filtering in the form of cepstral analysis makes it possible to detect and resolve rereflected signals in a multipath channel and to estimate their level and delays. It is noted that the homomorphic processing of multipath signals can be used effectively in aircraft landing systems operating at a low noise level. B.J.

A87-30118
PHASED ARRAYS FOR AIRBORNE ECM - THE REST OF THE STORY
R. L. MOYNIHAN (Sanders Associates, Inc., Nashua, NH) Microwave Journal (ISSN 0026-2897), vol. 30, Jan. 1987, p. 34, 36, 38 (9 ff.). Navy-supported research. refs

A tutorial is presented on the use of ESA (electronically steerable array) antennas for airborne electronic countermeasures (ECM). An ECM system, in contrast to a standard radar system, does not transmit until a threat signal originating elsewhere is received. A broadband receiver is needed to process and test all

intercepted signals. For signals determined to be threats, the systems must respond at the correct frequency and in the appropriate direction. Pointing accuracy and spatial coverage illuminated are important considerations. Broader concepts for arrays, ECM system basics, receive requirements and limitations, ESA transmit configurations, a requirement and a solution regarding direction-of-arrival (DOA) sorting and spatial filtering, expanding electronic-support-measures functions, and the need for low-cost error-free precision direction finding are covered. D.H.

A87-30121
PHASED ARRAYS FOR MICROWAVE LANDING SYSTEMS
JAMES M. HOWELL (Raytheon Co., Wayland, MA) Microwave Journal (ISSN 0026-2897), vol. 30, Jan. 1987, p. 129, 130, 132, 134-137.

The most widespread use of phased array antennas in the near future will be for MLS, not (as might be expected) ballistic missile defense. The time-reference scanning beam approach will be used. A typical angle guidance configuration consists of a data antenna and two phased arrays known as the az and el (azimuth and elevation) antennas. An L-band precision distance measuring equipment transponder is used for measuring range. The FAA is currently developing and building approximately 200 systems to be installed at U.S. airports, and about 700 more will be open to bids soon. The Air Force is interested and plans to procure about 80 systems. The MLS approach yields angle accuracies comparable to much larger GCA PAR radars. The concept, necessary equipment, and relative advantages are considered in detail. D.H.

A87-30270#
THE FAA'S ADVANCED AUTOMATION SYSTEM - STRATEGIES FOR FUTURE AIR TRAFFIC CONTROL SYSTEMS
VALERIO R. HUNT and ANDRES ZELLWEGER (FAA, Washington, DC) Computer (ISSN 0018-9162), vol. 20, Feb. 1987, p. 19-32. refs

Major areas of concern in the FAA efforts to design and implement a next generation ATC system are explored. Existing ATC functions, equipment and responsibilities are described, noting a recent upsurge in the total traffic volume due to deregulation. Emphasis has been laid on increasing levels of automation since the early 1950s, using fault-tolerant mainframe computers for distributed en route and local displays. The planned Advanced Automation System (AAS) will feature new hardware and software at all levels. Implementation of the AAS will require installation of the new system and switchover while the old system is still in place, the accommodation of evolutionary changes in avionics and other data systems, 24 hr/day noninterruptible service, continued user-friendly operation, and as early an introduction as is feasible. Strategies being followed to accomplish the transition goals are examined in depth. M.S.K.

A87-30275
ON THE ACHIEVEMENT OF A HIGHLY DEPENDABLE AND FAULT-TOLERANT AIR TRAFFIC CONTROL SYSTEM
ALGIRDAS AVIZIENIS (California, University, Los Angeles) and DANFORTH E. BALL (Mitre Corp., McLean, VA) Computer (ISSN 0018-9162), vol. 20, Feb. 1987, p. 84-90. refs

The design specifications for a fault-tolerance in the ATC Advanced Automation System (AAS) now in the design proposal phase are delineated. The discussion focuses on the area control computer coupler (ACCC) and its desired reliability, maintainability and availability (RMA) requirements. The levels of operating modes which will be delivered by the ACCC, depending on its state of operability, the necessity for a transparent recovery, the conditions which constitute system failure, and the specification of an allowable 2.6 min downtime per year are described. Fault tolerance problems which may arise from innovative aspects of the distributed architecture ACCC are identified, along with software techniques which will applied to enhance the probability that the RMA requirements will be met. Finally, techniques being used to validate the projected RMA of proposed designs are outlined. M.S.K.

A87-31100*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
APPLICATION OF LOW-POWER, HIGH-RATE PCM TELEMETRY IN A HELICOPTER INSTRUMENTATION SYSTEM
MITCHEL E. THOMAS and JOHN K. DIAMOND (NASA, Langley Research Center, Hampton, VA) ISA, International Instrumentation Symposium, 33rd, Las Vegas, NV, May 3-8, 1987, Paper. 16 p.

The use of low-power, high-rate pulse code modulation (PCM) in a helicopter instrumentation system is examined. A Helicopter Instrumentation and Recording System (HIARS) was developed to obtain main rotor blade measurements and fuselage performance measurements. The HIARS consists of a low-power PCM telemeter, a digital PCM system, an optical rotor position sensor, and a PCM decommutation unit; the components and functions of these subsystems are described. Flight tests were conducted to evaluate the ability of the HIARS to measure aircraft parameters. The test data reveal that the PCM telemetry is applicable to helicopter instrumentation systems. I.F.

N87-18522*# Massachusetts Inst. of Tech., Cambridge. Flight Transportation Lab.
DEVELOPMENT OF AN LED DISPLAY SYSTEM FOR CROSS-TRACK DISTANCE AND VELOCITY FOR LORAN-C FLIGHT
NORRY DOGAN *In* NASA Langley Research Center Joint University Program for Air Transportation Research, 1983 p 11-13 Mar. 1987
Avail: NTIS HC A05/MF A01 CSCL 17G

The methodology for estimating cross-track velocity by combining rate-gyro and Loran-C data is illustrated in block diagrams. At present, preliminary analysis has established values for K sub 1, K sub 2, the parameters of the digital control loops. A computer program was written to implement a digital simulation of the system as illustrated. Given a model for the noise in the rate-gyro and Loran-C receiver, and their dynamic response, the simulation provides a working model to establish good control loop parameters. The layout of the LED display for flight testing of Loran-C approach flying, which was constructed during a visit to Langley Research Center, is shown. Four bar-graph LED displays are paired to provide cross-track distance and velocity from a Loran-C defined runway centerline. Two seven-segment LED displays are used to provide alphanumeric readout of range to touchdown and desired height. A metal case was built, a circuit board designed, and manufactured with the assistance of NASA Langley personnel. Author

N87-18523*# Massachusetts Inst. of Tech., Cambridge. Flight Transportation Lab.
LORAN-C APPROACH GUIDANCE PROJECT CURRENT STATUS
A. L. ELIAS *In* NASA Langley Research Center Joint University Program for Air Transportation Research, 1983 p 15-20 Mar. 1987
Avail: NTIS HC A05/MF A01 CSCL 17G

There are four areas of work in the Loran-C flight test project. Current results provide performance data on the effects of Signal Noise Ratio (SNR) on the dynamic performance of the receiver filters for Loran-C data, and data on Loran-C grid deformation at a microscale of 100 meters. The Loran-C receiver provides a line of position (LOP) Master and Slave transmitter at an angle 0 to magnetic north. No transformation to latitude-longitude reference frame is required since this is the major source of Loran-C navigation errors. A local coordinate frame is established centered at touchdown point on the runway with directions along and across the runway. A Loran-C data collection system was set up. The Loran-C data are sent directly to an Apple II computer with a 12 inch monitor. The effect of SNR on Loran-C precision is shown for two receiver filters of different frequency response. A set of ground level static readings of touchdown was taken around Hanscom Field and transferred to an accurate detailed layout drawing; this showed local distortions of the average touchdown values. Author

N87-18527*# Ohio Univ., Athens. Dept. of Electrical and Computer Engineering.
PATH DISCREPANCIES BETWEEN GREAT CIRCLE AND RHUMB LINE
RAJAN KAUL *In* NASA Langley Research Center Joint University Program for Air Transportation Research, 1983 p 39-47 Mar. 1987 Previously announced as N84-17168
(TM-98) Avail: NTIS HC A05/MF A01 CSCL 17G

A simulation of a mathematical model to compute path discrepancies between great circle and rhumb line flight paths is presented. The model illustrates that the path errors depend on the latitude, the bearing, and the trip length of the flight. Author

N87-18557# Royal Signals and Radar Establishment, Malvern (England).
THE USE OF NEW TECHNOLOGY IN THE CONTROL OF CIVIL AIR TRAFFIC AT AIRWAY JUNCTIONS
P. T. HUMPHREY Jun. 1986 26 p
(AD-A174303; RSRE-86007; DRIC-BR-100657) Avail: NTIS HC A03/MF A01 CSCL 17G

The methods used to deal with airway junctions at present are considered, and how new technology could impact on this process in the future is reviewed. GRA

N87-18560# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
INVESTIGATION ON MLS APPROACH PATH INTERCEPTION AND TRANSITION TECHNIQUES. PART 2: FLIGHT SIMULATOR INVESTIGATION
L. J. J. ERKELENS and P. J. VANDERGEEST 10 Jan. 1986 148 p
(Contract RLD-523)
(NLR-TR-85097-U-PT-2; B8678399; ETN-87-99277) Avail: NTIS HC A07/MF A01

The feasibility of the concept of microwave landing system guided interception procedures was assessed. During flight simulations manual (flight director) approaches were executed with a simulated Boeing 747 aircraft. Four interception procedures were studied, and two flight director concepts were examined with respect to their use with these procedures. The flight director systems are based on a closed loop and an open loop concept regarding the turns. Results of the investigation, including the evaluation of the interception procedures, flight director concepts and special avionics, such as an experimental navigation display and a modified horizontal situation indicator are discussed. ESA

N87-19371 Bundesanstalt fuer Flugsicherung, Frankfurt am Main (West Germany).
AIRCRAFT CONTROL TOWER SERVICE [GEHOBENER FLUGVERKEHRSKONTROLLDIENST]
Mar. 1984 17 p In GERMAN
(ETN-87-99169) Avail: Issuing Activity

The West German institute for air safety is presented. It runs the aircraft control, information, and warning service. It surveys 1 million takeoffs and landings a year. The aircraft control tower is described. ESA

N87-19372# Radio Technical Commission for Aeronautics, Washington, D. C.
MINIMUM OPERATIONAL PERFORMANCE STANDARDS FOR AIRBORNE AREA NAVIGATION EQUIPMENT USING LORAN-C INPUTS
17 Nov. 1986 187 p Supersedes RTCA/DO-159
(RTCA/DO-194; RTCA/DO-159) Avail: NTIS HC A09/MF A01

Minimum operational performance standards for airborne area navigation 2D and 3D equipment using Loran-C inputs are presented. Equipment characteristics are incorporated within the standards which should be useful for users, designers, manufacturers and installers of the equipment. Defined are performance, functions and features for a 2D system, which performs only lateral guidance, and a 3D system, which performs both lateral and vertical guidance. Typical equipment applications and operational goals are described, and the basis for the standards stated are formed. Tests for the installed equipment are included. Author

N87-19373# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
INVESTIGATION ON MICROWAVE LANDING SYSTEM (MLS) APPROACH PATH INTERCEPTION AND TRANSITION TECHNIQUES. PART 1: FAST-TIME COMPUTER SIMULATIONS
L. J. J. ERKELENS, P. J. VANDERGEEST, T. H. M. HAGENBERG, D. SCHRIER, and R. POUWELS 1 Jul. 1985 78 p
(Contract RLD-523)
(NLR-TR-85097-U-PT-1; B8678398; ETN-87-99276) Avail: NTIS HC A05/MF A01

Four microwave landing system approach path interception procedures were considered to serve all operational purposes. A fast-time computer simulation was carried out to evaluate the predictability and logic of the proposed interception procedures and the accuracy and complexity of the used algorithms for various (open versus closed loop) turn techniques and related glide path definitions. Modeling and results of the computer simulation using a Boeing 747 aircraft computer model are described. ESA

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AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A87-27774
MIKOYAN FLOGGER
Air International (ISSN 0306-5634), vol. 32, Jan. 1987, p. 16-23, 50-52.

A development history and a performance evaluation are presented for the family of MiG-23 variants and their powerplants, with attention to the changes in design details that have been incorporated in the course of optimization for various air-air as opposed to air-ground combat mission profiles. Most drastic among these modifications is the cockpit and nose structure redesign that resulted in the MiG-27 ground attack aircraft variant. All versions employ a three-sweep-settings variable geometry wing, one-man crew, a single Tumansky turbojet engine of 20,000-lb thrust class, and an undercarriage optimized for short, rough airfield operations. Minimum maintenance support has been a primary focus of design. O.C.

A87-27822
CAD APPLICATION IN DEFINITION OF AIRCRAFT GEOMETRY
P. BARKER (British Aerospace, PLC, Warton Div., Preston, England) Aerospace Dynamics (ISSN 0263-2012), vol. 20, Autumn 1986, p. 11-13.

The use of Numerical Master Geometry (NMG) in aircraft design and manufacturing is examined. The NMG is a complete aircraft definition stored on a computer as a full-scale surface model. NMG provides data on aerodynamics, design, wind tunnel, production, tooling, inspection, and stress. The composition and capabilities of the Consurf and Bicubic surfaces are discussed. I.F.

A87-28150
T-46A FLIGHT TEST RESULTS
WENDELL H. SHAWLER (Fairchild Republic Co., Edwards, CA) Cockpit (ISSN 0742-1508), July-Sept. 1986, p. 4-9.

The T-46 military jet trainer test aircraft had flown 129 flights (197 hours) as of September 19, 1986, in a test program that encompassed basic airworthiness, initial flight control optimization, and initiation of flutter testing. The test method involved envelope expansion through the accomplishment of something new as a primary objective on each flight. Attention is presently given to

handling qualities; one area requiring improvement is noted to be that of lateral and longitudinal trim. A brief comparison is made between these test results and those obtained with a 62-percent scale model of the T-46. O.C.

A87-28151
THE USE OF DISCRETE MINIMIZATION IN THE DESIGN OF A STRAIGHT CONTROL SECTION IN THE FUSELAGE OF TRANSPORT AIRCRAFT [POUZITI DISKRETNI MINIMALIZACE PRI NAVRHU PRIMEHO USEKU TRASY RIZENI V TRUPU DOPRAVNIHO LETOUNU]
VIT BUCHTA Zpravodaj VZLU (ISSN 0044-5355), no. 5, 1986, p. 241-247. In Czech.

The paper is concerned with the problem of optimizing the length of control rods in the fuselage of transport aircraft, where pull rod connections can be located only at predetermined points (fuselage bulkheads). The problem is formulated in a form convenient for software implementation. Three standard minimization methods are modified for use within a given discrete space. The control system design procedure is briefly described, as are some principles used during software development. V.L.

A87-28372
HELICOPTER AERODYNAMICS
RAY W. PROUTY (Hughes Helicopters, Inc., Culver City, CA) Peoria, IL, PJS Publications, Inc., 1985, 179 p.

A comprehensive introductory treatment of helicopter aerodynamics and systems technologies is presented, with attention to complex interactions of airframe and rotor dynamics with each other and with the flight environment as well as their consequences for piloting. Basics of helicopter operation encompass static and dynamic stability, vertical and forward flight, high performance maneuvering, and possible accidents. Treatments of helicopter engineering address main and tail rotors' design criteria, horizontal and vertical stabilizers, stability augmentation systems, turboshaft propulsion system configurations, and the relationship of structural loads to component service lives. O.C.

A87-28539
EXPERIMENTAL AND THEORETICAL MODAL ANALYSIS ON TWO VERSIONS OF A TWIN TURBOPROP GENERAL AVIATION AIRCRAFT
LEONARDO LECCE and FRANCESCO MARULO (Napoli, Universita, Naples, Italy) IN: International Modal Analysis Conference, 4th, Los Angeles, CA, Feb. 3-6, 1986, Proceedings. Volume 1 . Schenectady, NY, Union College, 1986, p. 303-310. refs

The results of general vibration tests and FEM modal analyses of the 8-seat Spartacus and 11-seat Viator versions of the AP-68 TP general-aviation aircraft are presented in tables and graphs and discussed. The sine-sweep/dwell (SSD) and single-input frequency-response-function (SIFRF) vibration-test procedures and the construction of beamlike and lumped-mass models (using a 3000-statement FORTRAN code on a minicomputer) are described in detail. The SIFRF procedure is found to be generally reliable and somewhat faster than the SSD method, the modal damping results being slightly lower due to the lower excitation energy employed. It is pointed out, however, that the SSD method is required for determining the modes of the control surfaces. The FEM models are shown to be in good agreement with the experimental data. T.K.

A87-28925
DERIVATION OF VIBRATION TEST SPECTRA FROM FLIGHT DATA
W. B. ROBERTS (British Aerospace PLC, Air Weapons Div., Hatfield, England) (Institute of Environmental Sciences, Spring Meeting, Fort Worth, TX, May 5-8, 1986) Society of Environmental Engineers, Journal (ISSN 0374-356X), vol. 25-4, Dec. 1986, p. 3-8. Research supported by the Ministry of Defence (Procurement Executive). refs

The processes of acquisition and subsequent reduction of vibration data from instrumented aircraft-carried weapon systems are discussed. Interpretation of such data over many years has led to a better understanding of structural excitation mechanisms under aircraft carriage conditions. Consequently the resulting derived vibration test spectra for complete stores/units offer benefits in the way of realism and cost effectiveness for the purpose of optimizing design. These and other factors relating to currently promulgated National/International Qualification Test Specifications and their impact on the concept of test tailoring are also discussed. Author

A87-29278#
COST-EFFECTIVE, HIGH-TECHNOLOGY CIVIL TRANSPORTS
JOHN M. SWIHART (Boeing Co., Seattle, WA) (CASI, Annual General Meeting, 33rd, Vancouver, Canada, May 12, 1986) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 32, Dec. 1986, p. 295-305.

This paper discusses the cost of high technology and its benefits to commercial air transportation. The manufacturer's dilemma today is that, while it was possible to pay a 16-percent price premium to obtain a 10-percent reduction in fuel cost in the late 1970's, in 1985 that price premium has diminished to only 2.5 percent to achieve a 10 percent fuel saving. Consequently, the benefits of high technology must be obtained at an extremely low cost. Four areas are discussed in some depth: aerodynamics (including the effects of computational fluid dynamics, wing design, and laminar flow); structures (including the effects of new materials, both metallic and nonmetallic, and the automated tools necessary to build the nonmetallic structure); avionics (including both fly-by-wire and fly-by-light and the improvements due to high-speed digital computers as well as flat-panel flight-deck displays); and propulsion systems (including the effects of high bypass ratio, high-pressure turbofan engines, and single and counter-rotation turbopropellers). The final result is an integration of these four areas of technology into a composition transport aircraft and the resulting performance. Author

A87-29282#
DHC-8 STATIC TEST PROGRAM
BRIAN LEE and MICHAEL J. WALTON (de Havilland Aircraft Company of Canada, Ltd., Downsview) (CASI, Structures and Materials Symposium, 3rd, Ottawa, Canada, June 9-11, 1986) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 32, Dec. 1986, p. 333-347.

After noting the features of the DHC-8 transport aircraft's Detail Static Test program, with emphasis on detail specimen types, attention is given to tests aimed at demonstrating the pressure fail-safe capability of the passenger cabin. The logistics of the Major Static test program and the rationale for the division of the complete airframe into three parts for such tests are then discussed. The test documentation generated by the tests, test apparatus loading systems, and test instrumentation used are also detailed. O.C.

A87-29321
ADVANCED STOVL - WHO BUYS WINS
KAREN WALKER Flight International (ISSN 0015-3710), vol. 130, Dec. 20, 1986, p. 26-28.

An evaluation is made of configurational concepts currently being considered as bases for next-generation short takeoff, vertical landing combat aircraft similar in capabilities to the Harrier but able to extend the flight envelope into the supersonic-dash regime. Any such aircraft would not enter service before the year 2000, but is widely anticipated to take the form of a single-engined fighter/attack aircraft with propulsion system output in the 35,000-40,000-lb thrust range; it will also incorporate stealth features. Plenum chamber burning of fan output for added thrust, as well as augmenting diffusers for lift operations and long driveshaft-equipped fans, are among the prominent propulsion system alternatives discussed. O.C.

A87-29322
FASTEST BLADES IN THE WORLD
HARRY HOPKINS Flight International (ISSN 0015-3710), vol. 130, Dec. 27, 1986, p. 24-27.

An account is given of the design features and performance capabilities of the propulsion and rotor blade system that allowed a modified Lynx helicopter to set a world speed record in August, 1986; attention is given to the fabrication method and aerodynamic basis for the rotor blades used. The blades are constructed in both unidirectional and +/- 45-deg layers of E glass and XAS carbon fibers, as well as glass/carbon fiber hybrid weaves which yield high torsional stiffness. The wide chord blade tips owe their high angle of attack, high advancing tip speed capabilities to the strake edge-like generation of strong, lift-enhancing vortices by the leading edge. Rotor vibration is also reduced. O.C.

A87-29351
THE FORESEEABLE EVOLUTION OF ROTOR-POWERED FLYING MACHINES [L'EVOLUTION PREVISIBLE DES APPAREILS A VOILURE TOURNANTE]
RENE MOUILLE (Aerospatiale, Division Helicopteres, Marignane, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275), no. 119, 1986, p. 11-24. In French.

Near- and medium-term advances in the technologies of rotor-powered aircraft, e.g., helicopters, are discussed. ONERA developed the OA3 family of blades to lower the amount of flow separation at high speeds and to reduce transonic effects at the blade extremities, the latter by introducing dihedral blade tips. Future blades, perhaps made of composite materials, may have multiple articulations and profiles to optimize performance. Alternatively, the blades may be attached to the hub by adjustable arms to control blade drag in different flight regimes and to allow use of simpler blade designs. Fenestron rear rotors avoid accidental collisions between forward and rear blades and eliminate rear rotor icing. Techniques which will be used to reduce vibrations, implement active control systems, combine rotors and fixed-wing design features, and allow helicopters to travel at speeds up to 550 km/hr are summarized. M.S.K.

A87-29352
NEW AIRCRAFT ARCHITECTURE. II [NOUVELLE ARCHITECTURE DES AVIONS. II]
LEONARD ROSENTHAL (Centre de Documentation de l'Armement, Paris, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275), no. 119, 1986, p. 25-40. In French. refs

New aircraft, wing and winglet designs being examined for medium-term incorporation in aircraft are described. Emphasis is placed on architectures being studied in France and the U.S. Features of the proposed ADDAX and MP 18 supersonic fighter and civilian aircraft are summarized, along with those of the U.S. stealth fighters and flying wings and SR71 derivatives. NASA experiments with the AD-1 oblique wing and its joined-wing version are outlined, including the theoretically predicted flowfields which are being examined experimentally. The placement, shapes and aerodynamic behavior of fixed and adjustable canards are discussed, as are vortex flaps, wing tip sails and winglets, with extensive wind tunnel data being provided for the latter. Finally, the use of active mechanisms to regain vortex energy is discussed. M.S.K.

A87-29593#
COMPOSITES PROVING DURABLE
RICHARD DEMEIS Aerospace America (ISSN 0740-722X), vol. 25, Jan. 1987, p. 12, 13.

The durability that composite materials have exhibited since use in 1 pct of the nonload-bearing parts of the 747 has encouraged their inclusion in primary structures in the planned 7J7 aircraft. Use will be constrained by the costs of facilities needed to produce and test composite parts such as floor beams, wings, tails, etc., and the ability to amortize the costs over hundreds of aircraft. Prototype carbon stabilizers on the 737 permitted learning that small repairs can be made using resin, while damage to large parts can be handled by wet layups and low temperature curing. In-service test programs have revealed a need to buffer contacts between carbon and Al parts, to ensure that the stiffness of patches matches that of surrounding parts, and to use coatings which provide protection from UV degradation when the parts will have heavy exposure to sunlight in their nominal regions of service. M.S.K.

A87-29602#
DEVELOPMENT OF DAMAGE TOLERANCE AND DURABILITY DESIGN TECHNOLOGY
KETANG LI (Chengdu Aircraft Co., Development Dept., People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 7, Dec. 1986, p. 531-538. In Chinese, with abstract in English. refs

In this paper, a number of problems are reviewed and discussed. These include two kinds of experiences and lessons; development of design conception; characteristics of damage tolerance and durability design technology; practical examples in aircraft design; and some problems to be further studied. Author

A87-29634
V/STOL/STOVL; PROCEEDINGS OF THE AEROSPACE TECHNOLOGY CONFERENCE AND EXPOSITION, LONG BEACH, CA, OCT. 13-16, 1986
Conference sponsored by SAE. Warrendale, PA, Society of Automotive Engineers, Inc. (SAE SP-680), 1986, 85 p. For individual items see A87-29635 to A87-29639.
(SAE SP-680)

The present conference discusses takeoff prediction methods for powered-lift aircraft, a parametric approach to the hover balance analysis of two STOVL fighter concepts, and the High Technology Test Bed Program MOD 3 STOL modification of a C-130 transport aircraft. Also discussed are future prospects for tactical jet aircraft V/STOL configurational development, and prospective performance of the AV-8B in operations from a novel aircraft carrier design. O.C.

A87-29635* California Polytechnic State Univ., San Luis Obispo.
TAKEOFF PREDICTIONS FOR POWERED-LIFT AIRCRAFT
DOUGLAS A. WARDWELL, DORAL R. SANDLIN (California Polytechnic State University, San Luis Obispo), and ANDREW S. HAHN (NASA, Ames Research Center, Moffett Field, CA) IN: V/STOL/STOVL; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 1-9. refs
(SAE PAPER 861630)

Takeoff predictions for powered lift short takeoff (STO) aircraft have been added to NASA Ames Research Center's aircraft synthesis (ACSYNT) code. The new computer code predicts the aircraft engine and nozzle settings required to achieve the minimum takeoff roll. As a test case, it predicted takeoff around rolls and nozzle settings for the YAV-8B Harrier that were close to the actual values. Analysis of takeoff performance for an ejector-augmentor design and a vectoring-nozzle design indicated that ground roll can be decreased, for either configuration, by horizontally moving the rear thrust vector closer to the center of gravity, by increasing the vertical position of the ram drag-vector, or by moving the rear thrust vector farther below the center of gravity. Author

A87-29636* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A PARAMETRIC APPROACH TO HOVER BALANCE ANALYSIS OF TWO STOVL FIGHTER CONCEPTS
JEFFREY J. SAMUELS and ANDREW S. HAHN (NASA, Ames Research Center, Moffett Field, CA) IN: V/STOL/STOVL; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 11-22. refs
(SAE PAPER 861631)

Successful development of an aircraft with vertical landing capability must address the critical problem of balancing the aircraft

for hover. In this paper a parametric method for balancing short takeoff and vertical landing (STOVL) aircraft in hover is described and applied to the analysis of two conceptual STOVL fighters. One uses a remote augmented lift system and the other a thrust-vectoring hybrid tandem-fan engine. Author

A87-29637
HIGH TECHNOLOGY TEST BED PROGRAM MOD 3 STOL
WILLIAM F. GROSSER (Lockheed-Georgia Co., Marietta, GA) IN: V/STOL/STOVL; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 23-32. refs
(SAE PAPER 861633)

A configurational feature and performance capability improvement account is given of the High Technology Test Bed research aircraft, which is a modified and highly instrumented C-130 airlifter tasked with system integration evaluation for advanced aerodynamics, control, avionics, and flight systems technologies. Among the novel technologies incorporated are an improved cockpit display HUD, high sink rate landing gear, drooped leading edges, an 8000-psi hydraulic system, double-slotted flaps, and horizontal and vertical fin root strakes. Attention is given to the performance capability improvements resulting from these modifications in the case of a tactical assault mission profile. O.C.

A87-29638
TACTICAL JET V/STOL - ITS FUTURE IN A CTOL WORLD
J. W. FOZARD (British Aerospace, PLC, Weybridge, England) IN: V/STOL/STOVL; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 33-57.
(SAE PAPER 861637)

The need for V/STOL operational capabilities in tactical aviation is discussed, and the Harrier family of warplanes is set in its historical context with a view to the comparative successes of the entire spectrum of V/STOL aircraft design and development efforts over the past 30 years. Attention is drawn to the versatility and simplicity of the Harrier's powered lift systems and flight modes, by comparison with other configurational alternatives. The increasing vulnerability of airfields and, especially, of aircraft carriers, is noted to be a compelling reason for the development of second-generation V/STOL tactical aircraft. The achievement of economical supersonic flight is a critical issue to be addressed by next-generation V/STOL aircraft designers. O.C.

A87-29641* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
EVALUATION OF COMPOSITE COMPONENTS ON THE BELL 206L AND SIKORSKY S-76 HELICOPTER
DONALD J. BAKER (NASA, Langley Research Center; U.S. Army, Aviation Research and Technology Activity, Hampton, VA) IN: New materials in civil aviation; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 1-15. refs
(SAE PAPER 861671)

A development flight testing status evaluation is presented for composite material structural components used in the Bell 206L and Sikorsky S-76 commercial helicopters, encompassing litter doors, baggage doors, forward fairings, and vertical fins. These flight tests have been conducted in various climatic conditions. The materials used in the fabrication of these components are also undergoing a separate exposure and testing program. Attention is given to results of 73,000 hrs of accumulated flight time on 206L components and 50,000 hrs on S-76 components. O.C.

A87-29643* Douglas Aircraft Co., Inc., Long Beach, Calif.
TEN YEARS OF FLIGHT SERVICE WITH DC-10 COMPOSITE RUDDERS - A BACKWARD GLANCE
ARTHUR V. HAWLEY (Douglas Aircraft Co., Long Beach, CA) IN: New materials in civil aviation; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 33-40. NASA-supported research. refs
(SAE PAPER 861674)

Carbon-epoxy upper aft rudders have been successfully evaluated on the DC-10 during 10 years of airline flight service. They have flown for more than 320,000 flight hours, with 36,000 flight hours flown by a single rudder. The rudder box is of thin-skin buckled construction and is cocured out-of-autoclave as a one-piece assembly. Weight saving can exceed the rudder weight if full advantage is taken of removing balance weight from the forward rudder. Author

A87-29644* Douglas Aircraft Co., Inc., Long Beach, Calif.
LESSONS LEARNED FROM THE DC-10 CARBON-EPOXY RUDDER PROGRAM
L. J. HART-SMITH (Douglas Aircraft Co., Long Beach, CA) IN: New materials in civil aviation; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 41-57. refs
(Contract NAS1-12954; NAS1-14724)
(SAE PAPER 861675)

With the DC-10 carbon-epoxy rudder, the Douglas Aircraft Company achieved one of the greatest percentage weight savings associated with composite structures. Apart from minor damage from lightning strikes, the 15 rudders put into service have experienced virtually trouble-free operation for about a decade. This paper explains why a multirib, postbuckled skin design was used for the DC-10 composite rudder, how it was justified, and how it would have compared with more conventional sandwich design concepts. Special attention is devoted to the reasons why, for such postbuckled designs, it is better to allow the skin to wrinkle and unload itself than to reinforce it and make it resist buckling until some higher load level is attained. With minor changes in the manufacturing technique, this design concept is ideal for the control surfaces on many aircraft. The paper includes suggestions on how to make even better composite control surfaces in the future. Author

A87-30001
BOEING 7J7 DESIGN TO BE FROZEN IN JULY
PIERRE CONDOM Interavia (ISSN 0020-5168), vol. 42, Jan. 1987, p. 23-26.

The B 7J7, which is intended for certification in 1992, will be a short/medium range aircraft with about 150 seats and two high speed, contrarotating propeller engines of either the propfan or unducted fan type. The choice between these two powerplant configurations is the most controversial aspect of the development program, since only one, or perhaps neither engine, may be available in 1992. It has been established that the 7J7 will have digital, electrically operated flight controls in all axes. The choice of fuselage diameter is another matter, however, that has thus far eluded finalization. Three different cabin width/aisle number-and-width possibilities are under consideration. The 7J7's primary dimensional characteristics and projected performance are tabulated for each of the three fuselage width/cabin layout configurations. O.C.

A87-30005
THE EFFICIENT FIGHTER - SMALL IS NOT NECESSARILY BEAUTIFUL
CHARLES GILSON Interavia (ISSN 0020-5168), vol. 42, Jan. 1987, p. 45-49.

A comprehensive comparative study is conducted for the performance capabilities of state-of-the-art fighter aircraft as a function of their airframe and propulsion system dimensions, weights, and capacities. An attempt is made to ascertain aircraft

scale and complexity factors' relationship to cost effectiveness in prospective missions. The aircraft considered include the Sea Harrier, Tornado, F-4E, F-5E, F-20, Lavi, Grippen, Viggen, F-14, F-15, F-16, F-18A, and Mirage 2000; the F-15 and F-16 tabulations encompass the A- and C-variants of the aircraft, respectively powered by the F-100-100 and F-100-200 engines, and the E-variants, powered by F-110s (as is the F-16XL follow-on development). O.C.

A87-30006
A NEW APPROACH FOR USAF'S ADVANCED TACTICAL FIGHTER
BILL SWEETMAN Interavia (ISSN 0020-5168), vol. 42, Jan. 1987, p. 49-51.

The Advanced Tactical Fighter (ATF) development schedule has stressed the management and reduction of risk rather than its avoidance. High-risk components and critical technologies have accordingly been given the greatest possible scheduling lead over other ATF elements; this is notably the case for the ATF engine, in deference to whose need for early size determination the weight requirement for the airframe was frozen almost four years before the choosing of an airframe contractor. Competition is another form of risk management which is being applied to as many systems as possible, ensuring that cost overruns are absorbed by the contractors rather than being passed on to the customer. Attention is given to the performance capabilities (such as Mach 1.4 cruise on dry thrust rather than afterburner) and avionics systems features toward which ATF development strives. O.C.

A87-30007
AMPHIBIANS - TOE IN THE WATER AGAIN, OR BIG NEW SPLASH?
MARC GRANGIER and GREG WASKUL Interavia (ISSN 0020-5168), vol. 42, Jan. 1987, p. 61, 62, 64.

An assessment is made of the comparative performance advantages and commercial viability of amphibious aircraft currently undergoing design, development, or production. The aircraft in question range in size from piston engine-powered personal aircraft and turboprop-powered executive aircraft to 46-seat commuter airliners, such as the AIT 460, and fire-fighting airlifters, such as the CL-215 T. Attention is given to the Caravan I, Seastar, P.300, Renegade, SS-X, and TFC 1 amphibious aircraft. O.C.

A87-30300#
DESIGN SCOPE FOR STUDENT SUPERSONIC PROJECTS
BUD D. NELSON (Northrop Corp., Aircraft Div., Hawthorne, CA) AIAA Student Journal (ISSN 0001-1460), vol. 24, Winter 1987, p. 5-17, 39-41. refs

In the course of judging student designs for the Supersonic Executive Jet Competition, the AIAA Aircraft Design Committee recognized that design with the area rule and the configurational consequences of increasingly modular state-of-the-art subsystems had been comparatively neglected by entrants. An attempt is presently made to enhance student understanding of these issues, with a view to the convening of a fighter aircraft design competition in which they will again be of great importance. A far-term compact (single-seat, single-engine) fighter has been taken as the baseline technology data base for the present discussion. O.C.

A87-30390#
THE AEROELASTIC TAILORING OF SWEPT FORWARD WINGS WITH ADVANCED COMPOSITES
GUOHUA WU (Beijing Institute of Aeronautics and Astronautics, People's Republic of China) Acta Materiae Compositae Sinica, vol. 3, Sept. 1986, p. 88-98, IX, X. In Chinese, with abstract in English. refs

Analytical techniques are presented for evaluating the mechanical properties of aeroelastically tailored composite forward swept wing designs. Theoretical methods are defined for predicting the divergence behavior of moderate to highly swept laminated composite wings with a high aspect ratio. The impact a laminate wind has on wing divergence is shown to be amenable to modeling with equations drawn from Euler-Bernoulli beam theory and strip theory. A relationship is shown to exist between flutter and divergence speed and fiber orientation, and the effect of the aspect ratio is explored. Finally, it is shown that the elastic coupling between bending and torsion in laminated composites may negate the unfavorable effect forward sweep of the wings has on the efficiency and divergence of the ailerons. M.S.K.

A87-30443
MESH GENERATION BY A SEQUENCE OF TRANSFORMATIONS
TIMOTHY J. BAKER (Princeton University, NJ) Applied Numerical Mathematics (ISSN 0168-9274), vol. 2, Dec. 1986, p. 515-528. refs

A sequence of transformations is used to map a three-dimensional aerodynamic shape into a simplified configuration. Coordinate surfaces are generated in the mapped space and the transformation sequence is inverted to produce a three-dimensional mesh that conforms with solid boundaries. The method has been used to generate meshes about typical aircraft shapes consisting of a wing, body, tail and fin. Author

A87-30933* Virginia Polytechnic Inst. and State Univ., Blacksburg.
EXPERIMENTS ON REDUCTION OF PROPELLER INDUCED INTERIOR NOISE BY ACTIVE CONTROL OF CYLINDER VIBRATION
C. R. FULLER and J. D. JONES (Virginia Polytechnic Institute and State University, Blacksburg) Journal of Sound and Vibration (ISSN 0022-460X), vol. 112, Jan. 22, 1987, p. 389-395. refs
(Contract NAG1-390)

The feasibility of reducing interior noise caused by advanced turbo propellers by controlling the vibration of aircraft fuselages was investigated by performing experiments in an anechoic chamber with an aircraft model test rig and apparatus. It was found that active vibration control provides reasonable global attenuation of interior noise levels for the cases of resonant (at 576 Hz) and forced (at 708 Hz) system response. The controlling mechanism behind the effect is structural-acoustic coupling between the shell and the contained field, termed interface modal filtering. I.S.

N87-18561*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
HIGH PERFORMANCE FORWARD SWEPT WING AIRCRAFT Patent Application
DAVID G. KOENIG, inventor (to NASA), KIYOSHI AOYAGI, inventor (to NASA), MICHAEL E. DUDLEY, inventor (to NASA), and SUSAN B. SCHMIDT, inventor (to NASA) 24 Nov. 1986 27 p
(NASA-CASE-ARC-11636-1; US-PATENT-APPL-SN-933963; NAS 1.71:ARC-11636-1) Avail: NTIS HC A03/MF A01 CSCL 01C

A high performance aircraft capable of subsonic, transonic and supersonic speeds employs a forward swept wing planform and at least one first-and-second-solution ejector located on the inboard section of the wing. A high degree of flow control on the inboard sections of the wing is achieved along with improved maneuverability and control of pitch, roll and yaw. Lift loss is delayed to higher angles of attack than in conventional aircraft. In one embodiment the ejectors may be advantageously positioned spanwise on the wing while the ductwork is kept to a minimum. NASA

N87-18562# Communications Research Centre, Ottawa (Ontario). Radar and Communications Technology Branch.
SHARP (STATIONARY HIGH ALTITUDE RELAY PLATFORM). PART A: TECHNICAL FEASIBILITY OF MICROWAVE-POWERED AIRPLANES Summary Report
G. W. JULL Sep. 1986 23 p
(CRC-1393-PT-A; ISBN-0-662-15215-8) Avail: NTIS HC A02/MF A01

Various types of airplanes and power transmission systems were analyzed. It was found that the cost of a powering system would be considerably reduced if it were to be operated at an ISM frequency of 5.8 GHz rather than at 2.45 GHz. A currently

available 2.45 GHz rectenna, capable of power conversion at a power flux density of 500W/square meters was tested to determine microwave to dc conversion efficiency and levels of out-of-band spurious emissions. To gain experience with microwave powering of airplanes, a 1.3m wing span model airplane has been designed and fitted with a novel type of dual polarization rectenna. It is planned to fly this airplane on microwave power. A 6kW transmitter and a 4.5m tracking antenna will be used to provide the power flux density required to fly the airplane to altitudes of up to 70m. It is concluded that there are no insuperable technical problems to achieving feasibility of the airplane and power transmission system. However, an acceptable rectenna has not yet been identified. Further, there are uncertainties in performance of lightweight airplanes in the operational environment. Author

N87-18563*# Lockheed-Georgia Co., Marietta.
APPLICATION OF DECOMPOSITION TECHNIQUES TO THE PRELIMINARY DESIGN OF A TRANSPORT AIRCRAFT Final Report
J. E. ROGAN and M. A. KOLB Feb. 1987 300 p
(Contract NAS1-18068)
(NASA-CR-178239; LG86ER0092; NAS 1.26:178239) Avail: NTIS HC A13/MF A01 CSCL 01C

A nonlinear constrained optimization problem describing the preliminary design process for a transport aircraft has been formulated. A multifaceted decomposition of the optimization problem has been made. Flight dynamics, flexible aircraft loads and deformations, and preliminary structural design subproblems appear prominently in the decomposition. The use of design process decomposition for scheduling design projects, a new system integration approach to configuration control, and the application of object-centered programming to a new generation of design tools are discussed. Author

N87-18564# Wisconsin Univ., Madison. Dept. of Mathematics.
OPTIMAL AND INSENSITIVE CONTROL OF HYPERBOLIC DISTRIBUTED PARAMETER SYSTEMS WITH APPLICATIONS TO WING FLUTTER PROBLEMS Final Report, Feb. 1984 - Jan. 1986
DAVID L. RUSSELL Jan. 1986 72 p
(Contract AF-AFOSR-0088-84)
(AD-A174954; AFOSR-86-2187TR) Avail: NTIS HC A04/MF A01 CSCL 20K

The titles include: On the Dirichlet Neumann Boundary Control Problem Associated with Maxwell's Equations in a Cylindrical Region, A Floquet decomposition for Volterra Equations with Periodic Kernel and a transform Approach to Linear Recursion Equations, and Mathematical Models for the Elastic Beam and their Control Theoretic Implications, and Mathematical Models for the Elastic Beam with Frequency Proportional Damping. GRA

N87-18565# Technische Univ., Brunswick (West Germany). Fakultaet fuer Maschinebau und Elektrotechnik.
INVESTIGATIONS OF FLIGHT PATHS FOR MANEUVERS WITH CONSTANT ENERGY AND CONSTANT CHANGES OF ENERGY INCLUDING DIFFERENT STRATEGIES OF STEERING, CALCULATIONS OF ENERGY REQUIREMENTS FOR GIVEN FLIGHT PATHS, DETERMINATION OF THE CRITERIA FOR SUCCESSFUL COMPLETION OF TURNING MANEUVERS IN THE VERTICAL PLANE Ph.D. Thesis
MICHAEL SOELTER 1985 123 p In GERMAN; ENGLISH summary
(ETN-87-99017) Avail: NTIS HC A06/MF A01

Turning maneuvers in the vertical plane for aerobatic and military pilots are studied using mathematical models and system analysis. Starting with the equations for the motion of an airplane in the longitudinal plane for maneuvers with constant energy, it is possible by simple expansion of the formula to include maneuvers with constant changes of energy using the same mathematical model in both cases. By choosing a suitable starting load factor as a parameter for the different steering strategies, a practical variable is defined, which in conjunction with the constant energy change, allows a simple classification of different types of flight paths in the plane of parameters. Simplified formulae facilitate the finding of optimal values and make the conditions obvious for the calculation of boundary areas. By defining simple flight paths, the question for the energy requirements and the feasibility of the maneuver can be determined. ESA

N87-18566# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
TECHNICAL EVALUATION REPORT ON THE AGARD FLUID DYNAMICS PANEL SYMPOSIUM ON IMPROVEMENT OF AERODYNAMIC PERFORMANCE THROUGH BOUNDARY LAYER CONTROL AND HIGH LIFT SYSTEMS
B. OSKAM and B. VANDENBERG 14 Feb. 1985 11 p Symposium held in Brussels, Belgium, 21-23 May 1984
(NLR-MP-85016-U; B8679800; ETN-87-99506) Avail: NTIS HC A02/MF A01

The importance of research into mechanical high-lift systems for transport aircraft to improve total performance was assessed. Computational techniques are shown to provide new tools for high-lift design. For drag reduction by laminar flow control it is concluded that the information needed to judge whether the laminar flow concept is workable in routine flight operations is becoming available. Research indicates that large benefits of extensive laminar flow on commercial transports may be achievable. Drag reduction by manipulation of turbulence in boundary layers is promising, but research is still in an early stage of development. The control of shock wave boundary layer interactions is also a research area of potential interest. ESA

N87-19376*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AIRCRAFT PARAMETER ESTIMATION
KENNETH W. ILIFF Jan. 1987 30 p Presented at the AIAA 25th Aerospace Sciences Meeting, Reno, Nev., 12-15 Jan. 1987
(NASA-TM-88281; H-1394; NAS 1.15:88281) Avail: NTIS HC A03/MF A01 CSCL 01C

The aircraft parameter estimation problem is used to illustrate the utility of parameter estimation, which applies to many engineering and scientific fields. Maximum likelihood estimation has been used to extract stability and control derivatives from flight data for many years. This paper presents some of the basic concepts of aircraft parameter estimation and briefly surveys the literature in the field. The maximum likelihood estimator is discussed, and the basic concepts of minimization and estimation are examined for a simple simulated aircraft example. The cost functions that are to be minimized during estimation are defined and discussed. Graphic representations of the cost functions are given to illustrate the minimization process. Finally, the basic concepts are generalized, and estimation from flight data is discussed. Some of the major conclusions for the simulated example are also developed for the analysis of flight data from the F-14, highly maneuverable aircraft technology (HiMAT), and space shuttle vehicles. Author

N87-19377# Fairchild Republic Div., Farmingdale, N. Y.
OPTIMUM AEROELASTIC CHARACTERISTICS FOR COMPOSITE SUPERMANEUVERABLE AIRCRAFT Final Technical Report, 1 Jun. 1985 - 31 May 1986
GABRIEL A. OYIBO and TERRENCE A. WEISSHAAR 31 Jul. 1986 117 p
(Contract F49620-85-C-0090)
(AD-A174785; AE002V7407; AFOSR-86-2040TR) Avail: NTIS HC A06/MF A01 CSCL 20D

In this investigation of an aeroelastically induced constrained warping phenomenon for a composite (supermaneuverable type) aircraft wing, the wing is analytically modelled as a straight flat laminated plate using various forms of highly simplified aerodynamic loads. The free vibrations and stability importance aspects are examined to obtain physical insights and determine their importance and/or design implications. An affine transformation concept and a non-dimensionalization scheme were used and an evolution of effective warping parameters with which to study this phenomenon was performed. The virtual work theorem and variational principles

were used to derive the equations of motion based on the assumed wing displacements. Closed form solutions to the uncoupled versions of these equations were examined with the following results: (1) incorrect modelling of the warping phenomenon can lead to errors in excess of 80% for the analytically predicted aeroelastic characteristics of composite aircraft wings; (2) accurate modelling of the warping phenomenon is particularly important for wings with mass coupling or elastic coupling (e.g., wings aeroelastically tailored using elastic coupling) and for higher vibration modes; (3) neglect of the warping constraint can result in either under- or overpredicted analytical results and lead to incorrect identification of aeroelastic divergence modes. GRA

N87-19378# General Research Corp., Santa Barbara, Calif.
NUCLEAR HARDNESS SIMULATION AND ANALYSIS OF COMPOSITE AIRCRAFT STRUCTURES. VOLUME 2: DUST EROSION ASSESSMENT Technical Report, 30 Jun. 1982 - 30 Nov. 1984
W. F. ADLER 31 Dec. 1985 82 p
(Contract DNA001-82-C-0245)
(AD-A174893; GRC-CR-85-1408; DNA-TR-86-132-V2) Avail: NTIS HC A05/MF A01 CSCL 11D

This volume assesses the state of dust erosion data for composite materials. A survey of the solid particle erosion literature revealed that some experimental data is available for polymeric materials and fiber-reinforced, non-metallic composites. Although not directly applicable to the specific compositions currently of interest, the available data is used to provide initial insights into the magnitude of the erosion problems which may exist for advanced composite materials on aircraft flying through nuclear-generated dust. Using published erosion data, the possibility exists for a significant amount of material removal to occur. Additional investigations are suggested to provide a more relevant estimate of the magnitude of the dust erosion problem. The report also discusses available test facilities and their capabilities and presents an extensive bibliography of relevant literature. GRA

N87-19380# United Technologies Research Center, East Hartford, Conn.
DYNAMIC STALL PENETRATION EXPERIMENTS ON A SWEPT WING Annual Technical Report, 15 Aug. 1985 - 15 Aug. 1986
FRANKLIN O. CARTA and PETER F. LORBER 12 Sep. 1986 21 p
(Contract F49620-84-C-0082)
(AD-A174962; AFOSR-86-2209TR; ATR-2) Avail: NTIS HC A02/MF A01 CSCL 20D

An experiment was conducted to study the aerodynamic response of a wing to large amplitude pitching motions, including dynamic stall. A two-dimensional model was tested at Mach numbers of 0.2, 0.3, and 0.4, corresponding to Reynolds numbers between 2 x 1000000 and 4 x 1000000. A total of 49 unsteady conditions were studied, including both sinusoidal oscillations and constant pitch rate ramps. The ramp motions ranged up to 0 to 30 deg at pitch rates between 17.5 and 350 deg/sec. A preliminary analysis of the results shows significant effects of pitch rate and Mach number on the surface pressures, integrated airloads, and locations of boundary layer transition and separation. A pressure oscillation was detected in the post stall region that appears to result from periodic vortex shedding that has synchronized to the imposed pitching motion. A more detailed analysis of these results will be conducted during the remainder of this activity. GRA

N87-19381# Fairchild Industries, Inc., Farmingdale, N.Y.
ASSESSMENT OF DAMAGE TOLERANCE REQUIREMENTS AND ANALYSIS. VOLUME 5: ASSESSMENT AND RECOMMENDATIONS Final Technical Report, Sep. 1982 - Nov. 1985
MEIR LEVY Sep. 1986 429 p
(Contract F33615-82-C-3215)
(AD-A175111; AFWAL-TR-86-3003-VOL-5) Avail: NTIS HC A19/MF A01 CSCL 20K

A structural test program of typical aircraft structural configuration was conducted to assess the current Air Force damage tolerance design requirements defined in MIL-A-83444. The specimens (made of 2024-T3XX and 7075-T6XX), were subjected to randomized flight-by-flight spectra, representative of fighter/trainer and bomber/cargo type loading spectra, respectively, and to constant amplitude loading spectrum. A total of 72 specimens were tested. The test results were correlated with analytical predictions using the crack growth method and combined method. As a result of this study, recommendation is provided to the validity of MIL-A-83444, to develop guidelines for selection of critical crack locations, and to assess the state-of-the-art analytical capabilities in predicting crack growth and crack initiation time. This volume (Volume 5) of a five-volume report presents the assessment and recommendations pertaining to the current damage tolerance design requirements and analyses based on the analyses and testing done under this contract. GRA

N87-19382# Naval Postgraduate School, Monterey, Calif.
COMPUTER PROGRAM FOR CONCEPTUAL HELICOPTER DESIGN M.S. Thesis
ROBERT L. DRAKE Sep. 1986 155 p
(AD-A175140) Avail: NTIS HC A08/MF A01 CSCL 01C

The conceptual phase of helicopter design requires that many calculations and iterations be completed. Often specifications are exceeded in the latter stages of the design, requiring a complete rework of the design to bring these specifications within limits. This thesis develops a program to be used in the Helicopter Design - AE-4306 course taught by the Department of Aeronautics at the Naval Postgraduate School, Monterey, California to alleviate many of the tedious calculations required in conceptual design development. This program provides the student with the ability to perform trade-off studies to enhance design parameters. GRA

N87-19383# Army Cold Regions Research and Engineering Lab., Hanover, N. H.
NATURAL ROTOR ICING ON MOUNT WASHINGTON, NEW HAMPSHIRE
K. ITAGAKI, G. E. LEMIEUX, and H. W. BOSWORTH Sep. 1986 71 p
(AD-A175276; CRREL-86-10) Avail: NTIS HC A04/MF A01 CSCL 01B

Icing of a four-bladed rotor was studied under natural conditions at the top of Mt. Washington, N.H. The rotor had two cylindrical blades and two airfoil blades. The results were compared with studies conducted in icing wind tunnels. Considerable differences in icing regimes were observed. For instance, with comparable liquid water content and wind speed the wet-to-dry growth regime transition temperature was up to 10 C higher under natural conditions than in the wind tunnel studies. Results of other studies made under natural conditions were close to those of the present study, indicating that wind tunnel conditions are significantly different from natural conditions. Close examination of the conditions indicated that supersaturation of water vapor existing in most of the wind tunnel studies is the most probable cause of the differences. GRA

N87-19384# Naval Postgraduate School, Monterey, Calif.
AUTOMATED AIRCRAFT STATIC STRUCTURAL TESTING WITH COMPUTER AIDED INTERPRETATION M.S. Thesis
JAMES J. MILLER Sep. 1986 83 p
(AD-A175321) Avail: NTIS HC A05/MF A01 CSCL 01C

The objective of this thesis is to improve three primary aspects of static structural testing at the Naval Postgraduate School. First,

computer controlled digital multimeters simultaneously display twelve data locations on the structure while the test is in progress. Second, immediate interaction is permitted. If some unexpected data occurs during the testing, the test plan can be modified to focus in on any area of interest. Third, the operator is presented with two different real-time visual interpretations of the strain gage data reduced to the strain tensor components with animated deformations. These objectives contribute to enhancing the real-time correlation between input load and output structural response in terms of direct physical measurements rather than indirect abstract tensor components. GRA

N87-19385# Army Aviation Engineering Flight Activity, Edwards AFB, Calif.
AIRWORTHINESS AND FLIGHT CHARACTERISTICS TEST (A AND FC) OF THE BHTI (BELL HELICOPTER TEXTRON, INC.) 214ST HELICOPTER Final Report, 1 Jul. - 27 Aug. 1985
ROBERT A. WILLIAMS, RANDALL W. CASON, and ROBERT M. BUCKANIN Feb. 1986 180 p
(AD-A175349; USAAEFA-85-10) Avail: NTIS HC A09/MF A01 CSCL 01C

The Airworthiness and Flight Characteristics Test of the Bell 214ST helicopter (S/N N3186W) was conducted by the US Army Aviation Engineering Flight Activity (USAAEFA). The test was conducted at Edwards Air Force Base (elevation 2302 feet), Bakersfield (elevation 488 feet), Bishop (elevation 4120 feet) and Coyote Flats (elevation 9980 feet), California. A total of 62.6 hours (27.5 productive hours) were flown between 1 July and 27 August 1985. Hover, level flight and autorotational descent performance tests were conducted. Handling qualities tests included static and dynamic stability, maneuvering stability, power management, systems failures, mission maneuvers and flight in simulated Instrument Meteorological Conditions (IMC). The airspeed for best glide distance determined from the autorotational descent performance test results of this evaluation was significantly less than the best glide distance airspeed presented in the flight manual. The out-of-ground effect hover test results when compared to the flight manual indicated less hover capability at standard day conditions and altitude below 8060 feet but better hover capability at higher altitudes. The maximum difference between the flight manual and the test results of this evaluation was 250 pounds below 8060 feet. GRA

N87-19386# Naval Postgraduate School, Monterey, Calif.
A CASE STUDY OF A COMBAT AIRCRAFT'S SINGLE HIT VULNERABILITY M.S. Thesis
ROBERT E. NOVAK, JR Sep. 1986 194 p
(AD-A175723) Avail: NTIS HC A09/MF A01 CSCL 01C

The methodology for a detailed vulnerability assessment of a generic aircraft in the conceptual/preliminary design stage is presented. The single hit vulnerability of the aircraft to a 100 grain fragment is determined using the textbook, The Fundamentals of Aircraft Combat Survivability Analysis and Design. The intent of this work is to provide a realistic case study of a vulnerability assessment that can be used by others as a learning tool. GRA

N87-19387# Naval Postgraduate School, Monterey, Calif.
DEVELOPMENT OF FLIGHT PERFORMANCE ALGORITHMS AND A TACTICAL COMPUTER AIDED MISSION PLANNING SYSTEM FOR THE A-7E AIRCRAFT M.S. Thesis
CHRISTOPHER G. NUTTER Sep. 1986 137 p
(AD-A175724) Avail: NTIS HC A07/MF A01 CSCL 01C

This thesis presents a fully developed, tactically oriented computer aided mission planning system for the A7E aircraft. The system is designed to be extremely easy to operate by someone with no computer experience, and is a replacement for 53 NATOPS performance charts that are most applicable to flight and mission planning. High altitude performance, as well as low altitude and maximum range performance, are available. Tactical navigation routes may be entered, edited, and saved in a disk file. Navigation computations are linked with aircraft performance to provide printout of a completed mission planning jet log. Numerical techniques for obtaining analytical expressions from chart and tabular data included multiple linear regression analysis, curve fitting, and cross plotting of regression coefficients. The computer program results have been correlated with NATOPS data and actual flight test, and have been found to be highly accurate. The program is designed to be run on the IBM /PC/XT/AT and compatible computers with a minimum of 256K memory available. GRA

N87-19388# Naval Postgraduate School, Monterey, Calif.
SIMULATING THE HELICOPTER-SHIP INTERFACE AS AN ALTERNATIVE TO CURRENT METHODS OF DETERMINING THE SAFE OPERATING ENVELOPES Research Report, Jan. - Dec. 1985
J. V. HEALEY 30 Sep. 1986 83 p
(AD-A175911; NPS67-86-003) Avail: NTIS HC A05/MF A01 CSCL 01B

In the past decade, there has been a dramatic increase in the use of helicopters in conjunction with non-aviation ships by the U.S. Navy. Landing the helicopter on the ship in the presence of high winds and stormy seas can be a hazardous process. The safe operating envelopes are determined at sea by the Naval Air Test Center and is a slow laborious and expensive process. Moreover, there is a substantial backlog of about eleven helicopters and twenty ships that, at the present rate, cannot be cleared in this century. This has led to the suggestion that the problem might be solved by simulation, and it is with this suggestion that the present paper is concerned. (1) The airflow to the ship can be predicted sufficiently accurately, (2) A good basic ship motion prediction exists, but requires some further development and validation with real ships, (3) The ship airwake is almost unknown and previous attempts to analyze it were faulty, (4) Further work is required on turbulence modeling of helicopters, and (5) Before it is possible to determine the size of computer necessary for simulation it is necessary to determine the extent to which the mathematical model of the helicopter and the physical model of the complex fluid flowfield can be simplified, while still retaining the fidelity of the helicopter motion. GRA

N87-19389# Technische Hogeschool, Delft (Netherlands).
DESIGN AND EVALUATION OF DYNAMIC FLIGHT TEST MANEUVERS Ph.D. Thesis
JAN ALBERT MULDER 26 Oct. 1984 314 p Sponsored by Universitair Hoofd Docent
(ETN-87-99085) Avail: NTIS HC A14/MF A01

Longitudinal and lateral control input signals were evaluated in flight using an automatic control system. Significant differences between the performance of different types of control input signals are shown to exist. A technique for the optimization of control input signals with respect to norms of the information matrix is described. It is shown that in linear systems the computational effort required for the optimization can be significantly reduced by computing and storing a set of so-called elementary information matrices. The parameter-state estimation problem of dynamic flight tests is discussed in the linear and in the nonlinear case. It is shown that under certain conditions the parameter-state estimation problem can be solved in two consecutive steps pertaining to the reconstruction of the state and the estimation of the aerodynamic model parameters respectively. ESA

N87-19390# Bristol Univ. (England). Dept. of Aeronautical Engineering.
THE FEASIBILITY OF AIRCRAFT WITH ROTATING CYLINDER WINGS B.S. Thesis
K. FULLER and R. HALL Jun. 1985 101 p
(BU-327; ETN-87-99190) Avail: NTIS HC A06/MF A01

The feasibility of employing rotating cylinders as the primary lifting surfaces on a small remotely piloted vehicle was considered. A means of controlling the flow of air around a rotating cylinder was determined by wind tunnel testing. This involved the use of a rear-mounted flap, located independently of the rotating cylindrical body. The aerodynamic characteristics of a complete aircraft configuration were determined. Consideration of the estimated weight, power, and structural factors reveals no insurmountable problems. The dynamic stability characteristics of the proposed

layout indicate the aerodynamic advantages to be gained from a rotating cylinder wing. However, limitations appear to be imposed by the use of a conventional tail. This suggests an extension of the main concept to include a rotating cylinder tailplane. ESA

N87-19391# Bristol Univ. (England). Dept. of Aeronautical Engineering.
INSTALLATION OF A RADIATOR IN A LIGHT AIRCRAFT B.S. Thesis
M. A. HORSFIELD and D. M. JOHNSON Jun. 1985 48 p
(BU-330; ETN-87-99193) Avail: NTIS HC A03/MF A01

A radiator installation to be used in a light aircraft, fitted on the underside of the fuselage, just aft of the main undercarriage was tested. All models tested were full scale and included a radiator core of the type to be used on the aircraft. The models were mounted in a false floor in the wind tunnel, which was used to simulate the fuselage. Speeds used were representative of typical aircraft flight speeds. The original design, as supplied by the aircraft manufacturer, was tested first and subsequently modifications were made to try to improve the cooling efficiency and drag of the installation. Significant improvements in performance achieved. ESA

N87-19392# Bristol Univ. (England). Dept. of Aeronautical Engineering.
CONSTRUCTION AND TEST OF A COMPOSITE MICROLIGHT WING STRUCTURE B.S. Thesis
A. J. BRIGHTLEY and M. W. MEAD Jun. 1986 78 p
(BU-341; ETN-87-99204) Avail: NTIS HC A05/MF A01

The feasibility of replacing the present wing of the Microlight MW5 with a foam supported Glass Fiber Reinforced Plastic (GFRP) skin structure was studied. A full chord, one-third span test model was designed and built, and then statically loaded to twice the proof load. Construction techniques are described. Stresses within the loaded structure were measured using strain gage rosettes, and compared to a theoretical computerized analysis. The results indicate that on financial and practical grounds the foam supported wing skin structure studied is not a suitable alternative to the existing wing. However, the structure is considerably stronger and more resistant to buckling than anticipated. ESA

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A87-28125
CESSNA AIRCRAFT CABIN DOOR MOUNT FOR PHOTOGRAPHIC AND VIDEOGRAPHIC CAMERAS
DANIEL S. LONG, JOHN E. TAYLOR (Montana State University, Bozeman), and JACK MCCARTHY (Northern Arizona University, Flagstaff, AZ) Photogrammetric Engineering and Remote Sensing (ISSN 0099-1112), vol. 52, Nov. 1986, p. 1753-1755. refs

An aircraft camera mount design for collecting small-format aerial photographs and video images is described. The mount consists of a leading edge fillet, a camera compartment, and a trailing edge fillet. The construction of the mount, which is a streamlined rectangular enclosure fastened over an opening cut into the right cabin door, and the mounting of the cameras into the right cabin door are examined; the advantages of this mount design are discussed. This mount design is applied to the Cessna 150 and 172 for remote sensing activities. It is noted that the camera mount design is an inexpensive and efficient approach for small-format photographic and videographic image collection. I.F.

A87-28389
MASTER OF NIGHT ATTACK
DAVID A. ANDERTON Horizons (ISSN 0095-7615), vol. 22, no. 2, 1986, p. 2-9.

An account is given of the subsystem design modifications and additions that will be incorporated by the next-generation A-6F Intruder carrier-based attack aircraft, as well as the night-attack capabilities that these modifications will facilitate. Both targeting and, for the first time, navigation FLIR systems will be used for nocturnal operations. Both pilot and bombardier/navigator will wear 'cat's eyes' light-amplifying night vision goggles in the form of binocular lenses mounted on their helmets. The combination of a laser designator and ranging device with an IR sensor produces a versatile system than can under many conditions produce the same results as radar, but without alerting enemy air defenses. O.C.

A87-28435#
DEVELOPMENT AND EXPERIMENT OF AIRBORNE MICROWAVE RAIN-SCATTEROMETER/RADIOMETER SYSTEM. I - HARDWARE SYSTEM. II - EXPERIMENTAL DATA PROCESSING SOFTWARE SYSTEM
KENICHI OKAMOTO, TAKEYUKI OJIMA, SHIN YOSHIKADO, HARUNOBU MASUKO, HIDEYUKI INOMATA et al. Radio Research Laboratory, Review (ISSN 0033-801X), vol. 32, June 1986, p. 55-105. In Japanese, with abstract in English. refs

The features and performance of the hardware and software and the results of analyses of data gathered with an experimental airborne microwave scatterometer precipitation sensor (AMPS) are reported. AMPS has both active (10 GHz and 34.5 GHz) and passive (9.86 GHz and 34.21 GHz) microwave elements. The system was mounted on a Cessna 404 and used to scan the tops of raining areas through clouds during 80 hr of test flights. Details of the system software, including the pre-processing, data analysis, data display and support programs, their outputs and the hardware realizations and the performance of the subsystems are discussed. M.S.K.

A87-28966
AN IMPROVEMENT OF THE CALIBRATION OF THE EPPLEY PYRGEOMETER FOR THE CASE OF AIRBORNE MEASUREMENTS
GERARD BROGNIEZ, JEAN-CLAUDE BURIEZ, JEAN-CLAUDE VANHOUTTE, and YVES FOUQUART (Lille I, Universite, Villeneuve-d'Ascq, France) Beitraege zur Physik der Atmosphaere (ISSN 0005-8173), vol. 59, Nov. 1986, p. 538-551. Research supported by the Programme National d'Etude de la Dynamique du Climat. refs

Eppley pyrgeometers are widely used for measurements of radiant flux densities. This paper proposes a calibration technique which has been developed for airborne measurements. This method implicitly accounts for the thermal gradients to which the pyrgeometer dome is subject during aircraft flights, and which are obviously dependent on the experimental conditions. Practically, temperatures of dome, housing and ambient air are monitored continuously; phases of flight allowing for constant radiant fluxes are used to relate empirically the air and housing temperatures to the temperature the dome would have in equivalent laboratory conditions. The technique has been tested during the NEPHOS campaign, both in clear and cloudy conditions; it allows for a maximum uncertainty of 10 W/sq m, that is a relative uncertainty between 2 and 4 percent in most cases. Author

A87-29631#
NEAR-FIELD RADAR FOR HELICOPTER OBSTACLE AVOIDANCE [NAHBEREICHSRADAR ZUR HINDERNISWARNUNG FUER HUBSCHRAUBER]
H.-G. WIPPICH, R. BACKHUS, and G. OCH (Telefunken AG, Ulm, West Germany) Ortung und Navigation (ISSN 0474-7550), vol. 27, no. 3, 1986, p. 400-418. In German.

The development and performance testing of an onboard warning radar to help prevent helicopter-obstacle collisions are reported. The equipment design is based on the experimental measurements of Bischoff et al. (1981) and comprises a 66-GHz

radar sensor, a radar processor, and a color display giving obstacle data in polar coordinates (with an audible alarm in the case of imminent collision hazard). The display color coding differentiates four obstacle heights for the normal (look-up) operating mode: from ground to 100 ft below flight level, 100-50 ft below flight level, from 50 ft below flight level to maximum surmountable height, and insurmountable; corresponding but lower categories are available in the look-down mode. Displays from test flights toward high-voltage lines, a highway bridge, a tall antenna, and a single nonconducting cable are shown, demonstrating the ability of the equipment to detect multiple cables at 1000 m, single 30-mm-diameter cables at 800 m, and single 3-mm-diameter cables at 300 m. T.K.

A87-30550
NEW HORIZONS IN FLIGHT DISPLAYS
HARRY HOPKINS Flight International (ISSN 0015-3710), vol. 131, Jan. 31, 1987, p. 28-30.

Such standby flight instruments as horizon, airspeed, and altimeter indicators are required to give the pilot adequate instrument flying capabilities in the event of primary system failure. Attention is presently given to the development status and performance characteristics of flat panels employing LEDs or liquid crystal displays (LCDs) that use novel, but effective, symbology for pilot orientation, while taking up little panel space in the cockpit when not in use. When simplicity is a major design requirement, single-crystal LCDs can be used with layouts of separate elements created across their surfaces. O.C.

N87-19393*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
A SIMULATION EVALUATION OF A PILOT INTERFACE WITH AN AUTOMATIC TERMINAL APPROACH SYSTEM
DAVID A. HINTON Apr. 1987 21 p
(NASA-TP-2669; L-16222; NAS 1.60:2669) Avail: NTIS HC A02/MF A01 CSCL 17G

The pilot-machine interface with cockpit automation is a critical factor in achieving the benefits of automation and reducing pilot blunders. To improve this interface, an automatic terminal approach system (ATAS) was conceived that can automatically fly a published instrument approach by using stored instrument approach data to automatically tune airplane radios and control an airplane autopilot and autothrottle. The emphasis in the ATAS concept is a reduction in pilot blunders and work load by improving the pilot-automation interface. A research prototype of an ATAS was developed and installed in the Langley General Aviation Simulator. A piloted simulation study of the ATAS concept showed fewer pilot blunders, but no significant change in work load, when compared with a baseline heading-select autopilot mode. With the baseline autopilot, pilot blunders tended to involve loss of navigational situational awareness or instrument misinterpretation. With the ATAS, pilot blunders tended to involve a lack of awareness of the current ATAS mode state or deficiencies in the pilots' mental model of how the system operated. The ATAS display provided adequate approach status data to maintain situational awareness.

N87-19394# Air Force Human Resources Lab., Williams AFB, Ariz.
INTEGRATING A HEAD-UP DISPLAY WITH DOME VISUAL SIMULATION TECHNOLOGY Final Technical Paper, Dec. 1985 - May 1986
SYBIL DEGROOT and PHILLIP PEPPLER Dec. 1986 29 p
(AD-A175222; AFHRL-TP-86-43) Avail: NTIS HC A03/MF A01 CSCL 01C

When viewing a real planar image displayed in a dome through an aircraft Head-Up Display (HUD) focused for infinity, diplopia and parallax problems render the HUD useless as an aiming or training device. Since HUDs are essential to high-fidelity training in a simulator, this problem must be addressed and resolved. Two potential solutions were investigated: (1) three-dimensional (3-D) scene projection inside the dome, and (2) insertion of a newly designed and fabricated external decollimating lens over the exit lens of the HUD. Three-dimensional imagery resolved the diplopia problem, but unacceptable parallax still remained. The decollimating lens removed the double imagery and parallax problems, but had one major side effect: shrinkage of the HUD's total field of view approximately 12%, as determined by theodolite readings. It is concluded that 3-D head/eye-tracked dome displays, with mathematical correction for parallax, have a potential for use with unmodified HUDs. An external lens is the most cost-effective means making a standard aircraft HUD usable in a dome display, but further research should be pursued to determine the effects, if any, of the diminished image on training effectiveness. GRA

07

AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboa rd auxiliary power plants for aircraft.

A87-27811#
APPLICATION OF REISSNER METHOD TO FREE VIBRATIONS OF A TAPERED, TWISTED, AEROFOIL CROSS-SECTION TURBINE BLADE, MOUNTED AT A STAGGER ANGLE ON A ROTATING DISC
J. S. RAO and N. S. VYAS (Indian Institute of Technology, New Delhi, India) Defence Science Journal (ISSN 0011-748X), vol. 36, July 1986, p. 273-292. Research supported by the Aeronautical Research and Development Board. refs

The dynamic Reissner functional in conjunction with Ritz process has been employed to derive the equations of motion of a practical case of a tapered, twisted, asymmetric aerofoil cross-section steam-turbine blade mounted at a stagger angle on a rotating disc. Higher order effects such as shear deformation, rotary inertia, coriolis forces have been neglected. A general computer program developed solves the eigenvalue problem to give the natural frequencies of the blade. Author

A87-27989*# Texas A&M Univ., College Station.
OFF-DESIGN ANALYSIS OF COUNTER-ROTATING PROPELLER CONFIGURATIONS
K. D. KORKAN and J. A. GAZZANIGA (Texas A & M University, College Station) Journal of Propulsion and Power (ISSN 0748-4658), vol. 3, Jan.-Feb. 1987, p. 91-93.
(Contract NAG3-354)

An analysis is conducted to determine whether the counterrotating propeller configuration maintains, and perhaps improves, its excellent performance in the off-design mode for the constant-speed or variable-pitch case. While the twist distribution is maintained, the blade angle is changed to absorb shaft horsepower as a constant rpm setting is maintained under varying freestream velocities. A relatively flat propeller efficiency curve is obtained for advance ratios of 1.5-5.0. O.C.

A87-28350
EXCITATION AND VIBRATION OF A BLADED DISK UNDER OPERATING AND SIMULATED OPERATION CONDITIONS
A. MALEK Zprava VZLU, no. Z-48, 1986, p. 1-10. refs

This report is concerned with the vibration of bladed disk assemblies, especially of compressor impellers. The theoretical part is focused on an analytical description of exciting rotating vectors, i.e., the forcing functions which result from the difference between the number of blades and the number of vanes. From knowledge of rotating vectors of excitation and of the dynamical properties of a bladed disk, it is possible to predict resonances that occur under the given operating conditions. This knowledge may also be used for the simulation of the operating excitation that enables the study of the wave phenomena even on the nonrotating bladed disks. The experimental results confirmed the validity of the theoretical solution. Attention in the experimental part is also paid to the behavior of real impellers which possess

two independent modes of vibration and thus two natural frequencies for each number of nodal diameters. Author

A87-29265
INSTALLATION AERODYNAMICS OF EJECTORS IN COMBAT AIRCRAFT
P. G. KNOTT and D. N. CUNDY (British Aerospace, PLC, Military Aircraft Div., Warton, England) Aeronautical Journal (ISSN 0001-9240), vol. 90, Dec. 1986, p. 410-413.

The aerodynamics of ejector augmentors for increasing the takeoff and landing performance of STOL combat aircraft are discussed. The main design problems are the intake and exhaust shapes, the degree of thrust vectoring required, and the need for a benign footprint. Comparisons are made between the effects of thrust augmentation and dilution. The problem is reduced to tradeoff in disk area, flow volume and mass. Candidate inlet shapes are examined and a bell mouth is identified as the reference shape for attaining pressure recoveries up to 98 pct, provided certain other measures are taken of critical flight phases. Thrust vectoring is demonstrated to be necessary for satisfactory transition performance. M.S.K.

A87-29281#
FATIGUE CRACK GROWTH TESTING OF J85-CAN-40 COMPRESSOR DISCS
A. HULL (Toronto, University, Canada), R. V. DAINTY, M. D. RAIZENNE (National Aeronautical Establishment, Ottawa, Canada), and D. W. HOEPPNER (Utah, University, Salt Lake City) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 32, Dec. 1986, p. 321-332. refs

Attention is given to the results of a spin pit test program conducted on three fifth-stage compressor disks used on the J85-CAN-40 turbojet engine in order to ascertain the growth rate behavior of cracks or discontinuities found to be propagating from the tie bolt holes in the disks. The data thus obtained can be used to determine the applicability of such a component to the 'retirement-for-cause' lifting approach. The tests encompassed constant amplitude and variable amplitude loading and quantitative fractographic analysis of selected cracks, as a means of comparing field service crack growth rates with those obtained through spin pit tests. O.C.

A87-29388#
PERFORMANCE ANALYSIS OF A MIXED FLOW TURBOFAN ENGINE AT THE DESIGN POINT
C. SRINIVASA (National Aeronautical Laboratory, Bangalore, India) IN: National Conference on I.C. Engines and Combustion, 9th, Dehra Dun, India, Nov. 19-22, 1985, Proceedings. Volume 2 . Dehra Dun, India, Indian Institute of Petroleum, 1986, p. J-7, p. 1-7.

An account is given of mixed flow turbofan engine performance calculation results for the design point, using a thermodynamic cycle analysis program which takes specific fuel consumption and turbine outlet temperature as the main parameters. The altitude and Mach number considered are 20,000 ft and 0.7, respectively, as would be encountered in subsonic, short range transport aircraft during cruise conditions. Performance conparisons are made between mixed and unmixed flow engine types; a deterioration of fuel efficiency is noted for bypass ratios higher than 5. O.C.

A87-29389#
SOME ASPECTS OF GAS TURBINE COMBUSTION USING AIR-BLAST ATOMIZERS
P. GOVINDARAJAN (Government College of Engineering, Salem, India) and S. G. MUKHERJEE (Indian Institute of Technology, Kharagpur, India) IN: National Conference on I.C. Engines and Combustion, 9th, Dehra Dun, India, Nov. 19-22, 1985, Proceedings. Volume 2 . Dehra Dun, India, Indian Institute of Petroleum, 1986, p. J-8, p. 1-4. refs

An experimental study is carried out to assess the suitability of air-blast atomizers for gas turbine combustion, especially at lower operating pressures with respect to combustion efficiency, lean stability limit and flame emissivity. Two types of air-blast nozzles namely the pre-filming and plain jet type were designed, fabricated and tested for their suitability in a conventional gas turbine combustor. A comparison is made between the two types of atomizers with respect to their combustion characteristics. Author

A87-29454#
DESIGN VERIFICATION SYSTEM FOR ADVANCED AEROSPACE ENGINES
H. M. GIBSON (Pratt and Whitney, East Hartford, CT) IN: Aerospace Testing Seminar, 9th, Los Angeles, CA, Oct. 15-17, 1985, Proceedings . Mount Prospect, IL, Institute of Environmental Sciences, 1986, p. 106-115.

A new design verification system based on validating a design is described. The relation between management and manufacturing systems and the design and verification process are examined. Examples of the application of the design verification system methodology to commercial and military engines are presented. An improved program for evaluating the Space Shuttle main engine is discussed. Consideration is given to the Japanaese 'Kan Ban' system and statistical process control related to engine design. I.F.

A87-29561#
PREDICTION OF COMPRESSOR AND TURBOJET PERFORMANCE WITH DISTORTED INLET FLOW
HUILI SHEN, FUGUN CHEN, GUODONG YANG, GECHENG CHA, and XIAOCHUN LIAN Northwestern Polytechnical University, Journal, vol. 3, July 1985, p. 385-390. In Chinese, with abstract in English.

Modifying the well-known 'parallel compressor model' with a view to making it applicable to the turbojet engine as a whole, the authors suggest a method for predicting the engine operating point, as well as compressor characteristics when distorted inlet flow is present. According to the model, two flows from subcompressors are assumed to mix completely in a hypothetical mixing chamber between the compressor and the burner. The real compressor is assumed to surge when one of the subcompressors does so. The gas parameters of the mixture of the two flows from the parallel subcompressors are computed according to given equations, and the matching equations for the case of a running engine are solved as in conventional calculations. The performance of a single spool turbojet with an inlet distorted flow field is computed as an example. The calculative results agree satisfactorily with experimental data. C.D.

A87-29576
STARTING SYSTEMS TECHNOLOGY II; PROCEEDINGS OF THE AEROSPACE TECHNOLOGY CONFERENCE AND EXPOSITION, LONG BEACH, CA, OCT. 13-16, 1986
Conference and Exposition sponsored by SAE. Warrendale, PA, Society of Automotive Engineers, Inc. (SAE SP-678), 1986, 64 p. For individual items see A87-29577 to A87-29583.
(SAE SP-678)

The present conference considers the past, present and future development of auxiliary power units (APUs), the technology development status of fast-start APUs, advanced pneumatic-start systems for APUs, and the development of a hot gas vane motor for aircraft starting systems. Also considered are a systems approach to engine starting system design, the minimization of heat rejection in aircraft accessory drive gearboxes, and the vibratory strain distribution in an integrally machined air turbine starter wheel. O.C.

A87-29577
PAST, PRESENT AND FUTURE OF HYDRAULIC APU START SYSTEMS
PHIL GALLOWAY (Vickers, Inc., Jackson, MS) IN: Starting systems technology II; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 1-10. refs
(SAE PAPER 861711)

Hydraulic auxiliary power unit (APU) starter systems for aircraft gas turbine engines furnish greater self-sufficiency and versatility, and lower weight, than existing alternative systems. Attention is presently given to the generic hydraulic APU start motor configuration, two actual applications, and design trends indicative of future developments. Higher system operating pressures and nonflammable hydraulic fluids are foreseen. O.C.

A87-29578
FAST START APU TECHNOLOGY
COLIN RODGERS (Sundstrand Corp., Sundstrand Turbomach, San Diego, CA) IN: Starting systems technology II; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 11-20. refs
(SAE PAPER 861712)

Auxiliary Power Unit (APU) start system weights can be a significant fraction of the total installed APU weight, especially for the case of such severe requirements as those for fast starts in sub-Arctic environments. It is presently shown that both start system weight and rotor containment armor weight are proportional to the product of rotational speed squared and rotating assembly inertia. Significant weight savings are therefore obtainable through the use of rotating assemblies that employ such low density materials as ceramics and composites. Attention is given to the results of analytical studies on APU systems of this type. O.C.

A87-29579
ADVANCED PNEUMATIC START SYSTEMS FOR APUS
R. W. GAZZERA (Garrett Fluid Systems Co., Tempe, AZ) IN: Starting systems technology II; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 21-29.
(SAE PAPER 861713)

Pressurized Air Start System (PASS) technology offers an alternative to conventional electric or hydraulic starting systems for APUs. The major advantage of the PASS system over other systems is that it can provide effective starts at temperatures as low as -65 F. But what penalty must be paid in order to achieve this benefit of low-temperature operation? In this paper, the characteristics of some real-world PASS systems compared to electric or hydraulic systems are reviewed. Then some hypothetical questions are posed that help to generalize the comparisons. From these generalized comparisons, it is concluded that the PASS system is usually lighter than alternative approaches, but that work is required to improve the volume of PASS systems. Finally, a comparison among start systems is made in this paper based on the prediction of how these start systems will evolve in 1995. Author

A87-29580
DEVELOPMENT OF A HOT GAS VANE MOTOR FOR AIRCRAFT STARTING SYSTEMS
G. DUSENBERRY and D. CARLSON (Rocket Research Co., Redmond, WA) IN: Starting systems technology II; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 31-38.
(Contract F33615-84-C-2453)
(SAE PAPER 861714)

Design, analyses, and tests have been conducted on a double-cavity (pressure-balanced) hot gas vane motor suitable for aircraft APU starting over the temperature range of -54 to + 54 C. Testing of the motor was accomplished with H-70 (70 percent hydrazine, 30 percent water) monopropellant hot gas decomposition products. Motor development focused on testing minor modifications aimed at eliminator vane breakage. The performance goals (zero to 8800 rpm in 8 to 10 seconds) were achieved after approximately 40 tests. Hot restarts and starts at the extreme temperatures have also been demonstrated. Author

A87-29581
A SYSTEMS APPROACH TO ENGINE STARTING SYSTEM DESIGN
E. SCICCHITANO and F. TEPES (Grumman Corp., Aircraft Systems Div., Bethpage, NY) IN: Starting systems technology II; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 39-44.
(SAE PAPER 861734)

An account is given of systems methodology-defined aspects of pneumatic engine starting systems' mechanical design, together with achievable performance levels. Primary considerations encompass engine torque characteristics, the use of airport start cart or APU, system pressure drop level, accessory gearbox loading, and the use of cold-well starting systems. Attention is given to operational requirements and aircraft/engine design integration practices typical of state-of-the-art starting systems. O.C.

A87-29582
MINIMIZING HEAT REJECTION IN AIRCRAFT ACCESSORY DRIVE GEARBOXES
WILLIAM A. MARESKO (Sundstrand Corp., Sundstrand Aviation Mechanical Div., Rockford, IL) IN: Starting systems technology II; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 45-48.
(SAE PAPER 861736)

A test program was initiated to study the effects of improved lubrication delivery on the total heat rejection of an aircraft accessory drive gearbox. The goal of this program was to reduce the overall gearbox heat rejection by minimizing the viscous drag and churning losses. The most practical heat sink available to secondary power subsystems on supersonic aircraft is the fuel supply; and due to its limited capacity, reduced heat rejection from these systems is very desirable. A model of gearbox cooling requirements will be presented and compared with the lube distribution of a baseline gearbox and subsequent modified configurations. The effects of oil-in temperature, and lube gallery pressure on heat rejection are shown, with emphasis placed on minimizing this heat rejection. Author

A87-29583
VIBRATORY STRAIN DISTRIBUTIONS IN AN INTEGRAL-MACHINED AIR TURBINE STARTER WHEEL
JOEL R. GIARD and GRADY W. BOWERS (Garrett Fluid Systems Co., Tempe, AZ) IN: Starting systems technology II; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 49-59.
(SAE PAPER 861737)

Turbine blade fatigue failures began to occur on the Garrett Air Turbine Starter, Model ATS200-58, in commercial airline service. A comprehensive program including metallurgical analysis, finite-element analysis, and strain gage testing of instrumented turbine wheels resulted in large quantities of data on blade vibratory strain. The results of testing various configurations, including the addition of damping and the use of different numbers of stator vanes, are presented. Author

A87-29951
THE PREDICTION OF THE DYNAMIC BEHAVIOR OF AIRCRAFT ENGINES CRITICAL SPEEDS, THE EFFECTS OF UNBALANCES [PREDICTION DU COMPORTEMENT DYNAMIQUE DES MOTEURS D'AVION VITESSES CRITIQUES-EFFETS DE BALOURDS]
P. BERTHIER, G. FERRARIS, and M. LALANNE (Lyon, Institut National des Sciences Appliquees, Villeurbanne, France) Journal de Mecanique Theorique et Appliquee (ISSN 0750-7240), vol. 5, no. 4, 1986, p. 573-585. In French. DRET-SNECMA-supported research. refs

A numerical model is presented for the dynamic behavior multi-rotors in a coaxial configuration, i.e., turbojets. A finite element approach is implemented, with blades treated as beams experiencing shear, rotational inertia and Coriolis forces. Account is taken of periodicity in the stresses imposed by the flow on successive rows of blades, and of the downstream influence one row has on the flow impinging on the next row. Nodal displacements are employed to cover the effects of unbalances between blade rows. A pseudo-modal solution technique is described for the model, which can track the evolution of the natural modes of the blades. M.S.K.

A87-30501
AVCO-PRATT - GETTING ITS LHX ENGINE FIELD-READY
DAVID HARVEY Rotor and Wing International (ISSN 0191-6408), vol. 21, Feb. 1987, p. 26, 28, 56.

An account is given of two manufacturers' joint development and manufacturing of the U.S. Army LHX helicopter competition-oriented T-800-APW-800 turboshaft engine. The primary performance goals of this engine's development have been (1) high power/weight ratio; (2) high fuel economy; (3) a fast response rate to throttle settings, in keeping with required LHX agility; and (4) exceptional service life. The engine is of two-spool configuration, with a three-stage variable geometry compressor having two axial stages and a centrifugal one. Attention is given to development efforts aimed at the 'soldier proofing' of engine maintenance requirements. O.C.

A87-30502
LHTEC - PUTTING ITS T800 CANDIDATE TO THE TEST
DAVID HARVEY Rotor and Wing International (ISSN 0191-6408), vol. 21, Feb. 1987, p. 27, 29, 57.

A development status report is presented for two manufacturers' collaborative efforts in the U.S. Army's LHX helicopter engine competition; the T800 turboshaft that is the product of these eforts has recently been subjected to severe environment-simulating tests involving sand particle ingestion, ballistic impact, and ice ingestion damage resistance. The LHX engine must in addition be able to operate at maximum continuous power for six minutes without lubricating oil, without experiencing catastrophic failure. O.C.

A87-31150
LOW ASPECT RATIO AXIAL FLOW COMPRESSORS - WHY AND WHAT IT MEANS
ARTHUR J. WENNERSTROM (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH) SAE, Cliff Garrett Turbomachinery Award Lecture, 3rd, Long Beach, CA, Oct. 14, 1986. 14 p. refs (SAE PAPER 861837)

After 1970, low aspect ratio blade-employing axial compressor designs emerged which proved capable of reducing parts counts, improving structural ruggedness, and increasing aeroelastic stability. Efficiencies obtained in the current generation of such compressors are superior to those of compressors with more moderate aspect ratios, while weighing somewhat less. Coincident with decreasing aspect ratios have been rising Mach numbers, in virtue of the improving ability of designers to arrive at aerodynamically efficient cross sections as well as of advancements in metallurgical and manufacturing technologies that permit higher tip speeds. O.C.

A87-31187#
EXPERIMENTAL EXAMINATION OF A PREVAPORIZED PREMIXED COMBUSTOR
C. L. PROCTOR, II (Florida, University, Gainesville) and A. M. MELLOR (Drexel University, Philadelphia, PA) AIAA Journal (ISSN 0001-1452), vol. 25, April 1987, p. 573-577. USAF-sponsored research.

An experimental prevaporizing/premixing combustor configuration was examined. Evaluation of the combustor configuration was accomplished by extracting gas samples at discrete locations from within the combustor and analyzing them for unburned hydrocarbons, CO, CO2, and O2. These data were used to calculate local combustion efficiency and temperature. Contour plots were developed to interpret the gaseous flowfield. Results indicate two distinct regions of combustion: one in the recirculation zone providing constant ignition of incoming air/fuel mixture, and another where vitiated air impinges on the burning air/fuel mixture downstream of the ignition source. Author

A87-31209#
ROLLS REVS UP FOR THE NEW CENTURY
KENNETH OWEN Aerospace America (ISSN 0740-722X), vol. 25, Feb. 1987, p. 24-27.

Market and design studies have led Rolls Royce to focus on the Contrafan, Superfan and the propfan for new generations of commercial transport aircraft engines. Fuel efficiency will be a prime concern for longer-range aircraft engines, while maintenance and ownership will be dominant concerns for commuter aircraft. The 50,000 lb thrust RB529 Contrafan will have an aft-mounted contrarotating fan directly driven by the low pressure turbine, with no drive shaft in the engine core. The same ducted-fan approach will be used with the 25,000-40,000 lb thrust RB541 Superfan, for which tests are planned to evaluate the desirability of including variable pitch. The 10,000-25,000 lb thrust RB509 propfan engine may feature hollow blades and furnish 35 pct higher fuel efficiency than current engines. Consideration is being given to smaller turboprops, hypersonic propulsion systems, and a new SST to replace the Concorde are noted. M.S.K.

A87-31277*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PREDICTION OF THE STRUCTURE OF FUEL SPRAYS IN CYLINDRICAL COMBUSTION CHAMBERS
JIAN-SHUN SHUEN (NASA, Lewis Research Center; Sverdrup Technology, Inc., Cleveland, OH) Journal of Propulsion and Power (ISSN 0748-4658), vol. 2, Mar.-Apr. 1987, p. 105-113. Previously cited in issue 11, p. 1482, Accession no. A86-26636. refs
(Contract NAS3-24105)

A87-31278#
TEMPERATURE AND CONCENTRATION MEASUREMENTS IN A SOLID FUEL RAMJET COMBUSTION CHAMBER
G. SCHULTE, R. PEIN, and A. HOEGL (DFVLR, Institut fuer Chemische Antriebe und Verfahrenstechnik, Hardthausen am Kocher, West Germany) Journal of Propulsion and Power (ISSN 0748-4658), vol. 3, Mar.-Apr. 1987, p. 114-120. refs

The combustion of solid fuels has been studied by using a solid fuel ramjet combustion chamber equipped with a vitiated air heater. The fuels were polyethylene (PE) and hydroxyl-terminated polybutadiene (HTPB), with PE being the prevailing fuel. The air was heated by combustion of hydrogen and oxygen. In order to get a better understanding of the combustion process, a thermocouple and a gas-chromatographic technique were used to obtain temperature and species concentration profiles throughout the combustion chamber. The measurements were taken at several axial and radial positions of the combustion chamber, including measurements in the recirculation zone of the flameholder and in the afterburner chamber. The influence of different test conditions, like mixture ratio, inlet temperature, and mass flux, was also investigated. The results are discussed with regard to flame position, turbulent mixing, and combustion efficiency. Author

A87-31287#
TECHNOLOGY FOR THE DESIGN OF HIGH TEMPERATURE RISE COMBUSTORS
D. W. BAHR (General Electric Co., Cincinnati, OH) Journal of Propulsion and Power (ISSN 0748-4658), vol. 3, Mar.-Apr. 1987, p. 179-186. Previously cited in issue 18, p. 2623, Accession no. A85-39705. refs

N87-18567# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil). Work Group on Ramjet Engines.
THERMODYNAMIC STUDY OF RAMJET ENGINES [ESTUDO TERMODINAMICO DE ESTATO-REATORES]
CARLOS EDUARDO ROLFSENSALLES and WALTER GILL Dec. 1986 18 p In PORTUGUESE; ENGLISH summary
(INPE-4071-RPE/527) Avail: NTIS HC A02/MF A01

The recent worldwide interest in developing ramjet engines has motivated this preliminary study of the ramjet thermodynamic cycle. Results show that for fixed flight conditions (altitude, flight Mach number and thrust) there is an optimum combustor temperature which furnishes a minimum fuel consumption. Author

N87-18569# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
PERFORMANCE OF HIGH TEMPERATURE COATINGS ON F100 TURBINE BLADES UNDER SIMULATED SERVICE CONDITIONS
A. J. A. MOM and H. J. C. HERSBACH 20 Mar. 1986 17 p Presented at the International Symposium on High Temperature Corrosion, Marseille, France, 7-12 Jul. 1986
(NLR-MP-86021-U; B8675508; ETN-87-99515) Avail: NTIS HC A02/MF A01

The performance of various pack, gas phase, and noble metal aluminide and overlay coatings, applied on F100 first stage turbine blades, was determined in a 300 hr simulated service tests in a high temperature burner rig using flight-by-flight test conditions. Relative coating life and ranking, based on these particular blade/coating systems, was established. The NiCoCrAlY overlay coating shows superior performance. The coating life of the noble metal aluminides is no better than that of normal aluminides, despite their good oxidation/corrosion behavior. This is due to the brittle nature of the noble metal aluminides, which results in early cracking and spalling. ESA

N87-19395# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
COMBUSTION, SIMULATION AND TEST STATISTICS ON SOLID-FUELED RAMJET ENGINES [COMBUSTAO, SIMULACAO E TESTES ESTATICOS EM ESTATO REATORES A COMBUSTIVEL SOLIDO]
WALTER GILL, DEMETRIO BASTOSNETTO, CARLOS EDUARDO SERAPHICODES.MIGUEIS, JOSE GOBBOFERREIRA, JOAO ANDRADE DECARVALHOJUNIOR, and JOSE CARLOS ALBANODOAMARANTE Dec. 1986 16 p In PORTUGUESE; ENGLISH summary Presented at ENCIT/86
(INPE-4095-RPE/531) Avail: NTIS HC A02/MF A01

Aspects of the design and operation of vitiated air heaters used for the simulation of flight conditions in the testing of solid fueled ramjet engines are presented. The operational characteristics of such engines are also analyzed. Author

N87-19396# California Inst. of Tech., Pasadena.
MECHANISMS OF EXCITING PRESSURE OSCILLATIONS IN RAMJET ENGINES Annual Report, Sep. 1985 - Sep. 1986
FRANK E. MARBLE 1986 23 p
(Contract AF-AFOSR-0286-84)
(AD-A174608; AFOSR-86-0988TR) Avail: NTIS HC A02/MF A01 CSCL 21B

During the past two years, we have been able to understand, in principle, the mechanism of one predominant mode of combustion instability in dump combustors for ramjet engines. The objectives of further experiments have been to provide a quantitative, physical basis for elements of this mechanism which will allow application of the results to a wide class of combustor sizes, fuels and mixture ratios, and to more complex acoustic environments. One mode of unsteady combustion in dump burners, which under certain circumstances may lead to combustion instability, involves the periodic formation of a large vortex in the separated shear layer and its subsequent movement toward the combustor wall. When oscillations appear, the frequency of the vortex shedding coincides with that of some natural acoustic mode of the apparatus. Detailed experiments show that the heat release which drives the oscillation occurs predominantly as the result of an interaction between this vortex and the wall. Recent experiments and calculations have shown that the time delay between vortex formation and the wall encounter is strongly dependent on the pressure amplitude of the oscillation and, consequently, and acoustic mode of particular frequency will be excited to an amplitude required to produce the suitable phase of the heat release. Experiments have been performed to assess the role of chemical time in the overall time delay. GRA

N87-19397# Scientific Research Associates, Inc., Glastonbury, Conn.
FLOW THROUGH A COMPRESSOR STAGE Final Report, 21 Jun. 1983 - 31 May 1986
H. J. GIBELING, B. C. WEINBERG, S. J. SHAMROTH, and H. MCDONALD May 1986 55 p
(Contract F49620-83-C-0119)
(AD-A175026; R86-910004-F; AFOSR-86-2181TR) Avail: NTIS HC A04/MF A01 CSCL 20D

The present effort has led to the development of a numerical procedure of the stage flow field based upon solution of the Navier-Stokes equations. The specific case considered is the basic case in which two-dimensional flow and equal rotor and stator pitch are assumed. The procedure developed is capable of obtaining periodic solutions for a grid of 7500 points within ten CPU minutes of Cray run time. This represents a very efficient technique which will permit runs of this type on a regular basis, and which will allow extension to either three dimensions or to stages in which rotor and stator have unequal pitch and the multiple stages. The results obtained show the qualitatively expected features. Periodicity was obtained essentially within five cycles. The major effect of the interaction to the specific case considered appeared in the leading edge region of the downstream rotor blade. Significant perturbation pressures were noted, Delta Cp approx. = 0.4, which has major implications regarding unsteady loading and unsteady fluid structure interaction. The concentration of the interaction effect in the leading edge has particular significance in regard to unsteady pitching moment. Although less significant, unsteady effects were noted over the aft portion of the trailing blade, as well as over the entire leading blade. GRA

N87-19398# Purdue Univ., West Lafayette, Ind. School of Mechanical Engineering.
RESEARCH ON AERO-THERMODYNAMIC DISTORTION INDUCED STRUCTURAL DYNAMIC RESPONSE OF MULTI-STAGE COMPRESSOR BLADING Annual Summary Report, 16 May 1985 - 15 Jun. 1986
SANFORD FLEETER Aug. 1986 114 p
(Contract F49620-83-K-0029)
(AD-A175904; ME-TSPC-TR-86-11; AFOSR-86-2113TR) Avail: NTIS HC A06/MF A01 CSCL 20K

The structural dynamic response of turbomachinery components to aerothermodynamic distortion induced excitations is of major concern in the design of advanced gas turbine engines. Rotor speeds at which these resonant forced responses occur can be predicted with Campbell diagrams. However, due to inadequacies of existing time-variant aerodynamic models, no accurate prediction can be made for the amplitude of the resulting vibrations and stresses. Therefore, this research program seeks to quantitatively investigate the fundamental phenomena relevant to aerothermodynamic distortion induced structural dynamic blade responses in multi-stage gas-turbine engine components. Flow physics of multi-stage blade row interactions is being experimentally investigated, with unique unsteady aerodynamic data obtained to

understand, quantify, and discriminate the fundamental flow phenomena as well as to direct the modeling of advanced analyses. Data are being obtained to define both the potential and viscous flow interactions and the effect on the aerodynamic forcing function and the resulting unsteady aerodynamics of both rotor blades and stator vanes. Analytically, a first principles capability to predict the vibrational response of blading due to aerodynamic excitations is being developed. Unsteady viscous flow analyses, appropriate for aerodynamic forced response predictions, are also being developed. GRA

N87-19399# Technische Univ., Berlin (West Germany). Fachbereich 12 Verkehrswesen.
ALTERNATIVES FOR THE PROPULSION OF GLOBAL RANGE TRANSPORT AIRCRAFT Ph.D. Thesis [ANTREBSALTERNATIVEN FUER GLOBALE TRANSPORTFLUGZEUGE]
DIETRICH WOLFGANG FELLENZ 1985 365 p In GERMAN; ENGLISH summary
(ETN-87-98978) Avail: NTIS HC A16/MF A01

Alternatives for the propulsion of global range transport aircraft responsive to the depletion of fossile fuels as well as to socioeconomic boundary conditions are investigated. The generation of nuclear energy on board and the remote transmission of energy by laser radiation are considered. Studies are carried out for 4 Mach number regimes and for distances of 10,000, 15,000, and 20,000 km: subsonic, supersonic, hypersonic, and a rocket glider. The concepts are subjected to a multiparametric, socioeconomic evaluation, carried out separately for the points of view of the airline, the passenger, and the environment/public. The results indicate that in the subsonic regime a nominal improvement in rank is obtained by using alternate energy sources in combination with the hydrogen-burning propfan, and with increasing ranges. The strongest effect occurs in the supersonic regime, and with increasing range. In the hypersonic regime as well as for the rocket glider, chemical concepts are the only solution. ESA

08

AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

A87-28343#
PITCHING OSCILLATING DERIVATIVES OF WEDGES IN SUPERSONIC AND HYPERSONIC
HANMIN YANG (Nanjing Aeronautical Institute, People's Republic of China) and JINGSONG CHEN Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 4, Dec. 1986, p. 440-445. In Chinese, with abstract in English. refs

Using perturbation method of the frequency, numerical results for the pitching oscillating derivative of a wedge in supersonic and hypersonic flow are obtained, which consist of a series and including the fifth power of the frequency. The numerical results of this paper are in agreement with the numerical results of Van Dyke's (1954) and Lighthill's (1953) theories as a special case when the wedge angles are not large. The application ranges of the method in this paper have been extended from low frequency for the theory of Hui (1969) to the higher frequency case. Author

A87-28910*# Integrated Systems, Inc., Palo Alto, Calif.
NONLINEAR FLIGHT TEST TRAJECTORY CONTROLLERS FOR AIRCRAFT
P. K. A. MENON, M. E. BADGETT, R. A. WALKER (Integrated Systems, Inc., Palo Alto, CA), and E. L. DUKE (NASA, Flight Research Center, Edwards, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 10, Jan.-Feb. 1987, p. 67-72. refs
(Contract NAS2-11877)
(AIAA PAPER 85-1890)

Flight test trajectory control systems are designed to enable the pilot to follow complex trajectories for evaluating an aircraft within its known flight envelope and to explore the boundaries of its capabilities. Previous design approaches were baed on linearized aircraft models necessitating a large amount of data storage along with gain schedules. In this paper, the synthesis of nonlinear flight test trajectory controllers for a fixed-wing aircraft is described. This approach uses singular perturbation theory and the recently developed theory of prelinearizing transformations. These controllers do not require gain scheduling for satisfactory operation, can be used in arbitrarily nonlinear maneuvers, and are mechanized with a direct, noniterative analytic solution. Author

A87-28911#
APPLICATION OF EIGENSTRUCTURE ASSIGNMENT TO FLIGHT CONTROL DESIGN: SOME EXTENSIONS
KENNETH M. SOBEL (Lockheed-California Co., Burbank) and ELIEZER Y. SHAPIRO (HR Textron, Inc., Valencia, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 10, Jan.-Feb. 1987, p. 73-81. refs

The eigenstructure assignment flight control design methodology is extended to include dynamic compensator synthesis and damping ratio sensitivity reduction. Dynamic compensators may be designed via eigenstructure assignment by utilizing a composite system structure. The success of this design methodology depends upon proper choice of the desired eigenvectors. Sensitivity measures are developed that relate the perturbation of the damping ratio to perturbations in the stability derivatives. A damping ratio sensitivity plot is introduced that allows the damping ratio sensitivity to be reduced without altering the nominal damping ratio. Examples of the lateral dynamics of an L-1011 aircraft are presented to illustrate the design methods. Author

A87-28912#
LINEAR-QUADRATIC-GAUSSIAN WITH LOOP-TRANSFER RECOVERY METHODOLOGY FOR AN UNMANNED AIRCRAFT
D. BRETT RIDGELY, SIVA S. BANDA, TIMOTHY E. MCQUADE, and P. J. LYNCH (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 10, Jan.-Feb. 1987, p. 82-89. refs
(AIAA PAPER 85-1927)

The linear-quadratic-Gaussian with loop-transfer-recovery methodology is considered for flight control design. Several advantages of this method, as well as some precautions that practicing designers should consider during application, have been highlighted. A roll attitude control system is designed for an unmanned aircraft using this methodology. It is demonstrated that this methodology is transparent in addressing such issues as uncertainty descriptions, stability robustness, trade-offs between robustness and available actuator power, bandwidth limitations, and prefilter design. Author

A87-28918#
OPTIMIZATION OF CRUISE AT CONSTANT ALTITUDE
COLIN N. GORDON (General Motors Corp., Delco Systems Operations, Goleta, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 10, Jan.-Feb. 1987, p. 116-118. refs

Cruise trajectories computed by means of the cruise cost function proposed by Erzberger (1980), and the global flight paths of which they are a part, are found to be suboptimal. It is suggested

that, unless the error can be estimated or at least bounded for each trajectory, an exact cruise cost function should be used. Such a cost function may be selected from those presently discussed. O.C.

A87-29249
A DECENTRALIZED APPROACH TO INTEGRATED FLIGHT CONTROL SYNTHESIS
M. K. VUKOBRATOVIC (Institut za Automatizaciju i Telekomunikacije, Belgrade, Yugoslavia) and R. D. STOJIC (Aeronautical Institute, Belgrade, Yugoslavia) Automatica (ISSN 0005-1098), vol. 22, Nov. 1986, p. 695-704. refs

A new approach to decoupled control of large-scale nonlinear systems is applied to a dynamic flight control. Control synthesis is performed in two steps. First the nominal, programmed control is synthesized using the complete model of flight dynamics. This nominal control should realize the nominal trajectory under ideal conditions with no perturbations. In the second step the tracking of the nominal trajectory is realized. The system is viewed as a set of decoupled subsystems and for each subsystem local control is synthesized. Then, the stability of the overall system is analyzed and the global control is introduced to compensate coupling among some of the subsystems. A particular choice of subsystems in a case of flight control and of local and global control synthesis is proposed. A simulation of flight control with the proposed control law is also presented. Author

A87-29558#
NON-LINEAR OBSERVER FOR ESTIMATING AIRCRAFT STATE FROM FLIGHT TEST DATA
JIANHUA DENG and RUDOLF BROCKHAUS Northwestern Polytechnical University, Journal, vol. 3, July 1985, p. 343-354. In Chinese, with abstract in English. refs

A sufficiently accurate nonlinear observer for estimating aircraft state is introduced which takes into account coupling between longitudinal and lateral motion and includes proper feedback for all three acceleration components. The observer can be used to estimate simultaneously the angle of attack and the slip angle using accurately measured flight test data under steady or unsteady maneuver conditions. Results from flight tests prove that the observer has very good estimation characteristics in different flight maneuvers, meeting the required accuracy of 0.2 deg. The observer is very robust against stochastic turbulence and against drastic changes in flight conditions. C.D.

A87-29586* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AIRCRAFT PERFORMANCE AND CONTROL IN DOWNBURST WIND SHEAR
RICHARD S. BRAY (NASA, Ames Research Center, Moffett Field, CA) IN: Wind shear; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 13-38. refs
(SAE PAPER 861698)

The methods developed for analyses of the winds and of aircraft performance during an investigation of a downburst wind-shear-induced accident have been utilized in a more general study of aircraft performance in such encounters. The computed responses of a generic, large transport aircraft to take-off and approach encounters with a downburst wind field were used in examining the effects of performance factors and control procedures on the ability of the aircraft to survive. Obvious benefits are seen for higher initial encounter speeds, maximum thrust-weight values typical of two-engined aircraft, and immediacy of pilot response. The results of controlling to a constant, predetermined, pitch attitude are demonstrated. Control algorithms that sacrifice altitude for speed appear to provide a higher level of survivability, but guidance displays more explicitly defining flightpath than those commonly in use might be required. Author

A87-29588
A NEW LOOK AT PILOTING PROCEDURES IN MICROBURSTS
WILLIAM W. MELVIN (Air Line Pilots Association, Washington, DC) IN: Wind shear; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 49-59. refs

The airspeed increases which appear on all flight data recorders of aircraft which crashed in microburst wind shears are examined. Two reasons for these airspeed increases are suggested which contradict previous analysis. One reason is evident now from the recent studies on optimum trajectories. Another type of airspeed increase which occurs when aircraft escape a microburst is also examined. Several cases of both types of airspeed increases are discussed to show how some previous analysis has underestimated the severity of the wind shears which consequently has caused pilots to underestimate the risks involved. With reference to the study of optimum trajectories, recommendations to pilots are examined to discover if some pilots have been taught a recovery procedure which actually decreases their chance of successful penetration of a microburst. Other suggestions to pilots are compared to those based upon the optimum trajectory analysis. Author

A87-29607#
RESEARCH ON CONTROL LAW FOR ACTIVE FLUTTER SUPPRESSION
WEIPING WANG, ZHONGQUAN GU, and DEMAO ZHU (Nanjing Aeronautical Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 7, Dec. 1986, p. 566-574. In Chinese, with abstract in English.

This paper studies the technology of active flutter suppression by using the wind-tunnel model of a delta wing with low-aspect ratio as research specimen. The researches include the establishment of mathematical model for a servo-aeroelastic system and the synthesis and analysis of suboptimal output feedback control laws for active flutter suppression. Author

A87-29677
A COMPUTATIONAL METHOD FOR FREE TIME OPTIMAL CONTROL PROBLEMS, WITH APPLICATION TO MAXIMIZING THE RANGE OF AN AIRCRAFT-LIKE PROJECTILE
K. L. TEO (National University of Singapore, Singapore), G. JEPPS (Department of Defence, Weapons Systems Research Laboratory, Adelaide, Australia), E. J. MOORE, and S. HAYES (New South Wales, University, Kensington, Australia) Australian Mathematical Society, Journal, Series B - Applied Mathematics (ISSN 0334-2700), vol. 28, Jan. 1987, p. 393-413. refs

A class of non-standard optimal control problems is considered. The non-standard feature of these optimal control problems is that they are of neither fixed final time nor of fixed final state. A method of solution is devised which employs a computational algorithm based on control parametrization techniques. The method is applied to the problem of maximizing the range of an aircraft-like gliding projectile with angle of attack control. Author

A87-30226#
CONTROL OF AIRCRAFT BY DECOUPLED HIGH FEEDBACK GAIN SERVO
TATSUO CHUBACHI (Iwate University, Morioka, Japan) Japan Society for Aeronautical and Space Sciences, Transactions (ISSN 0549-3811), vol. 29, May 1986, p. 1-11. refs

In this paper a method of analysis of nonlinear high feedback gain tracking servo with signal saturation is introduced in the frequency domain, and as an application of it, a design method of lateral tracking servo system for aircraft is described. In this method, the system is decoupled into roll and yaw systems by suitable feedback, and is transformed into a single input and single output problem. Next a transfer function is set almost positive real, and an attempt is made to stabilize the nonlinear systems. This system is highly robust or insensitive to the variation of flight conditions. Simulations about a high speed aircraft showed satisfactory results. Author

A87-30227#
ON THE CONSTRUCTION OF AN ADAPTIVE FLIGHT CONTROL SYSTEM WITH THE ANGLE LIMITATION OF CONTROL SURFACE
TETSUROU NOGUCHI and KIMIO KANAI (Defense Academy, Yokosuka, Japan) Japan Society for Aeronautical and Space Sciences, Transactions (ISSN 0549-3811), vol. 29, May 1986, p. 12-33. refs

The problem of constructing an adaptive flight control system for an aircraft with the angle limitation of control surface is addressed. In the first part of this paper, by introducing a dispersion filter which makes it possible to discuss the construction of an adaptive control system as a linear problem for the plant with an input amplitude limitation, a synthesis method which can construct a finite-time settling adaptive control system of a time-invariant discrete scalar system with an input amplitude limitation is proposed. In the second part, this proposed scheme is applied to solve the problem of constructing an adaptive flight control system for both a supersonic and a VTOL aircraft with the angle limitation of control surface. It is shown that an adaptive longitudinal control augmentation system for both cases can be constructed. Simulation studies are included in order to demonstrate the effectiveness and the features of the proposed scheme. Author

A87-30407#
THE OPTIMIZATION OF LONGITUDINAL AIRCRAFT MOTION CONTROL DURING TAKE-OFF [OPTYMALIZACJA STEROWANIA RUCHEM PODLUZNYM SAMOLOTU PRZY STARCIE]
KAZIMIERZ GILEWSKI (Instytut Techniczny Wojsk Lotniczych, Warsaw, Poland) and LUDWIK GRUCHALSKI Technika Lotnicza i Astronautyczna (ISSN 0040-1145), Nov.-Dec. 1986, p. 6-9. In Polish.

An optimization and automation method for controlling the aircraft take-off process (including the take-off run) is proposed. The Tu-154 aircraft is used an example. The take-off process control algorithm is presented as well as graphs plotted from calculations. K.K.

A87-30415#
FLIGHT CONTROL SYSTEM FOR THE UH-1D HELICOPTER
PETER KROEMMER and WOLFGANG LOESEL Dornier Post (English Edition) (ISSN 0012-5563), no. 3, 1986, p. 32, 33.

An account is given of the installation of the Helipilot flight control system aboard a Bell UH-1D helicopter by Dornier System and certification (by the German Federal Procurement Office) of the aircraft to use that system. The flight control system, built by Sperry's Flight System Division, had been previously installed in a Bell 212 helicopter and certified to civil FAA regulations. The system is intended to reduce pilot workload in the testbed during the Helicopter Equipment Testbed/Night Vision Cockpit II (HAV/NSC II) tests. In the Attitude mode, hands-off flying must be possible so that the pilot can undertake the control operations required. The tests are to show how handling and flight management near the ground can be improved under instrument flight weather conditions and at night with the introduction of cockpit displays with central controls and the use of advanced sensor systems. Knowledge gained will be used in writing the specifications for the LTH/SAR/MH90 helicopter projects. D.H.

N87-18529*# Princeton Univ., N. J.
FAILURE DETECTION AND IDENTIFICATION FOR A RECONFIGURABLE FLIGHT CONTROL SYSTEM
FRANCOIS DALLERY *In* NASA Langley Research Center Joint University Program for Air Transportation Research, 1983 p 57-61 Mar. 1987
Avail: NTIS HC A05/MF A01 CSCL 01C

Failure detection and identification logic for a fault-tolerant longitudinal control system were investigated. Aircraft dynamics were based upon the cruise condition for a hypothetical transonic business jet transport configuration. The fault-tolerant control system consists of conventional control and estimation plus a new outer loop containing failure detection, identification, and reconfiguration (FDIR) logic. It is assumed that the additional logic has access to all measurements, as well as to the outputs of the control and estimation logic. The pilot may also command the FDIR logic to perform special tests. Author

N87-18530*# Princeton Univ., N. J.
AN APPLICATION OF ARTIFICIAL INTELLIGENCE THEORY TO RECONFIGURABLE FLIGHT CONTROL
DAVID A. HANDELMAN *In* NASA Langley Research Center Joint University Program for Air Transportation Research, 1983 p 63-72 Mar. 1987
Avail: NTIS HC A05/MF A01 CSCL 01C

Artificial intelligence techniques were used along with statistical hpyothesis testing and modern control theory, to help the pilot cope with the issues of information, knowledge, and capability in the event of a failure. An intelligent flight control system is being developed which utilizes knowledge of cause and effect relationships between all aircraft components. It will screen the information available to the pilots, supplement his knowledge, and most importantly, utilize the remaining flight capability of the aircraft following a failure. The list of failure types the control system will accomodate includes sensor failures, actuator failures, and structural failures. B.G.

N87-18570*# *National Aeronautics and Space Administration.* Ames Research Center, Moffett Field, Calif.
FLIGHT CHARACTERISTICS OF THE AD-1 OBLIQUE-WING RESEARCH AIRCRAFT
ALEX G. SIM and ROBERT E. CURRY Mar. 1985 29 p
(NASA-TP-2223; H-1180; NAS 1.60:2223) Avail: NTIS HC A03/MF A01 CSCL 01C

The AD-1 is a low-speed oblique-wing research airplane. This report reviews the vehicle's basic flight characteristics, including many aerodynamic, stability, and control effects that are unique to an oblique-wing configuration. These effects include the change in sideforce with angle of attack, moment changes with angle of attack and load factor, initial stall on the trailing wing, and inertial coupling caused by a roll-pitch cross product of inertia. An assessment of the handling qualities includes pilot ratings and comments. Ratings were generally satisfactory through 30 deg of wing sweep but degraded with increased sweep. A piloted simulation study indicated that a basic rate feedback control system could be used to improve the handling qualities at higher wing sweeps. Author

N87-18571*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
INHERENT ROBUSTNESS OF DISCRETE-TIME ADAPTIVE CONTROL SYSTEMS Final Report
C. C. H. MA Dec. 1986 39 p Submitted for publication
(Contract NAS1-18107)
(NASA-CR-178224; ICASE-86-79; NAS 1.26:178224) Avail: NTIS HC A03/MF A01 CSCL 01C

Global stability robustness with respect to unmodeled dynamics, arbitrary bounded internal noise, as well as external disturbance is shown to exist for a class of discrete-time adaptive control systems when the regressor vectors of these systems are persistently exciting. Although fast adaptation is definitely undesirable, so far as attaining the greatest amount of global stability robustness is concerned, slow adaptation is shown to be not necessarily beneficial. The entire analysis in this paper holds for systems with slowly varying return difference matrices; the plants in these systems need not be slowly varying. Author

N87-18572*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
TILT-ROTOR FLUTTER CONTROL IN CRUISE FLIGHT
KEN-ICHI NASU Dec. 1986 64 p
(NASA-TM-88315; A-86286; NAS 1.15:88315) Avail: NTIS HC A04/MF A01 CSCL 01C

Tilt-rotor flutter control under cruising operation is analyzed. The rotor model consists of a straight fixed wing, a pylon attached to the wingtip, and a three-blade rotor. The wing is cantilevered

to the fuselage and is allowed to bend forward and upward. It also has a torsional degree of freedom about the elastic axis. Each rotor blade has two bending degrees of freedom. Feedback of wingtip velocity and acceleration to cyclic pitch is investigated for flutter control, using strip theory and linearized equations of motion. To determine the feedback gain, an eigenvalue analysis is performed. A second, independent, timewise calculation is conducted to evaluate the control law while employing more sophisticated aerodynamics. The effectiveness of flutter control by cyclic pitch change was confirmed. Author

N87-18573# Army Aviation Research and Development Command, Moffett Field, Calif. Aeroflightdynamics Directorate.
INTRODUCTION TO GRASP (GENERAL ROTORCRAFT AEROMECHANICAL STABILITY PROGRAM): A MODERN APPROACH TO ROTORCRAFT MODELING
DEWEY H. HODGES, A. S. HOPKINS, DONALD L. KUNZ, and HOWARD E. HINNANT 1986 18 p Presented at the 42nd Annual Forum of the American Helicopter Society, Washington, D.C., 2-4 Jun. 1986
(AD-A174161) Avail: NTIS HC A02/MF A01 CSCL 01C

The General Rotorcraft Aeromechanical Stability Program (GRASP) is described in terms of its capabilities and development philosophy. The program is capable of treating the nonlinear static and linearized dynamic behavior of structures represented by arbitrary collections of rigid-body and beam elements that may be connected in an arbitrary fashion and are permitted to have large relative motions. The main limitation is that periodic coefficient effects are not treated, restricting the solutions to rotorcraft in axial flight and ground contact conditions. Rather than following in the footsteps of other rotorcraft programs, GRASP is more of a hybrid between finite element programs and spacecraft-oriented multibody programs. GRASP differs from standard finite-element programs by allowing multiple levels of substructures in which the substructures can move and/or rotate relative to others with no small-angle approximations. This capability facilitates the modeling of rotorcraft structures, including the rotating/nonrotating interface and details of the blade/root kinematics for various rotor types. GRA

N87-19400# Systems Technology, Inc., Hawthorne, Calif.
STOL HANDLING QUALITIES CRITERIA FOR PRECISION LANDINGS Final Report, Sep. 1983 - Jan. 1986
ROGER H. HOH and DAVID G. MITCHELL Nov. 1986 182 p
(Contract F33615-83-C-3606)
(AD-A175369; STI-TR-1208-1; AFWAL-TR-86-3050) Avail: NTIS HC A09/MF A01 CSCL 01C

This report documents an effort to expand on flying qualities design criteria for precision (STOL) landings. The primary emphasis is on non-powered lift, fighter-type aircraft using frontside control technique for longitudinal flight path control. The major thrust of this effort is, therefore, to be able to increase sortie generation due to bomb-damaged runways. Handling qualities criteria for STOL approaches and landings are developed. The proposed criteria have two elements: (1) the proper response-type for the task and (2) the minimum attitude and flight path bandwidths. Supporting data is reasonably complete for powered lift STOL aircraft, but less so for fighter STOL's. Fighter STOL's use precision touchdown accuracy and thrust reversing to achieve short field performance. A brief piloted moving base simulation was run on the USAF LAMARS to provide some data. Additional data was correlated from a variable stability inflight simulation of precision landings. A computer program was written to calculate all potential longitudinal and lateral handling qualities parameters for STOL approaches and landings. Finally, an extensive test plan is intended to provide guidance for future STOL testing. GRA

N87-19401# European Space Agency, Paris (France).
ROBUSTNESS QUALIFICATION AND IMPROVEMENT OF MULTIVARIABLE REGULATORS, WITH APPLICATION TO AIRPLANE CONTROL
HENRI BOURLES Oct. 1986 197 p Transl. into ENGLISH of "Qualification et Amelioration de la Robustesse des Regulateurs Multivariables, avec Application au Pilotage dun Avion" Chatillon, France Original language document was previously announced as N84-25720
(ESA-TT-867; ONERA-NT-1983-2; ETN-87-98884) Avail: NTIS HC A09/MF A01

The robustness of a dynamic system multivariable control law with respect to external disturbances, structural perturbations due to modeling and linearization errors, and dynamic perturbations in the feedback loop was analyzed. This proportional-plus-integral type control law minimizes the mathematical expectation of a quadratic performance index. Stability margins (especially the phase margin) of linear quadratic regulators are generalized. An algorithm that adjusts the cost penalty matrices iteratively to increase the system robustness is provided. ESA

N87-19402# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
DESIGN AND EXPERIMENTAL VERIFICATION OF A CALCULATION METHOD FOR FREQUENCY RESPONSE ANALYSIS OF DIGITAL CONTROL SYSTEMS IN A CONTINUOUS ENVIRONMENT
J. SCHURING 20 Jun. 1985 81 p
(Contract NIVR-313.3-1907)
(NLR-TR-85090-U; B8678397; ETN-87-99275) Avail: NTIS HC A05/MF A01

A method to analyze the transfer characteristics of combined discrete (digital) and continuous (analog) systems was developed. Digital controllers, operating in a continuous environment are considered. The hybrid system sampler is modeled in the frequency domain using the Fourier transform technique. Aliasing is modeled statistically. The transfer characteristics of other components of hybrid systems are considered, like analog filters, a digital computer, and a holding device for digital to analog conversion. A hybrid system configuration containing a feedback loop is dealt with. A computer program to apply the calculation method was developed. The transfer characteristics of the complete system as well as the transfer through the feedback loop are considered. Programmed plotting options include Bode, Nyquist, and Nichols plots. Application of the method in digital aircraft control systems is elaborated. Influence of sampling rate and input filtering is illustrated. The method is verified experimentally. ESA

N87-19403# National Aerospace Lab., Amsterdam (Netherlands). Staff Div.
COMPARISON BETWEEN MEASURED AND CALCULATED STALL-FLUTTER BEHAVIOR OF A ONE-BLADED MODEL ROTOR
H. BERGH and A. J. P. VANDERWEKKEN 29 Jul. 1985 18 p Presented at the 11th European Rotorcraft Forum, London, England, 10-13 Sep. 1985
(NLR-MP-85059-U; ETN-87-99290) Avail: NTIS HC A02/MF A01

Low-speed wind tunnel flutter tests were performed with a driven model rotor consisting of one rigid blade hinged at the root by a weak bending-torsion spring. Many flutter points in nonstalled and stalled flow were measured with three different model configurations by changing the rotor speed at constant tunnel velocity. Aerodynamic derivatives for the stall domain are deduced from the ONERA semi-empirical dynamic stall model for two-dimensional flow. Application of these derivatives in flutter calculations for the model rotor shows a very good agreement with the experiments. ESA

N87-19404# Bristol Univ. (England). Dept. of Aeronautical Engineering.
EVALUATION OF A FLIGHT DYNAMICS COMPUTER PROGRAM B.S. Thesis
G. V. ASSER and A. P. GYLES Jun. 1985 104 p
(BU-321; ETN-87-99185) Avail: NTIS HC A06/MF A01

The dynamic stability and control characteristics of three subsonic aircraft of very different configurations were predicted using a flight dynamics computer program. The program requires a simple numerical description of the external geometry of the aircraft plus the defining flight conditions. The equations of motion were solved, using model and flight test data, to assess the predictions of the program and to expose limitations due to its simple approach. The geometric parameters which govern the aerodynamic derivatives and associated mode shapes most influentially were derived. The aerodynamic derivatives are well predicted, but not the control derivatives. The program produces reasonable approximations to the mode shapes for dynamic response with the exception of the phugoid. Results for the larger aircraft are in better agreement than those for the small vehicle. The most influential geometry parameters are those which define the aspect and taper ratios. ESA

N87-19406# Bristol Univ. (England). Dept. of Aeronautical Engineering.
AN EVALUATION OF THE TSIM CONTROL SYSTEMS COMPUTER PACKAGE B.S. Thesis
A. J. POOLE and J. M. WILSON Jun. 1985 56 p
(BU-336; ETN-87-99199) Avail: NTIS HC A04/MF A01

The computer aided design package TSIM2 was adapted for use on a Multics system. To test the package a digital simulation of a longitudinal three degrees-of-freedom aircraft model with a digital flight control system was set up. Results from the TSIM2 model were compared with those obtained using previously available simulation programs, and the methods used in each were compared. Improvements to TSIM are suggested. ESA

N87-19407# Bristol Univ. (England). Dept. of Aeronautical Engineering.
A DIGITAL SIMULATION OF THE FAILURE PERFORMANCE OF A MULTIPLEX ACTUATOR B.S. Thesis
P. E. RIDGE and V. X. TRAN Jun. 1985 56 p
(BU-337; ETN-87-99200) Avail: NTIS HC A04/MF A01

A mathematical model to simulate failure performance of a multiplex taileron actuation system on a fly by wire aircraft was developed. Failure modes involving one failed hydraulic system coupled with failed electrical input or feedback signals were investigated. The failure performances were compared with the normal performance to assess the degree of degradation due to the various failure modes. The simulation indicates that there is no adverse effect on actuator response due to a single electrical failure coupled with a hydraulic failure for frequencies up to 10 Hz. At higher frequencies, up to 100 Hz, the failure responses show deviations from normal response, but these higher frequencies would never be encountered in operation. ESA

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RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

A87-28070#
REFLECTIONS REGARDING RECENT ROTARY RIG RESULTS
L. E. ERICSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) Journal of Aircraft (ISSN 0021-8669), vol. 24, Jan. 1987, p. 25-30. Previously cited in issue 07, p. 851, Accession no. A86-19703. refs

A87-28554
GP-180 WIND-TUNNEL FLUTTER TEST
I. A. MAZZONI and I. M. PIZZAMIGLIO (Rinaldo Piaggio - Industrie Aeronautiche e Meccaniche S.p.A., Finale Ligure, Italy) IN: International Modal Analysis Conference, 4th, Los Angeles, CA, Feb. 3-6, 1986, Proceedings. Volume 1 . Schenectady, NY, Union College, 1986, p. 581-588.

The single-point-excitation vibration testing and wind-tunnel flutter testing of a 0.175-scale model of the GP-180 general-aviation aircraft are reported. The factors considered in selecting the scale factors are discussed; the testing and data-analysis procedures are described in detail; and the results are presented in graphs and briefly characterized. The measured flutter characteristics are found to be in generally good agreement with the predictions of an FEM model based on the vibration data and with analytical results. T.K.

A87-28915#
DESIGN STUDY FOR A HIGH-ACCURACY THREE-AXIS TEST TABLE
LOUIS A. DEMORE, ROBERT A. PETERSON, LOUIS B. CONLEY, H. HAVLISCEK, NIKOS P ANDRIANOS (Contraves Goerz Corp., Pittsburgh, PA) et al. (Guidance, Navigation and Control Conference, Snowmas, CO, Aug. 19-21, 1985, Technical Papers, p. 318-333) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 10, Jan.-Feb. 1987, p. 104-114. Previously cited in issue 22, p. 3232, Accession no. A85-45912.
(Contract F08635-83-C-0486)

A87-29264
NEW ROTARY RIG AT RAE AND EXPERIMENTS ON HIRM
C. O. OLEARY and E. N. ROWTHORN (Royal Aircraft Establishment, Bedford, England) (NATO, AGARD, Symposium on Unsteady Aerodynamics, Fundamentals and Applications to Aircraft Dynamics, Goettingen, West Germany, May 6-9, 1985) Aeronautical Journal (ISSN 0001-9240), vol. 90, Dec. 1986, p. 399-409.

A rig for measurement of forces and moments due to continuous rate of roll has been commissioned at RAE Bedford. Tests have been made on a High Incidence Research Model (HIRM) in two wind tunnels at M = 0.2, 0.4 and 0.7. At present, models can be tested up to a 40 deg angle of attack at rotational speeds up to 350 rpm. Tests on HIRM included an investigation of configuration and Reynolds number effects. Results are compared with similar data from tests with another rolling rig and from small amplitude oscillatory tests. Author

A87-30848
AIRCRAFT CARRIER LANDING RESEARCH AT THE VISUAL TECHNOLOGY RESEARCH SIMULATOR - IMPLICATIONS FOR SIMULATOR DESIGN
DANIEL P. WESTRA (Essex Corp., Orlando, FL), GAVAN LINTERN (Illinois, University, Savoy), and DENNIS C. WIGHTMAN (U.S. Navy, Naval Training Systems Center, Orlando, FL) IN: Simulators III; Proceedings of the Conference, Norfolk, VA, Mar. 10-12, 1986 . San Diego, CA, Society for Computer Simulation, 1986, p. 118-123. refs

Results are reported from studies of carrier landing and training performed using the Visual Technology Research Simulator (VTRS) at the Naval Training Systems Center. Trials have been run to assess the effects of ten factors, including FOV, display line rate, ship detail, platform motion, etc., on the performance of experienced pilots. The benefits observed with the addition of variable length vertical length arrays, which provide descent rate information to go with displacement information in simulations, were sufficient that every carrier in the fleet will be equipped with the capability. Transfer trials evaluated the worth of the simulator training for new pilots for carrier landings. Comparisons of the performance of pilots who did and who did not have simulator experience before actual landing training showed that simulator experience significantly accelerated the learning process in real world landings. M.S.K.

A87-30850
F-16 SAMT EVALUATION - OVERVIEW AND COMMENTARY
J. A. FITZPATRICK and R. J. HRITZ (Applied Science Associates, Inc., Valencia, PA) IN: Simulators III; Proceedings of the Conference, Norfolk, VA, Mar. 10-12, 1986 . San Diego, CA, Society for Computer Simulation, 1986, p. 132-136.

This paper summarizes the findings of a study conducted between 1980 and 1983 for the Air Force Human Resources Laboratory at Lowry Air Force Base, CO (Technical Training Division). This research investigated the training effectiveness of a selected set of F-16 Simulated Aircraft Maintenance Trainers (SAMTs). The trainers studied included both flat panel and three-dimensional model trainers, and simulated several types of aircraft systems (i.e., electrical, engine, and avionics). The study was criterion-referenced, meaning that training effectiveness of the devices was compared to a fixed standard, rather than to the results of an alternate training strategy. Issues considered included the effects of fidelity levels, user acceptance, and instructional features (especially malfunction insertion). Statistical comparisons of performance and user attitude were made between different trainers and between different task types. The findings demonstrated that all of the devices under study were acceptably effective, but that significant differences in levels of effectiveness existed. These differences can be related to trainer design features as well as task or system type. Author

A87-30851
THE RISE OF THE PHOENIX - DEVELOPMENT OF A KC-135R OPERATIONAL FLIGHT TRAINER
EUGENE A. HOCK (Boeing Military Airplane Co., Wichita, KS), DALE RICKERSON, and DAVID VALENTA (USAF, McConnell AFB, KS) IN: Simulators III; Proceedings of the Conference, Norfolk, VA, Mar. 10-12, 1986 . San Diego, CA, Society for Computer Simulation, 1986, p. 225-232.

The refurbishment of a KC-135A Weapon System Trainer to serve for aircrew training for upgraded KC-135R aircraft used by the USAF is described. The KC-135R underwent re-engining, and replacement, deletion or modification of more than 35 on-board systems, resulting in an aircraft with altered flying qualities. The 6 deg of freedom KC-135A trainer had been in desert storage for 2 yr and more than 500 system components had to be assessed for operability before upgrading. The 18 mos upgrade involved replacement or modification of over 34 systems, including hardware and software to simulate the performance of the new engines, brakes, control loading, and an anti-skid system. The avionics suite was modified and a CGI display system was added. Out-the-window displays were developed for simulating various weather conditions. Details of the instructor station capabilities and the verification tests performed with the new trainer are provided. M.S.K.

A87-31276#
DEVELOPMENT OF TEST FACILITY AND OPTICAL INSTRUMENTATION FOR TURBULENT COMBUSTION RESEARCH
D. R. BALLAL, A. J. LIGHTMAN, and P. P. YANEY (Dayton, University, OH) Journal of Propulsion and Power (ISSN 0748-4658), vol. 3, Mar.-Apr. 1987, p. 97-104. Previously cited in issue 07, p. 851, Accession no. A86-19655. refs
(Contract F33615-82-C-2255)

N87-18574*# Old Dominion Univ., Norfolk, Va. Dept. of Mechanical Engineering and Mechanics.
USER GUIDE FOR THE DIGITAL CONTROL SYSTEM OF THE NASA/LANGLEY RESEARCH CENTER'S 13-INCH MAGNETIC SUSPENSION AND BALANCE SYSTEM Final Report, 23 Oct. 1985 - 30 Sep. 1986
COLIN P. BRITCHER Mar. 1987 81 p
(Contract NAS1-17993)
(NASA-CR-178210; NAS 1.26:178210) Avail: NTIS HC A05/MF A01 CSCL 14B

The technical background to the development of the digital control system of the NASA/Langley Research Center's 13 inch Magnetic Supension and Balance Systen (MSBS) is reviewed. The implementation of traditional MSBS control algorithms in digital form is examined. Extensive details of the 13-inch MSBS digital controller and related hardware are given, together with the introductory instructions for systems operators. Full listings of software are included in the Appendices. Author

N87-18575*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FULL-SCALE THRUST REVERSER TESTING IN AN ALTITUDE FACILITY
CHARLES M. MEHALIC and ROY A. LOTTIG 1987 24 p Prepared for presentation at the 23rd Joint Propulsion Conference, San Diego, Calif., 29 Jun. - 2 Jul. 1987; sponsored in part by AIAA, SAE, ASME and ASEE
(NASA-TM-88967; AIAA-87-1788; E-3435; NAS 1.15:88967)
Avail: NTIS HC A02/MF A01 CSCL 14B

A two-dimensional convergent-divergent exhaust nozzle designed and fabricated by Pratt and Whitney Aircraft was installed on a PW1128 turbofan engine and tested during thrust reverser operation in an altitude facility at NASA Lewis Research Center. A unique collection system was used to capture the thrust reverser exhaust gas and transport it to the primary exhaust collector. Tests were conducted at three flight conditions with varying amounts of thrust reverse at each condition. Some reverser exhaust gas spillage by the collection system was encountered but engine performance was unaffected at all flight conditions tested. Based on the results of this test program, the feasibility of altitude testing of advanced multi-function exhaust nozzle systems has been demonstrated. Author

N87-18576*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL EVALUATION OF TWO TURNING VANE DESIGNS FOR FAN DRIVE CORNER OF 0.1-SCALE MODEL OF NASA LEWIS RESEARCH CENTER'S PROPOSED ALTITUDE WIND TUNNEL
DONALD R. BOLDMAN, ROYCE D. MOORE, and RICKEY J. SHYNE Mar. 1987 148 p
(NASA-TP-2646; E-3175; NAS 1.60:2646) Avail: NTIS HC A07/MF A01 CSCL 14B

Two turning vane designs were experimentally evaluated for corner 2 of a 0.1 scale model of the NASA Lewis Research Center's proposed Altitude Wind Tunnel (AWT). Corner 2 contained a simulated shaft fairing for a fan drive system to be located downstream of the corner. The corner was tested with a bellmouth inlet followed by a 0.1 scale model of the crossleg diffuser designed to connect corners 1 and 2 of the AWT. Vane A was a controlled-diffusion airfoil shape; vane B was a circular-arc airfoil shape. The A vanes were tested in several arrangements which included the resetting of the vane angle by -5 degrees or the removal of the outer vane. The lowest total pressure loss for vane A configuration was obtained at the negative reset angle. The loss coefficient increased slightly with the Mach number, ranging from 0.165 to 0.175 with a loss coefficient of 0.170 at the inlet design Mach number of 0.24. Removal of the outer vane did not alter the loss. Vane B loss coefficients were essentially the same as those for the reset vane A configurations. The crossleg diffuser loss coefficient was 0.018 at the inlet design Mach number of 0.33. Author

N87-18577# British Aerospace Aircraft Group, Preston (England). Hot Gas Lab.
BAE WHARTON HOT GAS LABORATORY
A. P. WINSTANLEY 1 Oct. 1985 16 p
(ARG-207; ETN-86-96563) Avail: NTIS HC A02/MF A01

A hot gas laboratory was built for experiments requiring large quantities of high pressure air (hot or cold), and was sited to allow test work of a very noisy nature. A ground erosion rig was constructed and commissioned in the laboratory to evaluate the damage caused to ground samples by high pressure and temperature jet efflux. The hot gas is provided by a purpose-built combustion chamber supplied with cold compressed air and aircraft

fuel. Testing performed includes erosion of ground surfaces; flow field measurements to assess correlation of hot jet effects with theoretically predicted values of pressure/temperature distributions and heat transfer rates, appraisal for surface coating materials, and study of temperature, velocity, and noise levels near VTOL aircraft. Author (ESA)

N87-18578# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.

FLEXIBLE AND HIGH QUALITY SOFTWARE ON A MULTIPROCESSOR COMPUTER SYSTEM CONTROLLING A RESEARCH FLIGHT SIMULATOR

A. P. L. A. MARSMAN 30 Sep. 1985 15 p Presented at the AGARD Flight Mechanics Panel, Cambridge, England, 30 Sep. - 3 Oct. 1985

(NLR-MP-85061-U; ETN-87-99291) Avail: NTIS HC A02/MF A01

The research environment and the multiprocessor computer system required for flexible software for flight simulation programs are described. The program incorporates all hardware options with different calibration tables as the most simple solution, since for example the drive laws trimming the primary control systems are different for each system. Modularity of the simulation program allows the usage of subsets of the hardware. Any reasonable combination is possible, with or without motion, visual, flight instruments, etc. Even the primary controls can be replaced by inputs from a file. This enables the flexibility of parallel maintenance of hardware, while testing modified modules in the software. It reduces the costs for projects which do not need all systems. ESA

N87-18579# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.

AERODYNAMIC AND STRUCTURAL ASPECTS OF PROPELLER AND DRIVE FOR A 1/5 SCALE WIND TUNNEL PROGRAM

R. M. BASS, B. MUNNIKSMA, and J. VANHENGST 19 Sep. 1984 22 p Presented at the AGARD Symposium on Aerodynamics and Acoustics of Propellers, Toronto, Canada, 1-4 Oct. 1984

(Contract NIVR-1985)

(NLR-MP-84091-U; B8677589; ETN-87-99505) Avail: NTIS HC A02/MF A01

The development of a model propeller and its calibration in association with an axisymmetric nacelle in a low speed tunnel before testing on a complete 1/5 scale model are described. The calibration so obtained allowed the required operating propeller conditions to be set up on the complete F50 model. The influence of Reynolds number on propeller performances is discussed and data showing the good agreement obtained, after correction for scale effects, between experimental model results and full scale prediction presented. An unsuspected and unavoidable vibration originating in the reduction gear train of the drive unit gave rise to high propeller blade stresses, ultimately leading to a blade failure. In order to continue running with minimum delay, new propeller blades with high internal damping were manufactured from composite materials, and the program was successfully concluded. ESA

N87-18580# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.

REALIZATION OF AN AIRPORT NOISE MONITORING SYSTEM FOR DETERMINING THE TRAFFIC FLOW IN THE SURROUNDINGS OF A MILITARY AIRBASE

G. BEKEBREDE 7 Feb. 1986 10 p Presented at the International Conference on Noise Control Engineering (INTERNOISE 86), Cambridge, England, 21-23 Jul. 1986

(NLR-MP-86016-U; B8675512; ETN-87-99514) Avail: NTIS HC A02/MF A01

The feasibility study and implementation of a noise measurement system near a military airfield are described. Operating experience shows that the use of a noise monitoring system in the surroundings of a military airbase is restricted, although it functions technically very well and performs its task satisfactorily. ESA

N87-19410# RAND Corp., Santa Monica, Calif.

ASSESSING THE BENEFITS AND COSTS OF MOTION FOR C-17 FLIGHT SIMULATORS: TECHNICAL APPENDIXES Interim Report

J. R. GEBMAN, W. L. STANLEY, A. A. BARBOUR, R. T. BERG, and J. L. BIRKLER Jun. 1986 214 p

(Contract F49620-86-C-0008)

(AD-A174745; RAND/N-2301-AF) Avail: NTIS HC A10/MF A01 CSCL 05I

This document provides technical support for R-3276-AF. Appendixes describe: (1) experiments to determine the value of motion in training simulators; (2) aircraft features that will influence the motion of the C-17; (3) possible effects on motion cues of the C-17's stability and control augmentation system; (4) the fidelity of different simulator motion cueing alternatives; (5) a suggested methodology for assessing the training capability of simulators; (6) the effects of simulator motion on simulator training capability, safety, and avoidance of simulator sickness; and (7) the costs of providing motion in simulators. GRA

N87-19411# RAND Corp., Santa Monica, Calif.

ASSESSING THE BENEFITS AND COSTS OF MOTION FOR C-17 FLIGHT SIMULATORS Interim Report

J. R. GEBMAN, W. L. STANLEY, A. A. BARBOUR, R. T. BERG, and J. L. BIRKLER Jun. 1986 46 p

(Contract F49620-86-C-0008)

(AD-A174822; RAND/R-3276-AF) Avail: NTIS HC A03/MF A01 CSCL 05I

This study examines the benefits and costs of incorporating a motion system in the C-17 flight training simulator and suggests a standard framework for assessing simulator fidelity requirements in general, and motion cueing alternatives in particular. Using a framework detailed in this report, the research assesses three simulator alternatives: a system having no motion, a system using hydrauiic/pneumatic g-seats, and a system using a six-degree-of-freedom (dof) motion platform. The incremental costs of simulators using six-dof motion platforms appear warranted when measured against the likely benefits from their use, if the Air Force devices an adequate training syllabus for C-17 simulators and if the program plan ensures that adequate performance data are collected during flight testing to support simulator software development. Simulators with no motion systems, or those using g-seats, do not appear cost-effective for the C-17 training application. GRA

N87-19412# Arizona Univ., Tucson. Engineering Experiment Station.

EXPERIMENTS IN AN ADAPTABLE-WALL WIND TUNNEL FOR V/STOL TESTING Final Report, 1 May 1982 - 30 Sep. 1986

W. R. SEARS and D. C. LEE 30 Sep. 1986 184 p

(Contract AF-AFOSR-0185-82)

(AD-A174900; AFOSR-86-2088TR) Avail: NTIS HC A09/MF A01 CSCL 14B

Experiments were carried out, over a period of two years, in an Adaptable-Wall wind tunnel configured for testing of airplane models at very large lift. The program was intended especially to demonstrate Proof of Concept for this type of wind tunnel, in which the simulated stream vector is inclined appreciably to the tunnel axis. The measured inner flow is matched to the computed, updated outer flow by an iterative process. Wall-adaptation controls in this tunnel are vaned panels in the floor and ceiling of the working section and a variable-angle inlet nozzle. Velocity components are measured by a Laser-Doppler system using a fixed laser and movable optical components. The test model used in these experiments was a high-wing V/STOL configuration having full-span wing flaps with lower-surface blowing of their inboard portions. In all of the experiments reported here, the combination of angle of attack, flap setting, and flap blowing was such as to produce large flow deflection and severe wall interference in a conventional tunnel. The model configuration was always laterally symmetrical, and most runs were made under the assumption of symmetrical flow. The iterative procedure, based on measured control matrices, typically led to minimum matching-discrepancies

(root-mean-square values) of about three percent of stream speed after about six iterations. Author (GRA)

N87-19413# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
MODEL OF AIRCRAFT FOR TESTING IN A WIND TUNNEL
N. F. STERLIKOV and L. V. NOVIKOV 30 Dec. 1986 7 p Transl. into ENGLISH of Russian Patent no. 377663 (17 Apr. 1973) p 1-2
(AD-A176095; FTD-ID(RS)T-1298-86) Avail: NTIS HC A02/MF A01 CSCL 14B

This invention is the model of an aircraft for testing in wind tunnel. Its housing contains drain channels which are withdrawn into the inner cavity of the model's body, which is connected by a pipe with a source of liquid and source of compressed air. GRA

N87-19415# Bristol Univ. (England). Dept. of Aeronautical Engineering.
FLIGHT SIMULATOR WITH TRANSPUTERS B.S. Thesis
KEITH LANG Jun. 1985 73 p
(BU-333; ETN-87-99196) Avail: NTIS HC A04/MF A01

The feasibility of using the OCCAM language and transputers in flight simulation was studied. Transputers are microprocessors suitable for running OCCAM which is a parallel processing language. An approach to designing a flight simulator was examined to extract and identify the main classes of computation. These were reorganized to form the basis of a computer program structure, employing methods made available through OCCAM. Programs in PASCAL were used successfully to model a simple mass-spring-damper in order to determine the general software requirements of such a program. A dynamic system model structure and complete set of aircraft equations were formulated. It is concluded that OCCAM and transputers are attractive for flight simulation. ESA

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ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; space communications; spacecraft communications; command and tracking; spacecraftdesign; testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

A87-29357
COMBINATION ENGINES FOR SPACEPLANES [KOMBINATIONSANTRIEBE FUER RAUMFLUGZEUGE]
H. HOPMANN, G. SCHMIDT, and W. SCHMIDT (Messerschmitt-Boelkow-Blohm GmbH, Munich, West Germany) (Hermann Oberth Gesellschaft, Symposium ueber Gefluegelte Raumfahrzeuge, Hanover, West Germany, June 6-15, 1986) Astronautik (ISSN 0004-6221), vol. 23, Oct.-Dec. 1986, p. 115-119. In German.

Optimal engine systems for affordable spaceplanes are discussed. Alternative spaceplane configurations are addressed, and assumptions pertaining to the spaceplane missions and the spaceplanes themselves are given, comparing these requirements to those of a conventional aircraft and the Space Shuttle Orbiter. A model combination engine for spaceplanes is schematically depicted and described, including its functioning. C.D.

A87-29390#
AN EXPERIMENTAL STUDY ON SOLID FUEL RAMJET TYPE COMBUSTION
B. N. RAGHUNANDAN, E. R. RAVICHANDRAN, and A. G. MARATHE (Indian Institute of Science, Bangalore, India) IN: National Conference on I.C. Engines and Combustion, 9th, Dehra Dun, India, Nov. 19-22, 1985, Proceedings. Volume 2 . Dehra Dun, India, Indian Institute of Petroleum, 1986, p. J-9, p. 1-8. refs

Polyester fuel grains containing 25-percent AP for solid fuel ramjet operation have been experimentally tested to ascertain fuel regression rates. A strong pressure dependence indicates the importance imparted to the reaction rate by the premixing of AP; temperature profiles downstream of the fuel grains indicate that a mixing device, or additional mixing length, is required for better combustion efficiency. Experimental results are well suited to the judgment of regression rate sensitivity to thermochemical parameters represented by the transfer number in the regression rate expression. O.C.

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CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; propellants and fuels; and materials processing.

A87-28140
THE EFFECT OF FIBRE CHARACTERISTICS ON THE MORPHOLOGY AND PERFORMANCE OF SEMI-CRYSTALLINE THERMOPLASTIC COMPOSITES
R. M. TURNER and F. N. COGSWELL (Imperial Chemical Industries, PLC, Middlesbrough, England) SAMPE Journal (ISSN 0091-1062), vol. 23, Jan.-Feb. 1987, p. 40-44. refs

The feasibility of impregnating a range of fibers with a thermoplastic polyether etherketone is demonstrated. The fibers include high strength, intermediate modulus and high modulus carbon as well as aramid and both 'E' and 'R' glass. The study provides details of the mechanical properties of the resulting unidirectional composites and explores the varying interfacial properties that result from the differing fiber types. The use of different classes of fiber reinforcement introduces materials systems with a wide range of property spectra. This allows continuous fiber-reinforced thermoplastic composites to be considered for a wide range of applications besides aircraft structures. In particular, this paper discusses the selection of such composites when radar transparency, energy absorption and dimensional tolerance requirements are critical. Author

A87-28390
ADVANCED COMPOSITES FOR FUTURE AEROSPACE SYSTEMS
SAM J. DASTIN (Grumman Aerospace Corp., Aircraft Systems Div., Bethpage, NY) Horizons (ISSN 0095-7615), vol. 22, no. 2, 1986, p. 10-15.

A development history is presented for the aerospace industry's use of high performance fiber-reinforced composite materials, from the glass fiber-reinforced plastic of 1950s aircraft radomes to the IM-6 state-of-the-art graphite-epoxy being used in the Lavi fighter's wings. The airframe of the tilt-rotor V-22 Osprey will be the first all-composite combat aircraft primary structure, and will also employ IM-series graphite-epoxy as its material system. Prospects for high temperature organic matrices and metal-matrix composites, as well as refractory composites applicable to the National Aerospace Plane, are also noted. O.C.

A87-29203
AN EQUATION OF STATE FOR THE MATERIAL OF THE NOZZLE VANES OF A GAS-TURBINE ENGINE UNDER THERMAL CYCLING IN A SULFUR-CONTAINING MEDIUM [URAVNENIE SOSTOIANIIA MATERIALA SOPLOVYKH LOPATOK GTD PRI TEPLOSMENAKH V SREDE, SODERZHASHCHEI SERU]
B. D. KOSOV and G. N. TRETIACHENKO (AN USSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR) Problemy Prochnosti (ISSN 0556-171X), Dec. 1986, p. 13-18. In Russian. refs

An equation is presented which relates the remaining life of EP99 alloy, a parameter characterizing the damage sustained during thermal cycling, to the level of thermal stresses and sulfur concentration in the combustion products. It is assumed that damage kinetics under conditions of thermal cycling is determined by two processes; i.e., hardening and softening. The model allows for the dependence of the coefficients on the thermal stress level and sulfur concentration. It is shown that the model proposed here is valid over a wide range of these parameters. V.L.

A87-29355
STRIPPING PAINT FROM COMPOSITE STRUCTURES - EXPERIENCE ACQUIRED AND PROBLEMS TO SOLVE [DECAPAGE DE PEINTURE SUR STRUCTURES COMPOSITES - EXPERIENCE ACQUISE ET PROBLEMES A RESOUDRE]
M.-J. FRUSTIE (Aerospatiale, Toulouse, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275), no. 119, 1986, p. 60-63. In French.

The exteriors of new transport aircraft feature a number of different materials, including composites. Aerospatiale has recently decided to use a sequence of wash primer, polyurethane primer and polyurethane finish on composites, as is done with metal structures. Paint can be removed from the composite surfaces by chemical strippers if the undercoatings remain intact, thus retaining waterproofing, exposing no interior impact damage, and not providing pathways for electrostatic charges. Similar problems, plus the possibility of leaving an irregular surface, are encountered with compounding the surface mechanically with abrasive disks or airblasting the paint off with plastic pellets or apricot pits. It is recommended that composite stripping be carried out with currently used methods until new methods for protecting the undercoating are identified. M.S.K.

A87-29385#
FLAME TUBE WALL TEMPERATURE AND COMBUSTION EFFICIENCY OF A COMBUSTOR USING AIR BLAST ATOMIZATION
C. BISWAS and P. K. NAG (Indian Institute of Technology, Kharagpur, India) IN: National Conference on I.C. Engines and Combustion, 9th, Dehra Dun, India, Nov. 19-22, 1985, Proceedings. Volume 2 . Dehra Dun, India, Indian Institute of Petroleum, 1986, p. J-2, p. 1-9. refs

The use of pressure jet burners to atomize and combust liquid fuel in conventional gas turbine combustion chambers results in excessive exhaust smoke formation, nonuniform exit temperature, and high flame tube temperature. Air blast atomizers can be employed to atomize relatively low velocity liquid fuel streams with a high velocity air stream; this reduces droplet size over a wide range of fuel flow rates. Attention is presently given to the results of an experimental investigation of air blast atomization for a gas turbine combustion chamber. O.C.

A87-29571
CERAMIC COATINGS FOR ADVANCED HEAT ENGINES - A REVIEW AND PROJECTION
W. J. LACKEY (Georgia Institute of Technology, Atlanta), D. P. STINTON, G. A. CERNY, A. C. SCHAFFHAUSER (Oak Ridge National Laboratory, TN), and L. L. FEHRENBACHER (Technology Assessment and Transfer, Inc., Gambrills, MD) Advanced Ceramic Materials (ISSN 0883-5551), vol. 2, Jan. 1987, p. 24-30. refs
(Contract DE-AC05-84OR-21400)

The development status and future potential for the application of ceramic coatings in advanced diesel and gas turbine engines are assessed. Ceramics are more resistant than metals to creep, oxidation, corrosion, erosion, and wear; they are in addition superior thermal insulators. Ceramic thermal barrier coatings have established their value in hot components of both diesel and turbine powerplants. Efforts have been made toward the use of wear- and erosion-resistant, and low-friction, ceramic coatings for diesel engine cylinder liners, piston caps, valve faces and seats, and piston rings. Turbine engines may employ such coatings on combustors, blades, stators, seals, and bearings. The ceramics are of oxide, carbide, and nitride types. O.C.

A87-29642
APPLICATION OF ADVANCED COMPOSITES IN CIVIL AIRCRAFT
PAUL LANGSTON (Du Pont de Nemours and Co., Wilmington, DE) IN: New materials in civil aviation; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 17-31.
(SAE PAPER 861673)

The application of kevlar, E- and S-glass, boron, and graphite fiber-reinforced polymer matrix materials in both laminate and honeycomb core sandwich panels can reduce maintenance while increasing dispatch reliability, enlarging payload fractions and fuel loads, and reducing construction and life cycle costs. An evaluation is presently made of such composites' comparative performance, vis-a-vis metallic structures, in civil aircraft application exemplified by such novel designs as the Lear Fan 2100, AVTEK 400, and Dash-8 aircraft. Attention is given to reinforcing fiber strand tensile stress/strain, unidirectional composite bending stress/strain curves, loss factors from vibration decay, tension-tension fatigue behavior, the residual strength of laminates, and the strength of mechanical joints in metallic and composite structures. O.C.

A87-31288#
ELECTROSTATIC SPRAY MODIFICATION IN GAS TURBINE COMBUSTION
J. A. MILLER, O. BIBLARZ, A. ZAJDMAN, W. W. MANNING, II, and J. A. MAVROUDIS (U.S. Naval Postgraduate School, Monterey, CA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 3, Mar.-Apr. 1987, p. 187-192. Navy-supported research. Previously cited in issue 23, p. 3366, Accession no. A84-46940. refs

N87-18660# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
ADVANCED ALUMINUM ALLOY PLATE MATERIALS FOR DAMAGE TOLERANT AIRCRAFT STRUCTURES
W. G. J. THART, H. J. KOLKMAN, L. SCHRA, and R. J. H. WANHILL Nov. 1986 10 p Presented at the European Materials Research Society on Advanced Materials, R and D for Transport, Strasbourg, France, 26-28 Nov. 1985 Sponsored by the Netherlands Agency for Aerospace Programs
(NLR-MP-85078-U; ETN-87-99294) Avail: NTIS HC A02/MF A01

Engineering properties of the aluminum plate alloy 2324-T39 and the conventional alloy 2024-T351 are compared. Results for the aluminum-lithium alloy DTD XXXA-T651 (Aluminum Association designation 8090) are also included. The strengths of 2324-T39 and DTD XXXA-T651 are comparable and significantly higher than that of 2024-T351; 2324-T39 also has greater fracture toughness. The constant amplitude fatigue crack growth resistance of DTD XXXA-T651 is significantly better than that of the other alloys. Fatigue thresholds are fairly similar. Under flight simulation loading 2324-T39 is inferior to 2024-T351, as is DTD XXXA-T651 for 2 mm thick material. In the absence of significant improvements as compared to 2024-T351, the results imply that replacement of 2024-T351 by 2324-T39, DTD XXXA-T651 (or more lightly tempered version) in fatigue critical areas is not a straightforward proposition. ESA

N87-18661# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
SHORT STRESS CORROSION CRACKS IN ALUMINUM ALLOY COMPONENTS
R. J. H. WANHILL 16 Jan. 1986 19 p Submitted for publication
(NLR-MP-86001-U; ETN-87-99300) Avail: NTIS HC A02/MF A01

Stress corrosion cracking in high strength aluminum alloy aerospace components is discussed, particularly problems in older aircraft and the feasibility of continued service for components containing short cracks. Use of more modern alloys and heat-treatment conditions that have high resistance to stress corrosion is the most effective for new components. However, for susceptible components already in service this implies reheat-treatment or replacement. Both alternatives may have serious disadvantages in addition to the anticipated costs. Reheat-treatment includes the risk of unacceptable distortion and hence replacement, and timely replacement can be greatly hindered by long delivery periods. ESA

N87-18662# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
FATIGUE IN AIRCRAFT CORROSION TESTING: THE FIRST 10 YEARS
R. J. H. WANHILL and J. J. DELUCCIA 21 Jan. 1986 18 p Presented at the AGARD Structures and Materials Panel at the 62nd SPM Meeting, Oslo, Norway, Apr. 1986
(NLR-MP-86009-U; ETN-87-99302) Avail: NTIS HC A02/MF A01

The AGARD-coordinated Fatigue in Aircraft Corrosion Testing (FACT) program is reviewed. Objectives include assessment of the effectiveness of state-of-the-art protection schemes for aluminum alloys with respect to corrosion fatigue and corrosion + fatigue; stimulation of the development of protection products, procedures, and techniques; bringing together researchers on both sides of the Atlantic in a common testing effort that would result in a better understanding of the corrosion fatigue phenomenon and the means of mitigating it for aerospace alloys; and enabling participating laboratories to add to their fatigue testing capabilities by using a controlled atmospheric corrosion environment. ESA

N87-19450*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
A METHOD OF PREDICTING THE ENERGY-ABSORPTION CAPABILITY OF COMPOSITE SUBFLOOR BEAMS
GARY L. FARLEY Mar. 1987 22 p Prepared in cooperation with Army Aviation Research and Development Command, Hampton, Va.
(NASA-TM-89088; NAS 1.15:89088; USAAVSCOM-TM-87-B-4) Avail: NTIS HC A02/MF A01 CSCL 11D

A simple method of predicting the energy-absorption capability of composite subfloor beam structure was developed. The method is based upon the weighted sum of the energy-absorption capability of constituent elements of a subfloor beam. An empirical data base of energy absorption results from circular and square cross section tube specimens were used in the prediction capability. The procedure is applicable to a wide range of subfloor beam structure. The procedure was demonstrated on three subfloor beam concepts. Agreement between test and prediction was within seven percent for all three cases. Author

N87-19508# Research Inst. of National Defence, Stockholm (Sweden). Dept. 2.
EVALUATION OF AL-LI ALLOYS AS CONSTRUCTION MATERIALS FOR AIRCRAFT APPLICATIONS
SVEN BOGEGAARD Oct. 1986 19 p In SWEDISH; ENGLISH summary
(FOA-C-20623-2.5(2.1); ISSN-0347-3694; ETN-87-99094) Avail: NTIS HC A02/MF A01

The relationship between Al-Li microstructure and alloy mechanical properties, and mechanisms for precipitation hardening and its influence on the deformation properties are described. Casting and powder metallurgy, rapid solidification, and mechanical alloying are outlined. The Al-Li alloys and carbon fiber plastic compounds are compared: a cross-laminated composite has better mechanical properties. The Al-Li alloys have as advantages: low density, high resistance, low crack propagation speed, and can replace without rebuilding heavier Al-alloys. ESA

N87-19534# IIT Research Inst., Bartlesville, Okla. National Inst. for Petroleum and Energy Research.
DATA EVALUATION AND TECHNIQUE DEVELOPMENT FOR ANALYSIS OF JP-5 FUELS Status Report
J. W. VOGH, C. D. PEARSON, O. K. BHAN, and D. W. BRINKMAN Sep. 1986 16 p Prepared in cooperation with Department of Energy, Washington, D. C. and Naval Air Propulsion Test Center, Trenton, N.J.
(Contract DE-FC22-83FE-60149)
(DE87-002025; NIPER-207) Avail: NTIS HC A02/MF A01

An increasing number of problems are being experienced with the currently available jet fuels. These fuels can form solids, increase in peroxide number, corrosiveness, and develop color and high viscosity when stored. Antioxidants (hindered phenols) have been generally used to overcome storage instability in these fuels. The objectives of this project are: (1) develop methods for accurately monitoring antioxidant depletion and peroxide formation in JP-5 fuels; and (2) assess changes in chemical composition of fuels upon aging. The following two techniques were developed for determination of antioxidant concentration in jet fuels: (1) reverse-phase high performance liquid chromatography used in conjunction with an electrochemical detector; and (2) gas chromatography/mass spectroscopy with selective ion monitoring. Concentration of two commercially available antioxidants (AO-29 and AO-33 at 12 and 24 ppM levels in a JP-5 fuel) was monitored using these techniques. Jet fuel samples with and without antioxidants are currently being aged in an oven at 60 C. Samples are being withdrawn at regular intervals. The samples collected for up to 12 weeks of storage did not indicate any sign of instability; however, the peroxide number of the fuel sample without antioxidants added increased significantly with fuel aging. DOE

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ENGINEERING

Includes engineering (general); communications and radar; electronics and electrical engineering; mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

A87-27706#
NONSYNCHRONOUS MOTION OF SQUEEZE FILM DAMPER SYSTEMS
XUEHAI LI and DEAN L. TAYLOR (Cornell University, Ithaca, NY) ASME, Transactions, Journal of Tribology (ISSN 0742-4787), vol. 109, Jan. 1987, p. 169-176. refs

The nonsynchronous motion of a rigid rotor-squeeze film damper system was investigated. This research classifies the phenomenon of the system with perfectly preloaded centering springs, reveals its existence conditions, and analyzes the system's topological structures associated with the phenomenon. When the centering springs of the system do not perfectly balance the gravity load, a unidirectional gravitational residual is resulted. This research also studied the effect of the gravitational residual on the system's behavior and the degree of stability for the various topological structures of the corresponding autonomous system. It shows that the residual improves the performance of the system because it either suppresses the nonsynchronous orbit of the system or changes it into various subharmonic orbits. This research shows that though the squeeze film damper system is inherently stable, it can have some undesirable nonsynchronous behavior for a wide range of system parameters. Author

A87-28328#
UNITARY OPTIMIZATION DESIGN FOR THE LARGE AIRCRAFT STRUCTURE
XIASHI LIU (Chinese Helicopter Research and Development Institute, People's Republic of China) Acta Mechanica Solida Sinica, Sept. 1986, p. 216-228. In Chinese, with abstract in English. refs

A design-optimization procedure for large aircraft is described and demonstrated. A combined approach based on an efficient solution of the large set of linear equations for the overall structure is employed to incorporate the results of finite-element analysis while avoiding long computation times and/or overload of computer memory capacity. Numerical results for a large passenger jet are presented in tables and graphs. T.K.

A87-28347
COMBUSTION OF LIQUID FUEL IN THE COUNTER-SWIRLED JETS OF A GAS TURBINE PLANT ANNULAR COMBUSTION CHAMBER
A. G. TUMANOVSKII, N. N. SEMICHASTNYI, and K. IU. SOKOLOV (Nevskii Mashinostroitel'nyi Zavod, Leningrad; Vsesoiuznyi Nauchno-Issledovatel'skii Teplotekhnicheskii Institut, Moscow, USSR) (Teploenergetika, vol. 33, Mar. 1986, p. 37-42) Thermal Engineering (ISSN 0040-6015), vol. 33, March 1986, p. 136-141. Translation.

Tests were carried out on an annular combustion chamber rig with a stabilizer of the type used in the GTN-25 gas turbine plant to determine the feasibility of burning a liquid fuel (diesel fuel, GOST 4749-73) in a combustion chamber of this type. Very high performance was obtained for a number of important characteristics of the microflame combustion process in counterswirled jets where all the air was supplied through the front unit of the chamber. However, the tests did not make it possible to solve some of the problems which arise when operating under full-scale conditions, such as the required high combustion efficiency under variable operating conditions of a gas turbine plant; elimination of soot formation at the walls of the stabilizer and the internal surfaces of the pipes supplying fuel to the atomizers; and a decrease in smoking under conditions of excess air factor. I.S.

A87-28414* Texas Univ., Austin.
TREE ATTENUATION AT 869 MHZ DERIVED FROM REMOTELY PILOTED AIRCRAFT MEASUREMENTS
WOLFHARD J. VOGEL (Texas, University, Austin) and JULIUS GOLDHIRSH (Johns Hopkins University, Laurel, MD) IEEE Transactions on Antennas and Propagation (ISSN 0018-926X), vol. AP-34, Dec. 1986, p. 1460-1464. refs
(Contract N00024-85-C-5301; JPL-956520)

Attenuation due to single trees is experimentally investigated using UHF transmissions at 869 MHz between a remotely piloted aircraft and a ground receiver system located in a stationary vehicle. Single trees of each tree type in full foliage were found to attenuate from 10-20 dB, with an average median value of about 12 dB. Attenuation coefficients associated with path lengths through the foliage may on average be about 1 dB/m, with maximum values closer to 2 dB/m. R.R.

A87-28434#
SOME CONSIDERATIONS ON THE MODERN BEAM THEORY - DEVELOPMENT OF THE PRACTICAL METHODS
TADAHIKO KAWAI (Tokyo Science University, Japan) and YOSHINOBU FUJITANI (Hiroshima University, Japan) Tokyo, University, Institute of Industrial Science, Report (ISSN 0040-9006), vol. 32, no. 4, Aug. 1986, p. 1-51. refs

An FEM procedure for the analysis of thin-walled beamlike structures such as aircraft, ships, and bridges is described and demonstrated, applying the theoretical results obtained by Kawai and Fujitani (1986). In this approach, the stiffness equation for the overall structure is derived from the general stiffness matrix of the beam element (defined from arbitrary points on the beam-end cross sections). Consideration is given to the Saint-Venant torsion problem, the determination of the beam section properties, beam shear-deformation problems, and thin-walled beams. Numerical results are presented for sample problems involving a container ship, the free vibration of a tall building, and railroad-car bodies. T.K.

A87-28538
ANTENNA SUITABILITY FOR AIRCRAFT INSTALLATION
DOUGLAS E. MCCOY (U.S. Army, Technical Support Activity, Fort Monmouth, NJ) IN: International Modal Analysis Conference, 4th, Los Angeles, CA, Feb. 3-6, 1986, Proceedings. Volume 1 . Schenectady, NY, Union College, 1986, p. 245-250.

The vibration testing and modal analysis of a prototype radio antenna for the UH-1 helicopter are described and illustrated with drawings, graphs, and tables of numerical data. The FRP-covered Al antenna was subjected to impulse frequency-response tests; the data were processed with a dual-channel FFT analyzer to construct a modal model; and the apparent resonant frequencies were compared with the helicopter forcing frequencies (due mainly to the main and tail rotors). Several potentially hazardous resonances were identified and found to persist even after minor structural modifications were introduced; it was finally recommended that a different type of antenna design be sought. T.K.

A87-28542
A MODAL SYNTHESIS METHOD FOR MULTI-SUBSTRUCTURE SYSTEMS
WEIJI WANG and SHIJING ZHU (Nanjing Aeronautical Institute, People's Republic of China) IN: International Modal Analysis Conference, 4th, Los Angeles, CA, Feb. 3-6, 1986, Proceedings. Volume 1 . Schenectady, NY, Union College, 1986, p. 354-359. refs

In this paper a multi-substructure modal synthesis method is developed for multi-substructure systems in which a central substructure is rounded by many other smaller substructures. The method is easy to use, makes small on computer capacity demand and requires little on cost as well as time. It has been applied to the modal analysis of multi-blade-disk system models. The calculation results and the modal test data of these systems are listed for comparison. Author

A87-28543* Rockwell International Corp., Downey, Calif.
MODELING OF MULTI-ROTOR TORSIONAL VIBRATIONS IN ROTATING MACHINERY USING SUBSTRUCTURING
FOLA R. SOARES (Rockwell International Corp., Space Transportation Systems Div., Downey, CA) IN: International Modal Analysis Conference, 4th, Los Angeles, CA, Feb. 3-6, 1986, Proceedings. Volume 1 . Schenectady, NY, Union College, 1986, p. 360-370. refs
(Contract NAG3-391)

The application of FEM modeling techniques to the analysis of torsional vibrations in complex rotating systems is described and demonstrated, summarizing results reported by Soares (1985). A substructuring approach is used for determination of torsional natural frequencies and resonant-mode shapes, steady-state frequency-sweep analysis, identification of dynamically unstable speed ranges, and characterization of transient linear and nonlinear systems. Results for several sample problems are presented in diagrams, graphs, and tables. STORV, a computer code based on this approach, is in use as a preliminary design tool for drive-train torsional analysis in the High Altitude Wind Tunnel at NASA Lewis. T.K.

A87-28561
QUALITY OF MODAL ANALYSIS AND RECONSTRUCTION OF FORCING FUNCTIONS BASED ON MEASURED OUTPUT DATA
H. OERY, H. GLASER, and D. HOLZDEPPE (Aachen Rheinisch-Westfaelische Technische Hochschule, West Germany) IN: International Modal Analysis Conference, 4th, Los Angeles, CA, Feb. 3-6, 1986, Proceedings. Volume 2 . Schenectady, NY, Union College, 1986, p. 850-857. Research supported by the MBB-ERNO Raumfahrttechnik GmbH, DFG, and ESA. refs

The reconstruction of forcing functions and/or interface forces due to the measured structural response, in the prediction of

realistic spacecraft flight loads, is considered. It is shown that knowledge of the spacecraft stiffness matrix and a limited number of eigenmodes enables the use of the inverse Williams (1948) procedure, determining the forcing functions precisely enough for the strength analysis of the primary structure, and leading to an accurate distribution of the impulsive load. The influence of a condensed mathematical substructure on the accuracy of the interface motion and the internal bending moments is investigated. The method shows improvement over pure modal reconstruction and has application to the reconstruction of instationary airloads and their distribution on helicopter rotor blades. R.R.

A87-28562
RESPONSE OF STRUCTURES TO RANDOM EXCITATIONS IN TIME DOMAIN
JIU CHANG and YI GU (Northwestern Polytechnical University, Xian, People's Republic of China) IN: International Modal Analysis Conference, 4th, Los Angeles, CA, Feb. 3-6, 1986, Proceedings. Volume 2 . Schenectady, NY, Union College, 1986, p. 891-896. refs

A new and easily used state variable method of structural response analysis to random excitations in time domain is developed and its application is illustrated by two numerical examples. The method readily applies to any type of excitations characterized by power spectral densities. The random excitations can be mathematically matched as the outputs of a linear system which has a stationary white-noise process as its input. Then the equations of an augmented system driven by white-noise can be obtained. The algebraic matrix Riccati equation must be solved numerically to obtain the root-mean-square values of structural response. Two numerical examples are illustrated, namely: (1) a matched system of random excitation is described, and (2) a root-mean-square value of an airplane in turbulence is calculated. Author

A87-28750*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
MULTIGRID ACCELERATION OF THE ISENTHALPIC FORM OF THE COMPRESSIBLE FLOW EQUATIONS
N. DUANE MELSON (NASA, Langley Research Center, Hampton, VA) and E. VON LAVANTE (Old Dominion University, Norfolk, VA) Copper Mountain Conference on Multigrid Methods, 3rd, Copper Mountain, CO, Apr. 6-10, 1987, Paper. 34 p. refs
(Contract NAG1-633)

A numerical method for solving the isenthalpic form of the governing equations for compressible inviscid flows was developed. The method is based on the concept of flux vector splitting in its implicit form and was tested on several demanding configurations. Time marching to steady state was accelerated by the implementation of the multigrid procedure which very effectively increased the rate of convergence. High quality steady-state results were obtained for various test cases and required only short computational times due to the relative efficiency of the basic method. Author

A87-29081
DETERMINATION OF THE TEMPERATURE FIELD OF SHELL STRUCTURES [OPREDELENIE TEMPERATURNOGO POLIA OBOLOCHKOVYKH KONSTRUKTSII]
N. G. RODIONOV (Komsomol'skii-na-Amure Politekhnicheskii Institut, Komsomol'sk-na-Amure, USSR) Energetika (ISSN 0579-2983), Oct. 1986, p. 66-70. In Russian.

A stationary heat conduction problem is formulated for the case of shell structures, such as those found in gas-turbine and jet engines. A two-dimensional elliptic differential equation of stationary heat conduction is obtained which allows, in an approximate manner, for temperature changes along a third variable, i.e., the shell thickness. The two-dimensional problem is reduced to a series of one-dimensional problems which are then solved using efficient difference schemes. The approach proposed here is illustrated by a specific example. V.L.

A87-29167
SPATIAL DECOUPLING BETWEEN ANTENNAS ON LARGE BODIES [PROSTRANSTVENNYE RAZVIAZKI MEZHDU ANTENNAMI NA TELAKH BOL'SHIKH RAZMEROV]
K. K. BELOSTOTSKAIA, M. A. VASILEV, and V. M. LEGKOV Radiotekhnika (ISSN 0033-8486), Oct. 1986, p. 77-79. In Russian.

The paper examines an EMC analysis technique for evaluating the decoupling between weakly directional slot antennas placed on the surface of a model body consisting of a circular cylinder and a quadrilateral plate. This represents a particular case of antenna arrangement on an aircraft wing and fuselage. Calculation results are compared with experimental data, and it is found that the decoupling is determined mainly by the mutual location of the antennas in the plane perpendicular to the cylinder axis and by the orientation of the antennas. B.J.

A87-29204
THERMAL AND THERMALLY STRESSED STATE OF TRIGONAL PRISMS MODELING THE OPERATION OF THE EDGES OF GAS TURBINE BLADES [TEPLOVOE I TERMONAPRIAZHENNOE SOSTOIANIE TREKHGRANNYKH PRIZM, MODELIRUIUSHCHINKH RABOTU KROMOK LOPATOK GAZOVYKH TURBIN]
G. N. TRETIACHENKO and V. G. BARILO (AN USSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR) Problemy Prochnosti (ISSN 0556-171X), Dec. 1986, p. 41-44. In Russian. refs

A new exact method is proposed for determining temperature and thermal stress distributions in trigonal prisms modeling the operation of the edges of gas turbine blades with boundary conditions of the first and third kinds. Exact solutions are compared with temperature and stress calculations based on numerical approximation methods. It is shown that in the case of specimens with wedge-shaped zones, the use of numerical approximation methods for calculating temperature fields and thermal stresses may lead to an error that exceeds the difference between the last two approximations by more than three orders of magnitude.. V.L.

A87-29208
THE USE OF SINGULAR ELEMENTS IN SOLVING TWO-DIMENSIONAL AND THREE-DIMENSIONAL FRACTURE MECHANICS PROBLEMS [PRIMENENIE SINGULIARNYKH ELEMENTOV PRI RESHENII DVUMERNYKH I TREKHMERNYKH ZADACH MEKHANIKI RAZRUSHENIIA]
V. I. GRISHIN and T. K. BEGEEV Problemy Prochnosti (ISSN 0556-171X), Dec. 1986, p. 91-96. In Russian. refs

Finite-element algorithms are presented for calculating stress intensity factors for plane and three-dimensional elements of aircraft structures weakened by through-the-thickness and part-through cracks. The algorithms, which use special singular elements, have been implemented in a specialized set of application programs written in FORTRAN. Results obtained for several two- and three-dimensional fracture mechanics problems are compared with known analytical and numerical solutions. V.L.

A87-29268
PULSE CONTROL OF FLEXIBLE MULTIBODY SYSTEMS
K. CHANGIZI and A. A. SHABANA (Illinois, University, Chicago) Computers and Structures (ISSN 0045-7949), vol. 24, no. 6, 1986, p. 875-884. refs

An active pulse method for controlling impact-induced vibrations in flexible multibody systems is developed analytically, using the equations of energy and momentum balance for the impacting components to determine the pulse as a function of generalized coordinates and velocities. The derivation of the equations for the method is described in detail, and numerical results demonstrating the effectiveness of the control in a sample problem involving touchdown vibrations of a two-dimensional aircraft model are presented in graphs. T.K.

A87-29279#
DYNAMICS OF COMPRESSIBLE AIR FLOW IN DUCTS WITH HEAT EXCHANGE
M. ABDULHADI (Yarmouk University, Irbid, Jordan) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 32, Dec. 1986, p. 306-313. refs

An investigation into the effect of heat addition on subsonic flow of an air stream in a constant-area duct preceded by a convergent nozzle is carried out. A nozzle flow apparatus with a heat exchanger encasing the constant-area duct has been built for this purpose. Hot water is provided from an electric boiler where the flow rate and the in-flow hot water temperature could be controlled. It is confirmed experimentally, as predicted analytically, that heat transfer to the gas decreases its local static pressure along the duct axis, and that this decrease is associated with an increase in Mach number toward M = 1 at the exit (thermal choking). In the case of subsonic flow, the additional entropy generated by the heat interaction exceeding the amount that produces thermal choking can only be accommodated by moving to a new Rayleigh line, at a decreased flow rate which lowers the inlet Mach number. The good correlation between the experimental results and the analytical derivations illustrates that the experimental arrangement has potential for further experiments and investigations. Author

A87-29600
ASSESSMENT OF CONCEPTS FOR FATIGUE CRACK INITIATION AND PROPAGATION LIFE PREDICTION
P. HEULER and W. SCHUETZ (Industrieanlagen-Betrieb-gesellschaft, Ottobrunn, West Germany) Zeitschrift fuer Werkstofftechnik (ISSN 0049-8688), vol. 17, Dec. 1986, p. 449-456. refs

Concepts of fatigue crack initiation are assessed with respect to their ability to predict fatigue lives under variable amplitude loading. The approaches considered include Miner's rule, the relative Miner rule, and the local strain approach. Typical results using these methods are shown for elements of various alloys, and the advantages and drawbacks of each method are addressed. The application of these methods to crack growth prediction in the aircraft industry is emphasized. C.D.

A87-29601#
THE RELIABILITY AND THE INTENSITY OF AIRCRAFT STRUCTURES
DEPEI ZHU (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 7, Dec. 1986, p. 521-530. In Chinese, with abstract in English. refs

This paper reviews the reliability and the integrity of aircraft structures. Emphasis is put on introducing the various models of reliability analysis and applications of the reliability concept in design of aircraft structures, with evaluation of the state-of-the-art in these aspects. The structural integrity and the ASIP (Aircraft Structure Integrity Program) are also introduced in brief, in order to show the importance of design experience and of making use of all the links in the chain of ASIP in ensuring the reliability of aircraft structures. Finally, optimum design based on structural reliability is concisely introduced. Author

A87-29603#
ON SOME BRANCHES OF FLIGHT VEHICLE STRENGTH NOW
YAONAN GONG (Beijing Institute of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 7, Dec. 1986, p. 539-546. In Chinese, with abstract in English. refs

The present paper reviews briefly some developments in solid mechanics and shows the close relationship between the development of solid mechanics and its applications to engineering. Flight vehicle strength, as an application of solid mechanics to aeronautical and missile structures, is discussed. Some important aspects of flight vehicle strength, such as the mechanics of composite materials, computational mechanics, active suppression of flutter, safety and reliability of structures, and fatigue and fracture are given. The present paper aims at the investigation and study of the state-of-the-art of these branches and attempts to predict the possible research trends. Author

A87-29617
NDT OF JET ENGINES - AN INDUSTRY SURVEY. II
Materials Evaluation (ISSN 0025-5327), vol. 45, Jan.-Feb. 1987, p. 26, 28, 30-34.

An inventory is taken of NDT techniques currently being employed by gas turbine engine manufacturers in the USA. These methods encompass such EM techniques as eddy current probe testing, fluorescent penetrant testing, and magnetic induction measurements. Frequent use is also made of X-radiography, tomography, film radiography, real-time radiography, and automated inspection cell radiography. A substantial portion of these inspection services are conducted for the USAF; most of the remainder is concerned with airliners' high-bypass turbofans. O.C.

A87-29875
WILL THE JOINT HOLD?
JAMES H. BRAHNEY Aerospace Engineering (ISSN 0736-2536), vol. 7, Jan. 1987, p. 10-14.

Unlike mechanical fasteners, which concentrate loads in their immediate vicinity, adhesive bonds uniformly distribute the stresses of a primary aerospace structure over the entire bonded area; this characteristic of adhesive methods is profoundly consequential in that it allows the use of lighter gage materials and improves fatigue resistance. Adhesives also dampen structural vibrations. Attention is presently given to bonded aerospace structure fabrication methods employing thermosetting resins to produce airframe components of laminate and honeycomb core sandwich type. Service temperatures of 350 F are possible with epoxy adhesives; polyimides allow use at up to 550 F. O.C.

A87-29956* Imperial Coll. of Science and Technology, London (England).
CHARACTERISTICS OF A TRAILING FLAP FLOW WITH SMALL SEPARATION
D. ADAIR (NASA, Ames Research Center, Moffett Field, CA; Imperial College of Science and Technology, London, England) Experiments in Fluids (ISSN 0723-4864), vol. 5, no. 2, 1987, p. 114-128. Research supported by the Northern Ireland Department of Education, and NERC. refs

Detailed measurements of pressure and velocity characteristics are reported for the flow on and downstream of a trailing flap, whose 16 degree angle of incidence resulted in boundary layer separation, a small region of recirculating flow, and a curved downstream wake. Emphasis is placed on the region of recirculating flow and on the downstream wake. The characteristics were quantified by the use of pressure, hot-wire, and flying hot-wire probes. The flow characteristics are compared to those of a similar flow but with a larger region of recirculation reported by Thompson and Whitelaw (1985). The relative importance of the terms in the transport equations for mean momentum and turbulence energy are quantified and the implications of the results for viscous-inviscid interaction methods and turbulence modeling are discussed. Author

A87-30102
ADVANCED FASTENER TECHNOLOGY FOR COMPOSITE AND METALLIC JOINTS
EUGENE R. SPEAKMAN (Douglas Aircraft Co., Long Beach, CA) IN: Fatigue in mechanically fastened composite and metallic joints; Proceedings of the Symposium, Charleston, SC, Mar. 18, 19, 1985 . Philadelphia, PA, American Society for Testing and Materials, 1986, p. 5-38.

The investigations described in this paper were conducted to develop new fasteners and joining methods to reduce the weight and improve the fatigue life of aircraft structures. Three major modes of structural failure - fatigue, fretting, and stress corrosion - are discussed along with recommendations for improvement. Stress-coining was developed to cold-work aircraft structures for fatigue improvement. Fretting fatigue failures have been reduced

by using Teflon coatings on fasteners and in faying surfaces of splice joints. Standard stress corrosion test blocks have been designed for evaluation of this failure mode. A crown flush rivet configuration has been developed that does not require head shaving after installation. Qualification tests were performed in compliance with MIL-STD-1312 to obtain Federal Aviation Administration and military approval. Various new fasteners have been developed for aluminum, carbon-fiber composite, and titanium structures. These fasteners were designed to be 'forgiving to the hole' in that they fill and prestress the hole uniformly without being extremely sensitive to hole-preparation tolerances. New low-cost specimens have been designed to provide a basis for screening and comparing fastener tests conducted by fastener manufacturers and aircraft companies. These programs are directed toward creating technology for achieving a more balanced fatigue-resistant aircraft structure. Author

A87-30103
FATIGUE LIFE ENHANCEMENT AND HIGH INTERFERENCE BUSHING INSTALLATION USING THE FORCEMATE BUSHING INSTALLATION TECHNIQUE
ROBERT L. CHAMPOUX and MICHAEL A. LANDY (Fatigue Technology, Inc., Seattle, WA) IN: Fatigue in mechanically fastened composite and metallic joints; Proceedings of the Symposium, Charleston, SC, Mar. 18, 19, 1985 . Philadelphia, PA, American Society for Testing and Materials, 1986, p. 39-52. refs

The patented ForceMate bushing installation process, originally developed by McDonnell Aircraft, involves expansion of a hole and simultaneous installation of an interference fitted bushing. The process provides a significant improvement in the fatigue life of bushed holes in metallic structures and offers reduced bushing installation costs. Fatigue life improvement is attributed both to the creation of residual compressive stresses in the metal surrounding the hole and to the reduction in applied cyclic stress range caused by the interference fitted bushing. Installation is accomplished without loss of corrosion protection because of the initial clearance fit of the bushing in the hole. Installation costs are reduced by the elimination of liquid nitrogen needed for shrinkage of bushings, as well as the significant reduction in installation time and manpower. This paper describes the ForceMate process in detail. Fatigue lives of simulated aluminum lug geometries with bushings installed using the ForceMate process were compared with lives of lugs with bushings installed using conventional shrink fit methods. Constant amplitude and flight-by-flight spectrum loading were used for cyclic testing. Life improvement factors of greater than 3:1 were shown. Bushing-to-hole interferences were significantly greater than those achievable with traditional shrink-fit installation techniques. The process was demonstrated effectively with bushings manufactured from beryllium-copper, aluminum-nickel-bronze, and steel alloys. Author

A87-30106
EVALUATION OF A STOCHASTIC INITIAL FATIGUE QUALITY MODEL FOR FASTENER HOLES
JANN N. YANG (George Washington University, Washington, DC), SHERRELL D. MANNING (General Dynamics Corp., Fort Worth, TX), and JAMES L. RUDD (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: Fatigue in mechanically fastened composite and metallic joints; Proceedings of the Symposium, Charleston, SC, Mar. 18, 19, 1985 . Philadelphia, PA, American Society for Testing and Materials, 1986, p. 118-149. refs
(Contract F33615-83-K-3226)

An initial fatigue quality (IFQ) model, based on stochastic crack growth and the equivalent initial flaw size (EIFS) concept, is described and evaluated for the durability analysis of relatively small cracks in fastener holes of, for example, less than 2.54 mm. The IFQ model uses a stochastic crack growth rate model which accounts for crack growth rate dispersion. Procedures and concepts are also described and evaluated for optimizing initial flaw size distribution parameters based on pooled EIFS results. Fatigue crack growth test results for 7475-T7351 aluminum specimens subjected to fighter and bomber load spectra are used to evaluate the proposed IFQ model and model calibration procedures. The cumulative distribution of crack size at any given time and the cumulative distribution of the time-to-crack initiation at any given crack size are predicted using the derived EIFS distribution and a stochastic crack growth approach. The predictions compare well with the actual test results in the small-crack-size region. The methods described are very promising for durability analysis applications. Author

A87-30107
EXPERIMENTAL CHARACTERIZATION OF CRACKS AT OPEN HOLES AND IN ROUNDED-END STRAIGHT ATTACHMENT LUGS
GIANNI NICOLETTO (Bologna, Universita, Italy) IN: Fatigue in mechanically fastened composite and metallic joints; Proceedings of the Symposium, Charleston, SC, Mar. 18, 19, 1985 . Philadelphia, PA, American Society for Testing and Materials, 1986, p. 150-171. refs

The paper focuses on the application of the frozen-stress photoelastic technique to an assessment of various engineering solutions from the literature for several hole-related crack problems. Single corner, transitioning, and through-the-thickness cracks are examined. Remote tensile loading of a plate containing an open hole and 100 percent load transfer through a rigid pin in a rounded-end lug is considered. Experimental evidence demonstrates the presence of stress intensity factor (SIF) gradients for every crack configuration. Good correlation with existing SIF solutions is found for the through-the-thickness configuration in lugs. Less conclusive are the comparisons with engineering estimates for corner cracks emerging from open holes and lug. The transitioning behavior of a part-through crack is also discussed. Finally, modeling aspects of three-dimensional fracture problems are examined. Author

A87-30109
ENHANCED STOP-DRILL REPAIR PROCEDURE FOR CRACKED STRUCTURES
MICHAEL A. LANDY (Fatigue Technology, Inc., Seattle, WA), HARRY ARMEN, JR., and HARVEY L. EIDINOFF (Grumman Aerospace Corp., Bethpage, NY) IN: Fatigue in mechanically fastened composite and metallic joints; Proceedings of the Symposium, Charleston, SC, Mar. 18, 19, 1985 . Philadelphia, PA, American Society for Testing and Materials, 1986, p. 190-220. refs

A repair technique for cracked structures that consists of stop drilling the crack tip is examined. This repair procedure is enhanced by cold expanding the stop-drill hole and by installation of an interference-fit fastener. An experimental and analytical investigation of the effectiveness of the enhanced stop-drill procedure is presented. The analysis consists of elastic-plastic stress analysis utilizing the finite element approach to determine residual stress distributions, stress intensity factors around the stop-drill holes due to cold expansion, and stress intensity factors along the fatigue crack paths followed by crack initiation and crack growth life predictions. Comparisons of the life predictions and fatigue test data are also presented. The results indicate that cold expansion and interference-fit fastener installation improve the fatigue performance of stop-drill holes through crack tips by factors ranging from 3 to 20. Author

A87-30154
OPTIMUM DESIGN OF SANDWICH CONSTRUCTIONS
YUNLIANG DING (Kungl. Tekniska Hogskolan, Stockholm, Sweden) Computers and Structures (ISSN 0045-7949), I. 25, no. 1, 1987, p. 51-68. refs

Finite element analysis and the optimization problem of sandwich constructions are treated. The thicknesses of the face plates and the core are used as design variables. The hybrid approximation technique in combination with the dual method from mathematical programming is used. Three examples are solved using six-nodal triangular and eight-nodal quadrilateral sandwich shell elements. Author

A87-30297#
STOCHASTIC RESPONSE OF NONLINEAR STRUCTURES WITH PARAMETER RANDOM FLUCTUATIONS
R. A. IBRAHIM (Texas Tech University, Lubbock) and H. HEO (Structures, Structural Dynamics and Materials Conference, 27th, San Antonio, TX, May 19-21, 1986, Technical Papers. Part 2, p. 533-543) AIAA Journal (ISSN 0001-1452), vol. 25, Feb. 1987, p. 331-338. Previously cited in issue 18, p. 2659, Accession no. A86-38934. refs
(Contract AF-AFOSR-85-0008)

A87-30319
MODELING INTERFERENCE EFFECTS FOR LAND-MOBILE AND AIR-MOBILE COMMUNICATIONS
CHARLES E. COOK (Mitre Corp., Bedford, MA) IEEE Transactions on Communications (ISSN 0090-6778), vol. COM-35, Feb. 1987, p. 151-165. refs
(Contract F19628-86-C-0001)

Analytical and computer models are presented that can provide an assessment of land-mobile and air mobile communications performance in interference environments. The results obtained with these models, based on a communications region of operability criterion, include the effects of greater-than-free-space propagation path losses associated with low-elevation signal paths. The analytic models are used to examine the effects of higher order path loss on signal-to-interference contours for single and linearly distributed interference scenarios. The computer model can be used to investigate link performance for interference environments in which the link assets and each source of interference are arbitrarily located in three dimensions. A propagation submodel permits independent calculation of the loss over each link or interference signal path. Computer-generated plots are presented that illustrate the effect of antenna heights and frequency on the shape of the signal-to-interference (S/I) contours. Of particular interest is the effect on link region of operability when either the link transmitter or the sources of interference are at a higher altitude than the other. Author

A87-30321* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
LABORATORY MEASUREMENTS AND A THEORETICAL ANALYSIS OF THE TCT FADING CHANNEL RADIO SYSTEM
WILLIAM RAFFERTY (California Institute of Technology, Jet Propulsion Laboratory, Pasadena), JOHN B. ANDERSON, GARY J. SAULNIER (Rensselaer Polytechnic Institute, Troy, NY), and JOHN R. HOLM (Washington, University, Seattle) IEEE Transactions on Communications (ISSN 0090-6778), vol. COM-35, Feb. 1987, p. 172-180. refs

This paper documents the laboratory and theoretical performance of a pilot-aided digital radio system. The technique considered transmits a midband pilot tone to improve the receiver data detection performance in a multipath fading channel and is referred to as the tone calibrated technique (TCT). The performance of a 860 MHz prototype system carrying 2.4 kbit/s data under Rician fading conditions is reported. Both experimental and analytical results show that the error floor experienced with nonpilot-aided transmission methods is effectively removed by the TCT scheme, resulting in significant performance gains at high signal-to-noise ratio values. The paper also examines the TCT system performance under typical operating conditions and presents a new analysis of the TCT theoretical error probability. Author

A87-30478
FORCED VIBRATION OF A STIFF BODY IN A VISCOUS MEDIUM [ZWANGSSCHWINGUNG EINES STARREN KOERPERS IN EINEM VISKOSEN MEDIUM]
SPIROS KATSAITIS (Patras, University, Greece) Forschung im Ingenieurwesen (ISSN 0015-7899), vol. 52, Dec. 1986, p. 169-184. In German. refs

Implicit formulas are obtained for the damping coefficients of the differential equation of linear vibrations of a stiff body in a viscous medium. It is assumed that the damping does not significantly affect the form of the vibration. Using these formulas, amplification factors, phase angles, and damping coefficients can be explicitly determined for an arbitrary surrounding medium. Values obtained for air and water are presented. Damping and friction problems for vibrations in ships and aircraft, in damping turbines and gas turbines, pumps, and condensers can be solved using this method. C.D.

A87-30498* California Univ., Davis.
EFFICIENCY CHARACTERISTICS OF CRESCENT-SHAPED WINGS AND CAUDAL FINS
C. P. VAN DAM (California, University, Davis) Nature (ISSN 0028-0836), vol. 325, Jan. 29, 1987, p. 435-437. Research supported by the University of California and NASA. refs

Caudal (tail) fins of fish and aquatic mammals that cruise long distances, and wings of certain birds, often have the shape of a crescent moon. This study investigates how the crescent shape contributes to the traveling performance of these animals. A steady-flow theory (Maskew, 1982) that correctly models the trailing wake was used to analyze lifting surface efficiency, which is dependent on the level of induced (or vortex) drag for a given lift and span of the lifting surface. This analysis shows that backward curvature of a wing improves induced efficiency to a value greater than that of the flat untwisted wing of elliptical shape considered optimal in classical wing theory (Prandt, 1921 and Munk, 1921). This increase of induced efficiency results from the nonplanar trailing vortex sheet produced by the crescent-shaped wing at a given angle of attack. Author

A87-30677
APPLICATIONS OF LASER VELOCIMETRY AND RAYLEIGH SCATTERING TO ENGINE FLOWS
J. H. WHITELAW (Imperial College of Science and Technology, London, England) IN: Heat transfer 1986; Proceedings of the Eighth International Conference, San Francisco, CA, Aug. 17-22, 1986. Volume 1 . Washington, DC, Hemisphere Publishing Corp., 1986, p. 29-34. Research supported by Rolls-Royce, Ltd., Ford Motor Co., Ministry of Defence, SERC, and DOE. refs

Three examples of the use of laser optical techniques to the improvement of understanding of complex flows are described and correspond to the flows in the cylinders of internal combustion engines, in the region downstream of bluff-body stabilized premixed flames and in gas turbine combustors. Laser velocimetry was used to determine velocity characteristics in all cases with laser Rayleigh and thermocouple techniques used for temperature measurements when appropriate. Conventional probe methods have been used for the measurement of species concentrations. The reasons for choice of instrumentation are provided together with brief descriptions and sample results. Author

A87-30706* Arizona State Univ., Tempe.
FORCED CONVECTION HEAT TRANSFER TO AIR/WATER VAPOR MIXTURES
D. R. RICHARDS and L. W. FLORSCHUETZ (Arizona State University, Tempe) IN: Heat transfer 1986; Proceedings of the Eighth International Conference, San Francisco, CA, Aug. 17-22, 1986. Volume 3 . Washington, DC, Hemisphere Publishing Corp., 1986, p. 1053-1058. NASA-supported research. refs

Heat transfer coefficients were measured using both dry air and air/water vapor mixtures in the same forced convection cooling test rig (jet array impingement configurations) with mass ratios of water vapor to air up to 0.23. The primary objective was to verify by direct experiment that selected existing methods for evaluation of viscosity and thermal conductivity of air/water vapor mixtures could be used with confidence to predict heat transfer coefficients for such mixtures using as a basis heat transfer data for dry air only. The property evaluation methods deemed most appropriate require as a basis a measured property value at one mixture composition in addition to the property values for the pure components. Author

A87-30707
LOCAL HEAT TRANSFER AND FLUID FLOW STUDIES ON A RECTANGULAR PLATE INCLINED AT DIFFERENT ANGLES OF ATTACK AND YAW TO AN AIR STREAM
D. G. MOTWANI, U. N. GAITONDE, and S. P. SUKHATME (Indian Institute of Technology, Bombay, India) IN: Heat transfer 1986; Proceedings of the Eighth International Conference, San Francisco, CA, Aug. 17-22, 1986. Volume 3 . Washington, DC, Hemisphere Publishing Corp., 1986, p. 1059-1063. refs

The three-dimensional behavior of a turbulent boundary layer on a flat plate oriented to an oncoming air stream at various angles of attack (from 0 to 45 deg) and yaw (from 0 to 30 deg) was studied experimentally using a specially-designed plate-assembly apparatus and a low-turbulence (less than 1 percent) wind tunnel. For the case of zero yaw and zero incidence, a low-heat transfer zone was seen at the center, followed by a high-heat transfer zone, indicating the formation and reattachment of a separation bubble. As the angle of attack was increased to 15 deg at zero yaw, the low-heat transfer zone vanished; the separation bubble reattached very close to the leading edge, resulting in high heat-transfer coefficients. Relaminarization effects were noted away from the leading edge at higher angles of attack. For the yawed plate, a diagonal flow is responsible for the low heat-transfer zones observed at the farthest points. I.S.

A87-30718
EXPERIMENTAL INVESTIGATION ON THE COMPOSITE COOLING OF A SEMICYLINDER LEADING EDGE
JI-RUI CHENG and HONG-HU JI (Nanjing Aeronautical Institute, People's Republic of China) IN: Heat transfer 1986; Proceedings of the Eighth International Conference, San Francisco, CA, Aug. 17-22, 1986. Volume 3 . Washington, DC, Hemisphere Publishing Corp., 1986, p. 1219-1224. refs

Composite cooling of the leading edge region of a semicylinder simulating a turbine vane was studied experimentally. The cylinder's inner surface served as an impingement target for studying impingement cooling; the outer surface was used to study the film cooling effectiveness. The equipment for composite cooling was a sucked-wind tunnel with the test section of 140 x 200-sq m in cross section and with transparent windows for flow visualization. Three test models and five different impingement tubes were used. The effects of geometrical parameters of the test models and impingement tubes and of the location and direction of the film holes on both the impingement and the film cooling are described. I.S.

A87-30779
AIRCRAFT EARTH STATION FOR EXPERIMENTAL MOBILE SATELLITE SYSTEM
S. OHMORI, Y. HASE, K. KOSAKA, and M. TANAKA (Ministry of Posts and Telecommunications, Radio Research Laboratory, Koganei, Japan) IN: ICC '86; Proceedings of the International Conference on Communications, Toronto, Canada, June 22-25, 1986, Conference Record. Volume 3 . New York, Institute of Electrical and Electronics Engineers, 1986, p. 1392-1395.

A mobile satellite communication system, which can provide high quality service for small ships and aircraft, has been studied in Japan. This system is scheduled to be carried into experimental and evaluation phase in 1987, when a geostationary satellite (ETS-V) is launched by a Japanese rocket. This paper describes an aircraft earth station, which can establish telephone communication links for passengers on board the aircraft. The new technologies, especially an airborne phased array antenna, are developed. This is the first development in the world in mobile satellite communication areas. Author

A87-30845
SIMULATORS III; PROCEEDINGS OF THE CONFERENCE, NORFOLK, VA, MAR. 10-12, 1986
BRUCE T. FAIRCHILD, ED. (Applied Computer Technology, French Camp, CA) Conference sponsored by the Society for Computer Simulation. San Diego, CA, Society for Computer Simulation (Simulation Series. Volume 17, No. 2), 1986, 239 p. For individual items see A87-30846 to A87-30851.

Theoretical and applied research projects and applications of simulators for training, systems evaluation and on-line process monitoring are explored. The use of workstations at NASA Goddard to study graphics-based control room operations and monitor space missions is described. Problems encountered in the development and display of databases and the design of visual scenes for training simulations are delineated, and Naval Training Systems Center usage of simulators to investigate training techniques, simulator capabilities, and aids to pilots performing carrier landings is summarized. A study performed by the USAF to assess the relative effectiveness of alternate display simulations for F-16 maintenance training is delineated. Finally, a Boeing project which involved refurbishing an older simulator to serve as a training device for aircrew on a modernized KC-135R aircraft is detailed. M.S.K.

A87-31157#
DIRECT MEASUREMENTS OF DRAG OF RIBBON-TYPE MANIPULATORS IN A TURBULENT BOUNDARY LAYER
S. P. GOVINDARAJU and F. W. CHAMBERS (Lockheed-Georgia Co., Marietta) AIAA Journal (ISSN 0001-1452), vol. 25, March 1987, p. 388-394. Research supported by the Lockheed-Georgia Independent Research and Development Program. Previously cited in issue 07, p. 832, Accession no. A86-19793. refs

A87-31169#
NONLINEAR ANALYSIS OF PRETWISTED RODS USING 'PRINCIPAL CURVATURE TRANSFORMATION'. I - THEORETICAL DERIVATION
AVIV ROSEN, ROBERT G. LOEWY (Rensselaer Polytechnic Institute, Troy, NY), and MATHEW B. MATHEW AIAA Journal (ISSN 0001-1452), vol. 25, March 1987, p. 470-478. refs (Contract DAAG29-82-K-0093)

A numerical method for analyzing the nonlinear coupled bending-torsion of pretwisted rods is derived. This method combines use of principal curvature transformation and the technique of generalized coordinates, and a very efficient tool results. The two main advantages are the ease with which different kinds of nonlinear models incorporating different magnitudes of nonlinearities can be derived and implemented, and reduced computing time required, as compared with other methods for parametric studies where the loads, structural properties, and pretwist are varied. The present derivation includes three versions of a model for small strains and moderate elastic rotations. A fourth model, where products of the elastic rotations are not negligible compared with unity, is also presented. The second part of the paper will include numerical examples using the model described herein. Author

A87-31173*# Laval Univ. (Quebec).
SKIN FRICTION MEASUREMENTS FOLLOWING MANIPULATION OF A TURBULENT BOUNDARY LAYER
V. D. NGUYEN (Universite Laval, Quebec, Canada), A. M. SAVILL (Cambridge University, England), and R. V. WESTPHAL (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 25, March 1987, p. 498-500. Research supported by Rolls-Royce, Ltd. refs

Results are presented from three experiments in which direct, local measurements of the skin friction reduction due to flat-plate turbulence manipulators for overall viscous drag reduction were obtained. The results suggest that only a very small overall net drag reduction will be possible for such devices at moderate momentum thickness-derived Reynolds number values, since maximum skin friction drag is neither large nor sustained. O.C.

A87-31176*# Arizona Univ., Tucson.
PERFECT GAS EFFECTS IN COMPRESSIBLE RAPID DISTORTION THEORY
E. J. KERSCHEN and M. R. MYERS (Arizona, University, Tucson) AIAA Journal (ISSN 0001-1452), vol. 25, March 1987, p. 504-507. Research supported by the General Electric Co. refs
(Contract NAG3-357)

The governing equations presented for small amplitude unsteady disturbances imposed on steady, compressible mean flows that are two-dimensional and nearly uniform have their basis in the perfect gas equations of state, and therefore generalize previous results based on tangent gas theory. While these equations are more complex, this complexity is required for adequate treatment of high frequency disturbances, especially when the base flow Mach number is large; under such circumstances, the simplifying assumptions of tangent gas theory are not applicable. O.C.

A87-31179*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
RELAXATION ALGORITHMS FOR THE EULER EQUATIONS
S. F. WORNOM (NASA, Langley Research Center, Hampton, VA) and M. M. HAFEZ (California, University, Davis) AIAA Journal (ISSN 0001-1452), vol. 25, April 1987, p. 523, 524. Abridged.
(AIAA PAPER 85-1516)

The alternating direction implicit central-difference scheme algorithms may be replaced by successive-line-relaxation (SLR) procedures that are stable in three dimensions. Several Beamand Warming-type codes are presently modified on the basis of SLR solution procedures in order to compute the flows over a cylinder, a NACA-0012 airfoil, and a shock wave reflecting off a plate. Since the codes are written in a 'delta form', the implementation of relaxation procedures that rely only on the corrections is relatively easy; the steady state residual computation and any artificial viscosity terms may be left unchanged. O.C.

A87-31284*# Virginia Polytechnic Inst. and State Univ., Blacksburg.
EXPERIMENTAL INVESTIGATION OF UNSTEADY FAN FLOW INTERACTION WITH DOWNSTREAM STRUTS
W. F. NG, W. F. OBRIEN, and T. L. OLSEN (Virginia Polytechnic Institute and State University, Blacksburg) Journal of Propulsion and Power (ISSN 0748-4658), vol. 3, Mar.-Apr. 1987, p. 157-163. NASA-supported research. Previously cited in issue 22, p. 3263, Accession no. A86-45490. refs

N87-18721# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Avionics Panel.
MULTIFUNCTION RADAR FOR AIRBORNE APPLICATIONS
Loughton, England Jul. 1986 209 p In ENGLISH and FRENCH Symposium held in Toulouse, France, 14-18 Oct. 1985
(AGARD-CP-381; ISBN-92-835-0395-3) Avail: NTIS HC A10/MF A01

The present state-of-the-art of multifunction radar and new concepts for the design of future radar systems are presented. Specific subject areas addressed include all-weather operation, signal processing, high resolution imaging (synthetic aperture radar), beam steering, range and Doppler estimation, clutter and interference, equipment and component design, target detection and classification, multifunction integration, and radar system integration.

N87-18722# Thomson-CSF, Paris (France).
ABOUT THE FUTURE OF AIRBORNE RADAR
MICHEL H. CARPENTIER *In* AGARD Multifunction Radar for Airborne Applications 6 p Jul. 1986
Avail: NTIS HC A10/MF A01

The present state-of-the-art of airborne multifunctional radar is reviewed and possible developments for future systems are discussed. The operational requirements of military aircraft radars are outlined with particular attention given to target acquisition and tracking, radar navigation and terrain following. The electromagnetic environments these systems will operate in are also characterized. The limitations of present radars are defined and suggestions are made regarding the directions of future research. Four possible areas of development are addressed: (1) improvement of the range resolution and complexity of the transmitted waveforms; (2) better utilization of the received signals; (3) improvement of angular domain; and (4) cooperation with the electromagnetic countermeasure system and other sensors onboard the aircraft. M.G.

N87-18724# Radar Systems Group, Los Angeles, Calif. Advanced Development Dept.
MULTIMISSION AIRBORNE RADAR FOR THE 1990S
THOMAS H. ROBINSON *In* AGARD Multifunction Radar for Airborne Applications 2 p Jul. 1986
Avail: NTIS HC A10/MF A01

The continuing trend towards the development and production of aircraft capable of multiple missions indicates that future airborne radars must provide a broad spectrum of air-to-air and air-to-ground modes. This paper investigates the modal and functional requirements of a multimode radar projected for the mid-1990s period. The paper is divided into two sections. In the first, the multimission capabilities of current radars are presented to establish trends and capabilities. In the second, the requirements of the next generation system are established. Current multimode radars lay the basis for future systems. The experience gained on the APG-65 and APG-63/70 radars is presented and conclusions are drawn regarding their impact on future system requirements. Not only are modes and performance reviewed for these radars but also their system architecture. The discussion starts with the APG-65 radar which is the first true multimission radar with programmable signal and data processing. Following this, the evolution of the APG-63 radar, culminating with the most recent upgrading resulting in redesignation of APG-70, is presented. The incorporation of air-to-ground capabilities in the APG-70, resulting from the Dual Role Fighter program, is reviewed. Results from the Advanced Fighter Capabilities Demonstration program are presented showing how high resolution SAR was incorporated into a full weapon delivery solution. The specific radar requirements for the next decade radar system are developed. This development is done in two parts. First, mode requirements are synthesized for air superiority, navigation and strike/interdiction operation. This includes low altitude penetration requirements and a review of radar timeline constraints which arise. Second, the fundamental functional requirements needed to implement the mode requirements are explored. Architectural issues and their impact on reliability and sustainability are also considered. Author

N87-18725# Royal Signals and Radar Establishment, Malvern (England).
MULTIFUNCTION MILLIMETRE-WAVE RADAR FOR ALL-WEATHER GROUND ATTACK AIRCRAFT Abstract Only
K. E. POTTER *In* AGARD Multifunction Radar for Airborne Applications 1 p Jul. 1986
Avail: NTIS HC A10/MF A01

Details of the millimeter wave radar performance are presented which show that with potentially available power sources an all weather capability can be realized. Performance is evaluated as a function of frequency and antenna size, and the use of polarimetry with wide bandwidth/coherent processing is shown to offer potential enhancement for target discrimination. The millimeter wave radar is shown to be potentially capable of satisfying the following functions: take off/landing, terrain following, area correlation, tercom, and acquisition of targets. The above roles can be achieved in an all weather environment making the millimeter wave radar a valuable multifunction airborne radar.
Author

N87-18727# Huntec 70 Ltd., Scarborough (Ontario).
MOTION COMPENSATION REQUIREMENTS FOR A HIGH RESOLUTION SPOTLIGHT SAR Abstract Only
J. S. A. HEPBURN, G. E. HASLAM (Defence Research Establishment, Ottawa., Ontario), D. F. LIANG, and W. S. WIDNALL (Massachusetts Inst. of Tech., Cambridge) *In* AGARD Multifunction Radar for Airborne Applications 1 p Jul. 1986
Avail: NTIS HC A10/MF A01

The Canadian Department of National Defence is developing a high resolution airborne spotlight synthetic aperture radar (SAR). To attain the high contrast, high resolution and low geometric distortion objectives of the project, it is essential that very accurate motion compensation be applied to the radar returns to minimize the effects on SAR image quality of spurious antenna phase center motion. The motion compensation system being developed for the project includes a gimballed master inertial navigation system (INS) located near the center of gravity of the host aircraft, a strapdown inertial measurement unit (IMU) comprising gyroscope and accelerometer triads mounted on the radar antenna, as well as Doppler velocity and barometric altitude sensors for damping the inertial systems. The role of the master INS is to enable high accuracy alignment of the strapdown IMU. The raw sensor data are integrated using a U-D factorized Kalman filter to obtain optimal estimates of the motion of the radar antenna phase center while the SAR window is open. The data are used to adjust both the radar pulse repetition frequency and the phase and displacement of the radar returns. An analysis of the motion compensation requirements was carried out, leading to the specification of the motion compensation sensor configuration and accuracy. The performance of the motion compensation system has been evaluated by detailed computer simulation. This evaluation accounted for all major system error sources, including errors associated with sensors, transfer alignment and computation, with the system operating in a moderately turbulent environment.
Author

N87-18728# Defence Research Establishment, Ottawa. (Ontario).
IMPLEMENTATION OF AN AIRBORNE SAR MOTION COMPENSATION SYSTEM Abstract Only
D. DIFILIPPO, D. F. LIANG, L. POSTEMA (Lear Siegler, Inc., Grand Rapids, Mich.), and B. LEACH (National Aeronautical Establishment, Ottawa, Ontario) *In* AGARD Multifunction Radar for Airborne Applications 1 p Jul. 1986
Avail: NTIS HC A10/MF A01

The Canadian Department of National Defence has entered into the Phase 2 development of an airborne synthetic aperture radar motion compensation (SARMC) system, following a Phase 1 feasibility study which led to the specification of the SARMC sensor configuration and accuracy. This paper describes the hardware and software configurations of an airborne SARMC system implemented on board a Convair 580 research aircraft. The hardware configuration includes a gimballed LTN-51 inertial navigation system, a Decca Doppler radar, a baroaltimeter and a motion compensation inertial measurement subsystem (MCIMS). The MCIMS is a specially designed strapped-down inertial measurement unit mounted on the ring gear of the APS-506 radar antenna. Since motion compensation depends critically on knowledge of the MCIMS orientation with respect to the radar line-of-sight to the designated target, a laser alignment procedure was developed and performed to calibrate the azimuth encoder of the antenna ring gear. This procedure is discussed along with experimental results. Substantial effort was dedicated to streamlining the Kalman filter algorithms in the SARMC processing package to obtain a high degree of robustness and computational efficiency while optimally integrating the information from the motion compensation sensors. Preliminary flight trial data are presented and compared with simulation results to indicate the level of performance achievable with this optimized system. Author

N87-18729# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Inst. for Radio Frequency Technology.
MM WAVE SAR SENSOR DESIGN: CONCEPT FOR AN AIRBORNE LOW LEVEL RECONNAISSANCE SYSTEM Abstract Only
C. BOESSWETTER *In* AGARD Multifunction Radar for Airborne Applications 1 p Jul. 1986
Avail: NTIS HC A10/MF A01

The basic system design considerations for a high resolution SAR system operating at 35 GHz or 94 GHz are given. First it is shown that only the focussed SAR concept in the side looking configuration matches the requirements and constraints. After definition of illumination geometry and airborne modes the fundamental SAR parameters in range and azimuth direction are derived. A review of the performance parameters of some critical mm wave components (coherent pulsed transmitters, front ends, antennas) establish the basis for further analysis. The power and contrast budget in the processed SAR image shows the feasibility of a 35/94 GHz SAR sensor design. The discussion of the resulting system parameters points out that this unusual system design implies both benefits and new risk areas. One of the benefits besides the compactness of sensor hardware turns out to be the short synthetic aperture length simplifying the design of the digital SAR processor, preferably operating in real time. A possible architecture based on current state-of-the-art correlator hardware is shown. One of the potential risk areas in achieving high resolution SAR imagery in the mm wave frequency band is motion compensation. However, it is shown that the short range and short synthetic aperture lengths ease the problem so that correction of motion induced phase errors and thus focussed synthetic aperture processing should be possible. Author

N87-18752# AEG-Telefunken, Ulm (West Germany). Radio and Radar Systems Group.
EHF MULTIFUNCTION PHASED ARRAY ANTENNA Abstract Only
KLAUS SOLBACH *In* AGARD Multifunction Radar for Airborne Applications 1 p Jul. 1986
Avail: NTIS HC A10/MF A01

The design of a low cost demonstration EHF multifunction-phased array antenna is described. Both, the radiating elements and the phase-shifter circuits are realized on microstrip substrate material in order to allow photolithographic batch fabrication. Self-encapsulated beam-lead PIN-diodes are employed as the electronic switch elements to avoid expensive hermetic encapsulation of the semiconductors or complete circuits. A space-feed using a horn-radiator to illuminate the array from the front-side is found to be the simplest and most inexpensive feed. The phased array antenna thus operates as a reflect-array, the antenna elements employed in a dual role for the collection of energy from the feed-horn and for the re-radiation of the phase-shifted waves (in transmit-mode). The antenna is divided into modules containing the radiator/phase-shifter plate plus drive- and BITE-circuitry at the back. Both drive- and BITE-components use gate-array integrated circuits especially designed for the purpose. Several bus-systems are used to supply bias and logical data flows to the modules. The beam-steering unit utilizes several signal processors and high-speed discrete adder circuits to combine the pointing, frequency and beam-shape information from the radar system computer with the stored phase-shift codes for the array elements. Since space, weight and power consumption are prime considerations only the most advanced technology is used in the design of both the microwave and the digital/drive circuitry.
Author

N87-18756# AEG-Telefunken, Ulm (West Germany).
DUAL FREQUENCY MM-WAVE RADAR FOR ANTITANK HELICOPTER Abstract Only
F. X. JEHLE and H. MEINEL *In* AGARD Multifunction Radar for Airborne Applications 1 p Jul. 1986
Avail: NTIS HC A10/MF A01

Helicopters are gaining increasing significance for air close support, airborne landing, tank unit interdiction and both helicopter and tank engagement missions. To support these mission phases, sensors are required for obstacle warning, navigation, and moving and fixed target indication for weapon designation. The majority of the present systems use optical and infrared sensors; some of them apply laser systems. These sensor systems are subject to considerable limitations with respect to their capability of penetrating bad weather zones, fog, and battlefield environment (dust, smoke, man-made fog etc.). The design concept of a dual-frequency radar operating in millimeter wave range which avoids these drawbacks and complements existing sensors is presented. It consists of a 60 GHz radar subsystem for obstacle warning including the detection of wires up to a range of approximately 500 m; due to the selection of a frequency in the absorption line of oxygen resulting in a high atmospheric attenuation (16 dB/km), the susceptibility to interception and thus also to interference electronic countermeasures can be maintained at a very low level. A 50 GHz radar subsystem (attenuation as low as 0.3 dB/km) with its range of approximately 5 km against targets of interest is used for navigation, fixed and moving target indication as well as weapon designation. Due to the combination of the two subsystems (50/60 GHz), high-value components (antenna, scanner, receiver assemblies, control and indicator units) can be used jointly for both subsystems, so that the special features of each subsystem become available at reasonable expenses.
Author

N87-18759# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany).
REQUIREMENTS AND APPLICATIONS FOR RADAR SIMULATIONS: A STANDPOINT OF AN AIRFRAME COMPANY
WERNER KOHL and WOLFGANG HETZNER *In* AGARD Multifunction Radar for Airborne Applications 13 p Jul. 1986
Avail: NTIS HC A10/MF A01

An overview of requirements and applications for radar simulations performed by an airframe company is presented. The discussion covers offline computer models either as stand alone or implemented within air or sea combat simulations. The use for online models reach from interface simulations to rather complex models for manned aircraft simulations. The paper presents realized examples of radar models for air or sea combat simulations, an experimental engineering tool which simulates a core avionic system, a 1 versus 1 advanced flight simulation with a pilot in the loop and a radar signal simulation implemented in a terrain-following closed loop simulation at an avionic rig.
Author

N87-18797# Institut National de Recherche d'Informatique et d'Automatique, Rocquencourt (France).
NUMERICAL SIMULATION BY FINITE ELEMENT METHODS OF TRANSONIC UNSTEADY FLOW OF COMPRESSIBLE VISCOUS FLUIDS MODELED BY THE NAVIER-STOKES EQUATIONS [SIMULATION NUMERIQUE PAR DES METHODES D'ELEMENTS FINIS D'ECOULEMENTS TRANSSONIQUES INSTATIONNAIRES DE FLUIDES VISQUEUX COMPRESSIBLES MODELISES PAR LES EQUATIONS DE NAVIER-STOKES]
6 Nov. 1986 36 p In FRENCH
(Contract DRET-83-403)
(ETN-87-99048) Avail: NTIS HC A03/MFA01

A method which generalizes tools developed for solving the Navier-Stokes equations for incompressible fluids to viscous fluids is outlined. It covers the Stokes solver and the least squares method. A semi-implicit method for the total constant enthalpy model, and implicit scheme for the model with the temperature equation are emphasized. Applications to industrial flows are indicated. Two and three dimensional numerical results and simulations of the flow around an air intake are presented. ESA

N87-18798# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
FULL APPROXIMATIVE SCHEME (FAS) MULTIGRID EMPLOYING INCOMPLETE LOWER UPPER DECOMPOSITION/ STRONGLY IMPLICIT PROCEDURE (ILU/SIP) SMOOTHING: A ROBUST FAST SOLVER FOR 3D TRANSONIC POTENTIAL FLOW
A. J. VANDERWEES 29 Aug. 1985 21 p Presented at the 2nd European Conference on Multigrid Methods Sponsored by the Netherlands Agency for Aerospace Programs
(NLR-MP-85072-U; ETN-87-99292) Avail: NTIS HC A02/MF A01

The incomplete lower upper decomposition and strongly implicit procedure method is shown to be a very efficient and robust smoothing algorithm within the multigrid method for the solution of elliptic (subsonic) and mixed elliptic/hyperbolic (transonic) potential flow problems. The algorithm, the basis of the Multicomponent Aircraft Transonic Inviscid Computation System, is fully implicit and fairly insensitive to large grid cell aspect ratios; in the hyperbolic regions of the flow the algorithm is uniformly stable. It is shown that the best multigrid performance for 3D problems is obtained by performing a priori grid optimization, for which requirements are derived. With an optimized grid, the method is fast for engineering applications and the physical quantities of interest are determined with great efficiency. ESA

N87-18801*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ACCELERATION DISPLAY SYSTEM FOR AIRCRAFT ZERO-GRAVITY RESEARCH
MARC G. MILLIS Mar. 1987 22 p
(NASA-TM-87358; E-3117; NAS 1.15:87358) Avail: NTIS HC A02/MF A01 CSCL 01D

The features, design, calibration, and testing of Lewis Research Center's acceleration display system for aircraft zero-gravity research are described. Specific circuit schematics and system specifications are included as well as representative data traces from flown trajectories. Other observations learned from developing and using this system are mentioned where appropriate. The system, now a permanent part of the Lewis Learjet zero-gravity program, provides legible, concise, and necessary guidance information enabling pilots to routinely fly accurate zero-gravity trajectories. Regular use of this system resulted in improvements of the Learjet zero-gravity flight techniques, including a technique to minimize later accelerations. Lewis Gates Learjet trajectory data show that accelerations can be reliably sustained within 0.01 g for 5 consecutive seconds, within 0.02 g for 7 consecutive seconds, and within 0.04 g for up to 20 second. Lewis followed the past practices of acceleration measurement, yet focussed on the acceleration displays. Refinements based on flight experience included evolving the ranges, resolutions, and frequency responses to fit the pilot and the Learjet responses.
Author

N87-18825# Naval Sea Systems Command, Washington, D.C. Ship Control Systems and Equipment Division.
SELECTION PARAMETERS FOR HYDRAULIC SYSTEM FILTERS WITH A COMPARISON OF AIRCRAFT AND MARINE APPLICATIONS
WAYNE K. WILCOX 1986 28 p Presented at the 23rd Annual Technical Symposium, Washington, D.C., 1986
(AD-A174045) Avail: NTIS HC A03/MF A01 CSCL 13K

Hydraulic systems for ships and their filters have often been based on aircraft equipment and design practices. This paper compares the criteria for design and selection of filters for aircraft and ships. By considering important parameters, the designer can make a more intelligent choice in selecting filters for a particular application. Parameters discussed include filter location, essentiality and duration of operation, logistic support requirements, and maintenance philosophy, including costs. While most of the parameters for filter selection are similar for aircraft and ships there are important differences which must be considered. Dirt capacity requirements for military aircraft filters are generally inadequate for ship hydraulic systems as well as commercial aircraft. By considering the various design and maintenance

requirements, improved filtration can be provided for ship hydraulic systems at lower life cycle costs than at present although initial costs may be slightly higher. GRA

N87-18855*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SENSITIVITY ANALYSIS IN ENGINEERING
HOWARD M. ADELMAN, comp. and RAPHAEL T. HAFTKA, comp. (Virginia Polytechnic Inst. and State Univ., Blacksburg) Feb. 1987 369 p Symposium held in Hampton, Va., 25-26 Sep. 1986
(NASA-CP-2457; L-16278; NAS 1.55:2457) Avail: NTIS HC A16/MF A01 CSCL 20K

The symposium proceedings presented focused primarily on sensitivity analysis of structural response. However, the first session, entitled, General and Multidisciplinary Sensitivity, focused on areas such as physics, chemistry, controls, and aerodynamics. The other four sessions were concerned with the sensitivity of structural systems modeled by finite elements. Session 2 dealt with Static Sensitivity Analysis and Applications; Session 3 with Eigenproblem Sensitivity Methods; Session 4 with Transient Sensitivity Analysis; and Session 5 with Shape Sensitivity Analysis.

N87-18860*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SENSITIVITY METHOD FOR INTEGRATED STRUCTURE/CONTROL LAW DESIGN
MICHAEL G. GILBERT *In its* Sensitivity Analysis in Engineering p 59-75 Feb. 1987
Avail: NTIS HC A16/MF A01 CSCL 20K

The development is described of an integrated structure/active control law design methodology for aeroelastic aircraft applications. A short motivating introduction to aeroservoelasticity is given along with the need for integrated structures/controls design algorithms. Three alternative approaches to development of an integrated design method are briefly discussed with regards to complexity, coordination and tradeoff strategies, and the nature of the resulting solutions. This leads to the formulation of the proposed approach which is based on the concepts of sensitivity of optimum solutions and multi-level decompositions. The concept of sensitivity of optimum is explained in more detail and compared with traditional sensitivity concepts of classical control theory. The analytical sensitivity expressions for the solution of the linear, quadratic cost, Gaussian (LQG) control problem are summarized in terms of the linear regulator solution and the Kalman Filter solution. Numerical results for a state space aeroelastic model of the DAST ARW-II vehicle are given, showing the changes in aircraft responses to variations of a structural parameter, in this case first wing bending natural frequency. Author

N87-18862*# Ford Motor Co., Dearborn, Mich. Vehicle Methods and Components Dept.
SENSITIVITY OF OVERALL VEHICLE STIFFNESS TO LOCAL JOINT STIFFNESS
CHOON T. CHON *In* NASA. Langley Research Center Sensitivity Analysis in Engineering p 97-112 Feb. 1987
Avail: NTIS HC A16/MF A01 CSCL 20K

How overall vehicle stiffness is affected by local joint stiffness is discussed. By using the principle of virtual work and the minimum strain energy theorem, a closed form expression for the sensitivity coefficient was derived. The insensitivity of the vehicle stiffness to a particular joint, when its stiffness exceeds a certain value (or threshold value), was proven mathematically. In order to investigate the sensitivity of the structure to the joint stiffness, a so-called stick model was created, and the modeling technique is briefly described. Some data on joint stiffness of tested vehicles are also presented. Author

N87-18863*# Iowa Univ., Iowa City. Optimal Design Lab.
DESIGN SENSITIVITY ANALYSIS OF NONLINEAR STRUCTURAL RESPONSE
J. B. CARDOSO and J. S. ARORA *In* NASA. Langley Research Center Sensitivity Analysis in Engineering p 113-132 Feb. 1987
Avail: NTIS HC A16/MF A01 CSCL 20K

A unified theory is described of design sensitivity analysis of linear and nonlinear structures for shape, nonshape and material selection problems. The concepts of reference volume and adjoint structure are used to develop the unified viewpoint. A general formula for design sensitivity analysis is derived. Simple analytical linear and nonlinear examples are used to interpret various terms of the formula and demonstrate its use. Author

N87-18864*# Pennsylvania State Univ., University Park. Dept. of Mechanical Engineering.
OPTIMAL CONTROL CONCEPTS IN DESIGN SENSITIVITY ANALYSIS
ASHOK D. BELEGUNDU *In* NASA. Langley Research Center Sensitivity Analysis in Engineering p 133-145 Feb. 1987
Avail: NTIS HC A16/MF A01 CSCL 20K

A close link is established between open loop optimal control theory and optimal design by noting certain similarities in the gradient calculations. The resulting benefits include a unified approach, together with physical insights in design sensitivity analysis, and an efficient approach for simultaneous optimal control and design. Both matrix displacement and matrix force methods are considered, and results are presented for dynamic systems, structures, and elasticity problems. Author

N87-18869*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SENSITIVITY DERIVATIVES AND OPTIMIZATION OF NODAL POINT LOCATIONS FOR VIBRATION REDUCTION
JOCELYN I. PRITCHARD, HOWARD M. ADELMAN, and RAPHAEL T. HAFTKA (Virginia Polytechnic Inst. and State Univ., Blacksburg) *In its* Sensitivity Analysis in Engineering p 215-231 Feb. 1987
Avail: NTIS HC A16/MF A01 CSCL 20K

A method is developed for sensitivity analysis and optimization of nodal point locations in connection with vibration reduction. A straightforward derivation of the expression for the derivative of nodal locations is given, and the role of the derivative in assessing design trends is demonstrated. An optimization process is developed which uses added lumped masses on the structure as design variables to move the node to a preselected location; for example, where low response amplitude is required or to a point which makes the mode shape nearly orthogonal to the force distribution, thereby minimizing the generalized force. The optimization formulation leads to values for added masses that adjust a nodal location while minimizing the total amount of added mass required to do so. As an example, the node of the second mode of a cantilever box beam is relocated to coincide with the centroid of a prescribed force distribution, thereby reducing the generalized force substantially without adding excessive mass. A comparison with an optimization formulation that directly minimizes the generalized force indicates that nodal placement gives essentially a minimum generalized force when the node is appropriately placed. Author

N87-18871*# PRC Kentron, Inc., Hampton, Va. Aerospace Technologies Div.
APPLICATION OF A SYSTEM MODIFICATION TECHNIQUE TO DYNAMIC TUNING OF A SPINNING ROTOR BLADE
C. V. SPAIN *In* NASA. Langley Research Center Sensitivity Analysis in Engineering p 247-261 Feb. 1987
Avail: NTIS HC A16/MF A01 CSCL 20K

An important consideration in the development of modern helicopters is the vibratory response of the main rotor blade. One way to minimize vibration levels is to ensure that natural frequencies of the spinning main rotor blade are well removed from integer multiples of the rotor speed. A technique for dynamically tuning a

finite-element model of a rotor blade to accomplish that end is demonstrated. A brief overview is given of the general purpose finite element system known as Engineering Analysis Language (EAL) which was used in this work. A description of the EAL System Modification (SM) processor is then given along with an explanation of special algorithms developed to be used in conjunction with SM. Finally, this technique is demonstrated by dynamically tuning a model of an advanced composite rotor blade. E.R.

N87-18874*# PRC Kentron, Inc., Hampton, Va.
DESIGN SENSITIVITY ANALYSIS OF ROTORCRAFT AIRFRAME STRUCTURES FOR VIBRATION REDUCTION
T. SREEKANTA MURTHY *In* NASA. Langley Research Center Sensitivity Analysis in Engineering p 299-318 Feb. 1987
Avail: NTIS HC A16/MF A01 CSCL 20K

Optimization of rotorcraft structures for vibration reduction was studied. The objective of this study is to develop practical computational procedures for structural optimization of airframes subject to steady-state vibration response constraints. One of the key elements of any such computational procedure is design sensitivity analysis. A method for design sensitivity analysis of airframes under vibration response constraints is presented. The mathematical formulation of the method and its implementation as a new solution sequence in MSC/NASTRAN are described. The results of the application of the method to a simple finite element stick model of the AH-1G helicopter airframe are presented and discussed. Selection of design variables that are most likely to bring about changes in the response at specified locations in the airframe is based on consideration of forced response strain energy. Sensitivity coefficients are determined for the selected design variable set. Constraints on the natural frequencies are also included in addition to the constraints on the steady-state response. Sensitivity coefficients for these constraints are determined. Results of the analysis and insights gained in applying the method to the airframe model are discussed. The general nature of future work to be conducted is described. Author

N87-18883*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A COMPARATIVE STUDY OF SOME DYNAMIC STALL MODELS
T. S. R. REDDY (Toledo Univ., Ohio) and K. R. V. KAZA Mar. 1987 79 p
(NASA-TM-88917; E-3342; NAS 1.15:88917) Avail: NTIS HC A05/MF A01 CSCL 20K

Three semi-empirical aerodynamic stall models are compared with respect to their lift and moment hysteresis loop prediction, limit cycle behavior, easy implementation, and feasibility in developing the parameters required for stall flutter prediction of advanced turbines. For the comparison of aeroelastic response prediction including stall, a typical section model and a plate structural model are considered. The response analysis includes both plunging and pitching motions of the blades. In model A, a correction to the angle of attack is applied when the angle of attack exceeds the static stall angle. In model B, a synthesis procedure is used for angles of attack above static stall angles and the time history effects are accounted through the Wagner function. In both models the life and moment coefficients for angle of attack below stall are obtained from tabular data for a given Mach number and angle of attack. In model C, referred to an the ONERA model, the life and moment coefficients are given in the form of two differential equations, one for angles below stall, and the other for angles above stall. The parameters of those equations are nonlinear functions of the angle of attack. Author

N87-18891# Sandia National Labs., Albuquerque, N. Mex. Parachute Systems Div.
NEW SOLUTION METHOD FOR STEADY-STATE CANOPY STRUCTURAL LOADS
W. D. SUNDBERG Aug. 1986 25 p Presented at the 9th AIAA Aerodynamic Decelerator and Balloon Technology Conference, Albuquerque, N. Mex., 7 Oct. 1986
(Contract DE-AC04-76DP-00789)
(DE86-014294; SAND-86-0624C; CONF-861050-4) Avail: NTIS HC A02/MF A01

A new computer code has been written to perform structural analysis canopies. Although an existing code, CANO, has been available, the new code has better convergence reliability, is more understandably written, and is easier to use. The equations have been reformulated for the new solution method. The new code assumes a symmetric canopy, a steady-state condition, and no strength in the vertical direction. It computes the inflated shape, loads in the horizontal members, radial members, vent lines, and suspension lines, and total drag. Constructed geometry, material properties, dynamic pressure, and pressure distribution are required as input. DOE

N87-19541# Joint Publications Research Service, Arlington, Va.
JAPAN REPORT: SCIENCE AND TECHNOLOGY
23 May 1986 77 p Transl. into ENGLISH from various Japanese articles
(JPRS-JST-86-014) Avail: NTIS HC A05/MF A01

Topics addressed include: energy technology; new materials; science and technology policy; and transportation.

N87-19570# Georgia Inst. of Tech., Atlanta. Systems Engineering Lab.
DEVELOPMENT OF SIMULATED DIRECTIONAL AUDIO FOR COCKPIT APPLICATIONS Technical Report, Nov. 1984 - Jan. 1986
THEODORE J. DOLL, JEFFREY M. GERTH, WILLIAM R. ENGELMAN, and DENNIS J. FOLDS Jan. 1986 230 p Prepared in cooperation with MacAulay-Brown, Inc.
(Contract F33615-82-C-0513)
(AD-A175350; AAMRL-TR-86-014) Avail: NTIS HC A11/MF A01 CSCL 17A

The long-term objective of this work is to develop techniques for conveying accurate spatial information via audio signals delivered to the listener through headphones or earphones. This project included three major activities: (1) an extensive review and synthesis of the research literature on auditory localization, (2) the design, fabrication, and evaluation of an apparatus for demonstrating simulated auditory localization (SAL), and (3) experimental research to determine characteristics of the audio signal, in the time and frequency domains, which enhance localization performance with simulated cues. Previous research is reviewed which describes the cues involved in the perception of sound-source direction, both horizontally and vertically, when the head is stationary. Also reviewed is research on auditory distance perception, the roles of head movement and vision in auditory localization, the perception of auditory motion and volume, and the effects of noise on auditory localization. A feedback control model is presented, which integrates evidence derived from four different theoretical positions concerning the effects of head movement and vision on auditory localization. Possible applications of SAL technology in aircraft cockpits are outlined, and the potential benefits of such applications are discussed. GRA

N87-19646*# Imperial Coll. of Science and Technology, London (England). Dept. of Aeronautics.
VORTEX/BOUNDARY LAYER INTERACTION Semiannual Status Report, 1 Sep. 1986 - 28 Feb. 1987
P. BRADSHAW 1987 18 p
(Contract NAGW-581)
(NASA-CR-180255; NAS 1.26:180255) Avail: NTIS HC A02/MF A01 CSCL 20D

The second test case (longitudinal vortex above, but not merging with, a turbulent boundary layer) was investigated with flow

visualization studies, and photographs selected. The results of quantitative data acquisition for the non-merging test case are presented. Other work in progress includes further flow visualization of the delta-wing wake. Considerable effort is being devoted to the development of graphical output routines. B.G.

N87-19668# European Space Agency, Paris (France).
MATCHING OF VISCOUS FLUID AND INVISCID FLUID BY A FINITE ELEMENT METHOD
ODILE LABBE Oct. 1986 99 p Transl. into ENGLISH of "Couplage Fluide Visqueux - Fluide Parfait par une Methode dElements Finis" Chatillon, France Original language document was previously announced as N84-25957
(ESA-TT-866; ONERA-NT-1983-1; ETN-87-98883) Avail: NTIS HC A05/MF A01

The Navier-Stokes equations for two-dimensional viscous and inviscid steady incompressible flow are solved. A method using finite flow and vortex element is used to solve the equation Delta psi = omega throughout the domain of inviscid flow with omega kept at zero, and to solve the vortex diffusion-convective equation in the viscous area. The vortex error was estimated by replacing the full problem by the coupled problem. The algorithm uses a conjugate gradient method to solve the diffusion-convective equation. Numerical data for a symmetrical NACA 0012 profile are compared by moving the coupling boundary for a Reynolds number of 400. ESA

N87-19676# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
NUMERICAL TREATMENT OF SHOCKS IN UNSTEADY POTENTIAL FLOW COMPUTATION
H. SCHIPPERS 22 Apr. 1985 9 p Presented at the 11th IMACS World Congress, Oslo, Norway, 5-9 Aug. 1985
(NLR-MP-85044-U; ETN-87-99288) Avail: NTIS HC A02/MF A01

For moving shocks in unsteady transonic potential flow, an implicit fully-conservative finite-difference algorithm is presented. It is based on time-linearization and mass-flux splitting. For the one-dimensional problem of a traveling shock-wave, this algorithm is compared with the method of Goorjian and Shankar. The algorithm was implemented in the computer program TULIPS for the computation of transonic unsteady flow about airfoils. Numerical results for a pitching ONERA M6 airfoil are presented. ESA

N87-19697# Bristol Univ. (England). Dept. of Aeronautical Engineering.
AN INVESTIGATION OF SPRAY IMPACT FORCES
N. T. BRADSHAW and M. J. BRENNAN Jun. 1986 45 p
(BU-340; ETN-87-99203) Avail: NTIS HC A03/MF A01

A device to record impact forces on a small plate due to spray, similar to that produced by aircraft wheels on flooded runways was built. A sample section of a typical spray was isolated and the total impingement force of this was measured using a large plate. Force measurements were compared with those obtained by integration of data recorded by an intensity probe and the force measuring device. The intensity probe gives lower force predictions than the large plate, but the force measuring device produces much closer results, with a maximum error of 10%. Comparisons were made between the intensity probe and the new device to procude a correction procedure to be applied to previous intensity probe data in order to improve their accuracy. The operation of the force measuring device, basically a strain-gaged cantilever beam, is very dependent upon the amount of damping applied. ESA

N87-19754*# Kansas Univ. Center for Research, Inc., Lawrence. Flight Research Lab.
INVESTIGATION OF EMPENNAGE BUFFETING Final Report
C. EDWARD LAN and I. G. LEE Mar. 1987 84 p
(Contract NAG2-371)
(NASA-CR-179426; H-1393; NAS 1.26:179426) Avail: NTIS HC A05/MF A01 CSCL 20K

Theoretical methods of predicting aircraft buffeting are reviewed. For the buffeting due to leading-edge vortex breakdown, a method is developed to convert test data of mean square values of fluctuating normal force to buffeting vortex strength through an unsteady lifting-surface theory and unsteady suction analogy. The resulting buffeting vortex from the leading-edge extension of an F-18 configuration is used to generate a fluctuating flow field which produces unsteady pressure distribution on the vertical tails. The root mean square values of root bending moment on the vertical tails are calculated for a rigid configuration. Results from a flow visualization and hot films study in a water tunnel facility using a 1/48 scale model of an F-18 are included in an appendix. The results confirm that the LEX vortex is the dominant forcing function of fin buffet at high angles of attack. Author

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GEOSCIENCES

Includes geosciences (general); earth resources and remote sensing; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

A87-28020* National Center for Atmospheric Research, Boulder, Colo.
A HIGH RESOLUTION SPATIAL AND TEMPORAL MULTIPLE DOPPLER ANALYSIS OF A MICROBURST AND ITS APPLICATION TO AIRCRAFT FLIGHT SIMULATION
K. L. ELMORE, J. MCCARTHY (National Center for Atmospheric Research, Boulder, CO), W. FROST, and H. P. CHANG (FWG Associates, Inc., Tullahoma, TN) Journal of Climate and Applied Meteorology (ISSN 0733-3021), vol. 25, Oct. 1986, p. 1398-1425. Research supported by the National Center for Atmospheric Research, NSF, and NOAA. refs
(Contract NASA ORDER H-59314-B)

Multiple Doppler radar data collected during the Joint Airport Weather Studies (JAWS) Project is used to synthesize the three-dimensional wind in the region of a microburst. The particular microburst used in this study is the strongest one to date for which three-dimensional winds have been recovered. As a diagnostic tool, a six-DOF numerical aircraft model having characteristics similar to 727 series aircraft is used to investigate jet transport aircraft response to observed microburst winds during simulated approaches and departures. Simple pilot control laws are used to adjust thrust, pitch, roll, and yaw so as to maintain given approach or departure parameters. Generally, when horizontal wind shear along the approach or departure path is 0.01/s or greater, the model is unable to maintain the desired approach path and suffers a significant reduction in climb performance during a go-around or departure. Although the mean wind shear along a path gives a good qualitative measure of the wind shear threat to a jet transport, different paths with similar mean shears can yield markedly different results, as do the same paths through the microburst at different times. These findings are a direct consequence of the fine temporal and spatial scale of microburst winds. During any given modeled aircraft traverse through the region of highest horizontal shear, time variations in the microburst wind field are shown to have an insignificant effect on the modeled flight path. This is because the traverse period is short (30 s) compared to the lifetime of a microburst (300-600 s). Author

A87-28436#
DEVELOPMENT AND EXPERIMENT OF AIRBORNE MICROWAVE RAIN-SCATTEROMETER/RADIOMETER SYSTEM. III - RAIN MEASUREMENT AND ITS DATA ANALYSIS
MASAHARU FUJITA, KENICHI OKAMOTO, HARUNOBU MASUKO, SHIN YOSHIKADO, and KENJI NAKAMURA Radio Research Laboratory, Review (ISSN 0033-801X), vol. 32, June 1986, p. 107-125. In Japanese, with abstract in English. refs

An algorithm for estimating the rain rate using data from dual-frequency radar is presented, along with the results of a simulation of its performance. Rain rate is determined by comparing the power of the radar echoes backscattered from the ocean surface with predicted attenuation. A radiative transfer equation is employed to equate the antenna temperature to the rain rate profile sensed with a scatterometer. Account is taken of the effects of the sea surface temperature on the backscattered signal. The excess antenna temperature at 10 GHz is demonstrated to be proportional to the path-integrated rain rate. M.S.K.

A87-29001
AIRBORNE REMOTE SENSING FROM REMOTELY PILOTED AIRCRAFT
A. A. D. CANAS and D. A. IRWIN (Imperial College of Science and Technology, London, England) International Journal of Remote Sensing (ISSN 0143-1161), vol. 7, Dec. 1986, p. 1623-1635.

Highly effective small-scale remote sensing can be carried out using a remotely piloted aircraft as a platform for various instruments. The operation of such a platform is described and details of two sensors (a photographic camera and a multiband radiometer) are given. Some preliminary results are presented and future developments are discussed. Author

N87-18909*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
NASA/JPL AIRCRAFT SAR OPERATIONS FOR 1984 AND 1985
T. W. THOMPSON, ed. 1 Nov. 1986 126 p Original contains color illustrations
(Contract NAS7-918)
(NASA-CR-180237; JPL-PUB-86-20; NAS 1.26:180237) Avail: NTIS HC A07/MF A01 CSCL 17I

The NASA/JPL aircraft synthetic aperture radar (SAR) was used to conduct major data acquisition expeditions in 1983 through 1985. Substantial improvements to the aircraft SAR were incorporated in 1981 through 1984 resulting in an imaging radar that could simultaneously record all four combinations of linear horizontal and vertical polarization (HH, HV, VH, VV) using computer control of the radar logic, gain setting, and other functions. Data were recorded on high-density digital tapes and processed on a general-purpose computer to produce 10-km square images with 10-m resolution. These digital images yield both the amplitude and phase of the four polarizations. All of the digital images produced so far are archived at the JPL Radar Data Center and are accessible via the Reference Notebook System of that facility. Sites observed in 1984 and 1985 included geological targets in the western United States, as well as agricultural and forestry sites in the Midwest and along the eastern coast. This aircraft radar was destroyed in the CV-990 fire at March Air Force Base on 17 July 1985. It is being rebuilt for flights in 1987 and will likely be operated in a mode similar to that described here. The data from 1984 and 1985 as well as those from future expeditions in 1987 and beyond will provide users with a valuable data base for the multifrequency, multipolarization Spaceborne Imaging Radar (SIR-C) scheduled for orbital operations in the early 1990's. Author

N87-18945# Federal Aviation Administration, Atlantic City, N.J.
THE OPERATIONAL SUITABILITY OF THE AUTOMATED WEATHER OBSERVING SYSTEM (AWOS) AT HELIPORTS Final Report, Oct. 1986
RENE A. MATOS and ROSANNE M. WEISS Feb. 1987 29 p (DOT/FAA/PM-86/52; DOT/FAA/CT-87/3) Avail: NTIS HC A03/MF A01

A questionnaire, based on an OPM-approved questionnaire, was distributed to pilots and users who were involved in the project, The Siting, Installation, and Operational Suitability of the Automated Weather Observing System (AWOS) at Heliports. This report documents the conclusions of the questionnaire analysis and provides basis for the determination of operational suitability of AWOS at heliports. Author

N87-19798# Research Inst. of National Defence, Linkoeping (Sweden).
JASMIN 2: A SYSTEM FOR MULTISENSOR DATA FUSION. PROBLEMS AND STRUCTURE OF THE SYSTEM
NILS OLANDER, STEN NYBERG, BENGT ROSEN, and DAN STROEMBERG Oct. 1986 34 p In SWEDISH; ENGLISH summary
(FOA-C-30432-3.3; ISSN-0347-3708; ETN-87-99101) Avail: NTIS HC A03/MF A01; Research Institute of National Defence, Stockholm, Sweden KR 50

The combination of data from different sensors is reviewed, especially for aircraft applications. With the frames method, or class descriptions, it is possible to describe and give a structure of objects and events in specific situations. But facts and knowledge that cannot enter a FRAME system can be stored and processed in a knowledge engineering environment computer program, using a logic based language, allowing data-based or hypothesis-based reasoning. It is necessary to have access to more sophisticated ways, as special auxiliary programs for the development of the knowledge systems. The problem must be limited to only some of the situations in the environment model and not include all the possible functions available in a multisensor data system. ESA

N87-19815# Southwest Research Inst., San Antonio, Tex.
CUMULATIVE AIRPORT NOISE EXPOSURE METRICS: AN ASSESSMENT OF EVIDENCE FOR TIME-OF-DAY WEIGHTINGS
JAMES M. FIELDS Nov. 1986 168 p Sponsored by FAA
(AD-A174848; DOT/FAA/EE-86/10) Avail: NTIS HC A08/MF A01 CSCL 20A

The differential impact of noise on residents at different time of day is examined in analyses of the original machine-readable data from ten community surveys and in detailed reviews of the published results from 20 additional surveys. Analyses are conducted using alternative community response measures and analysis techniques. The primary objective is to determine the relative impact of noise during the daytime and nighttime by estimating the value of a time-of-day weighting in the adjusted energy model. Some support is found for nighttime and evening weightings. Estimates of these time-of-day weightings are found to be highly accurate. Examinations of the factors affecting this accuracy lead to the conclusion that studies of community response to noise will not provide a usefully accurate estimation of the time-of-day weighting parameter in the adjusted energy model. Data is provided on proportions of the United States population engaged in noise-sensitive activities at different times of day. The report reproduces all social survey results in which averages of nighttime response are plotted by nighttime noise levels. Analyses are conducted of the relationship between daytime and nighttime airport noise environments between daytime and nighttime noise environments around United States airports. GRA

N87-19856# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
INTERNATIONAL AEROSPACE AND GROUND CONFERENCE ON LIGHTNING AND STATIC ELECTRICITY HELD IN DAYTON, OHIO ON 24-26 JUNE 1986
Oct. 1986 444 p Conference held in Dayton, Ohio, 24-26 Jun. 1986
(AD-A174859; AFWAL-TR-86-3098) Avail: NTIS HC A19/MF A01 CSCL 04A

This report is a compilation of papers presented at the 1986 International Aerospace and Ground Conference on Lightning and Static Electricity, held at the Stouffer Dayton Plaza Hotel, Dayton, Ohio, June 24 to 26 1986. It includes papers concerning lightning phenomenology, lightning characterization, modeling and simulation, test criteria and techniques, and protection of both Airborne and Ground Systems. This conference was sponsored by the National Interagency Coordination Group (NICG) of the National Atmospheric Electricity Hazards Protection Program in concert with the Florida Institute of Technology and in association with the SAE-AE4 Committee on Lightning, the United Kingdom Civil Aviation Authority, the Royal Aircraft Establishment, Farnborough, U.K., and Culham Laboratories, U.K. Author (GRA)

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LIFE SCIENCES

Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and space biology.

N87-19911# Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.
AN ASSESSMENT OF ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS TECHNOLOGY FOR APPLICATION TO MANAGEMENT OF COCKPIT SYSTEMS
WAYNE L. MARTIN Sep. 1986 125 p
(AD-A175456; AAMRL-TR-86-040) Avail: NTIS HC A06/MF A01 CSCL 06D

A review of the literature in the field of artificial intelligence was performed to identify research and development efforts in industry, academia, and government laboratories that may be related (or relatable) to the cockpit management function in tomorrow's aircraft. Individual chapters address the following topics: Chapter 1 - An Introduction to Artificial Intelligence and Expert Systems; Chapter 2 - Artificial Intelligence Development Applications in DARPA, DOD, and NASA; Chapter 3 - State-of-the-Art Review and Projection of Future Expert System Developments; Chapter 4 - Human Factors Research in Artificial Intelligence and Expert Systems; Chapter 5 - Image Understanding; Chapter 6 - Natural Language Processing/Understanding; and Chapter 7 - Summary Comments on the Development and Application of Artificial Intelligence and Expert Systems. Separate bibliographies are provided at the end of each chapter to assist the reader in identifying specific literature of interest. A glossary of abbreviations, acronyms, and special terms used in the context of this report is also provided. GRA

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MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

A87-27699
IDENTIFICATION OF 3D OBJECTS FROM MULTIPLE SILHOUETTES USING QUADTREES/OCTREES
C. H. CHIEN and J. K. AGGARWAL (Texas, University, Austin) Computer Vision, Graphics, and Image Processing (ISSN 0734-189X), vol. 36, Nov.-Dec. 1986, p. 256-273. refs
(Contract F49620-85-K-0007)

Algorithms have been developed for the reconstruction and matching of 3-dimensional objects from multiple silhouettes. The techniques are based on the principles of volume intersection and normalization of objects with respect to centroid and principal axes. The efficiency of algorithms is a consequence of the compactness and regularity of the quadtree and octree structures, which account for the savings in terms of memory requirement. Only the principal quadtrees of models need to be stored in the database, since their octrees can be efficiently generated through a sequence of tree traversal procedures. Silhouettes treated by the algorithms include a number of aircraft: F15C, F16XL, F5E, F5G, Harrier, Hawk, MIG-25, MIG-29, Mirage, Saab, SU11, and SU15. Author

A87-28351
ORDER ESTIMATION OF LINEAR TIME INVARIANT SYSTEM
DOV WULICH and YACOV KAUFMAN (Negev, University, Beersheba, Israel) Franklin Institute, Journal (ISSN 0016-0032), vol. 322, Sept. 1986, p. 143-150. refs

An order estimation of a linear time invariant system has been developed. The order estimation (the number of sets of significant system parameters) is based on function elimination filters. In presence of noise, the estimation procedure has been improved by using the composite hypothesis and the maximum likelihood ratio. Finally, the estimated system order can be used to estimate the system parameters. It is to be assumed that the investigated system is not overdumped, has no aliasing problems and the system input is 'white noise'. The proposed method differs from other estimation methods because the system order can be found without knowledge about the system parameters. Author

A87-28566
A MICROCOMPUTER BASED SYSTEM FOR MEASURING NATURAL FREQUENCIES AND MODE SHAPES OF STRUCTURES
DANTAM K. RAO (USAF, Materials Laboratory, Wright-Patterson AFB, OH) IN: International Modal Analysis Conference, 4th, Los Angeles, CA, Feb. 3-6, 1986, Proceedings. Volume 2 . Schenectady, NY, Union College, 1986, p. 1117-1125. refs

A microcomputer based system for measuring the Resonance Frequencies, Modal Loss Factors, Frequency Response Functions (FRF), and Mode Shapes of a structure to a high degree of precision and repeatability is described. The STEPSINE segment first processes the structure data and continuously displays an evolving FRF plot of the structure as it increases the frequency of excitation in specified steps. The Modal Image Processor segment then measures and displays the mode shape on-line without any intermediate phase of Curve-fitting. Mode shapes of typical structures measured with this method are presented. R.R.

A87-29595*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
WORKSTATIONS TAKE OVER CONCEPTUAL DESIGN
GEORGE H. KIDWELL (NASA, Ames Research Center, Moffett Field, CA) Aerospace America (ISSN 0740-722X), vol. 25, Jan. 1987, p. 18-20.

Workstations provide sufficient computing memory and speed for early evaluations of aircraft design alternatives to identify those worthy of further study. It is recommended that the programming of such machines permit integrated calculations of the configuration and performance analysis of new concepts, along with the capability of changing up to 100 variables at a time and swiftly viewing the results. Computations can be augmented through links to mainframes and supercomputers. Programming, particularly debugging operations, are enhanced by the capability of working with one program line at a time and having available on-screen error indices. Workstation networks permit on-line communication among users and with persons and computers outside the facility. Application of the capabilities is illustrated through a description of NASA-Ames design efforts for an oblique wing for a jet performed on a MicroVAX network. M.S.K.

A87-29596#
MARKET SUPREMACY THROUGH ENGINEERING AUTOMATION
A. R. MITCHELL (Boeing Aerospace Co., Seattle, WA) Aerospace America (ISSN 0740-722X), vol. 25, Jan. 1987, p. 24-27.

State of the art industrial CAD/CAE practices used to explore design concepts, evaluate aerodynamic performance/configuration tradeoffs and numerically control tooling of a model are described. Minicomputer engineering workstations, soon to have access to mini-supercomputers and supercomputers, functioning on a LAN allow small engineering teams to generate, evaluate and define models within days instead of months. The specifications obtained are used to generate numerical code for shaping a model for the wind tunnel tests. Implementation of the capabilities at Boeing is described, with emphasis on software developed to permit tradeoff studies of rocket-ramjet and solid fueled missile and railgun concepts. A need is noted for management to combine diverse engineering personnel assets to optimize use of the engineering workstation network. M.S.K.

A87-29610#
MULTIPLE INPUT-OUTPUT FREQUENCY RESPONSE FUNCTIONS ESTIMATION
YUEFENG LI and MINFU LU (Nanjing Aeronautical Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 7, Dec. 1986, p. 596-603. In Chinese, with abstract in English. refs

The theory of multiple input-output frequency response functions estimation is studied based on the finite Fourier transform. Several possible input signal types are discussed. Based on this theory, a software package for six input-multiple output FRF estimation has been developed. The package has been used on real structures such as a free-free beam and a helicopter tail rotor. The results show that the deterministic signal excitation technique is better than the currently prevailing random excitation technique in terms of test time, amount of data required to be sampled and reduced, and estimation accuracy. It also requires simpler hardware and can be used with a dual-channel FFT analyzer only. C.D.

A87-30176
CLASSICAL DESIGN, WITH APPLICATION TO A 3 X 3 TURBOFAN ENGINE MODEL
J. VAN DE VEGTE (Toronto, University, Canada) International Journal of Control (ISSN 0020-7179), vol. 45, Jan. 1987, p. 1-16. NSERC-supported research.

The design equations and the approach of a technique for the classical design of 3 x 3 systems are improved and simplified. The equations are also formulated for plant transfer matrices derived from state models, with separate allowance for incorporating sensor and actuator dynamics. This formulation is applied to an IFAC theme problem on the control of an F100 turbofan engine model. Author

A87-30271
EVALUATING PROPOSED ARCHITECTURES FOR THE FAA'S ADVANCED AUTOMATION SYSTEM
JEAN-MARC GAROT, DELBERT WEATHERS (FAA, Advanced Automation Program Office, Washington, DC), and THOMAS HAWKER (Knowlex Technology Corp., Denver, CO) Computer (ISSN 0018-9162), vol. 20, Feb. 1987, p. 33-45. refs

The system architecture and design analyses that were specified by the FAA in the design competition phase (DCP) for contractors wishing to develop the Advanced Automation System (AAS) are described. The AAS will replace all current FAA ATC hardware, software and system distribution, and will be emplaced while the old system still functions. A generic ATC system is outlined to identify the architecture drivers for an automated system. The issues faced by the contractors developing design solutions for the distributed system are summarized. The system engineering and architecture analyses which are required in the DCP are detailed, along with the methods which the FAA will use to assess the effectiveness of the proposed architectures. Emphasis is placed on the availability of the systems and their amenability to evolution over the 20-30 yr life of the system. M.S.K.

A87-30274
CAPACITY MANAGEMENT OF AIR TRAFFIC CONTROL COMPUTER SYSTEMS
SANDRA BLEISTEIN (Computer Technology Associates, Inc., Denver, CO), ROBERT GOETTGE (Advanced Systems Technologies, Englewood, CO), FRANK PETROSKI (Mitre Corp., McLean, VA), and ROBERT WISEMAN (DOT, Washington, DC) Computer (ISSN 0018-9162), vol. 20, Feb. 1987, p. 73-82.

The capacity management capability of the en route ATC host computer system (HCS) which will replace the existing 9020 computer system when the Advanced Automation System (AAS) is installed are described. Attention is focused on the performance modeling procedures which were used to define the requirements of the HCS. The 9020 system occasionally cannot handle current ATC loads. The HCS performance requirements were specified in terms of the response times for the automation services provided in all operational conditions. Details of the display update, workload, response time, and amenability to future enhancements specifications developed for the HCS are presented, noting that much of the 9020 response data was not usable for predicting the demands that will be placed on the HCS. M.S.K.

N87-18993*# Textron Bell Helicopter, Fort Worth, Tex.
DEVELOPMENT OF A ROT22 - DATAMAP INTERFACE
K. R. SHENOY, T. WAAK, and J. T. BRIEGER Apr. 1986 105 p
(Contract NAS2-10331)
(NASA-CR-177403; NAS 1.26:177403) Avail: NTIS HC A06/MF A01 CSCL 09B

This report (Contract NAS2-10331- Mod 10), outlines the development and validation of an interface between the three-dimensional transonic analysis program ROT22 and the Data from Aeromechanics Test and Analytics-Management and Analysis Package (DATAMAP). After development of the interface, the validation is carried out as follows. First, the DATAMAP program is used to analyze a portion of the Tip Aerodynamics and Acoustics Test (TAAT) data. Specifically, records 2872 and 2873 are analyzed at an azimuth of 90 deg, and record 2806 is analyzed at 60 deg. Trim conditions for these flight conditions are then calculated using the Bell performance prediction program ARAM45. Equivalent shaft, pitch, and twist angles are calculated from ARAM45 results and used as input to the ROT22 program. The interface uses the ROT22 results and creates DATAMAP information files from which the surface pressure contours and sectional pressure coefficients are plotted. Twist angles input to ROT22 program are then iteratively modified in the tip region until the computed pressure coefficients closely match the measurements. In all cases studied, the location of the shock is well predicted. However, the negative

pressure coefficients were underpredicted. This could be accounted for by blade vortex interaction effects. Author

N87-19004# Dayton Univ., Ohio.
EXTENSION AND APPLICATION OF A PROCEDURE FOR DAMAGE ASSESSMENT OF AEROSPACE STRUCTURES Final Report, May 1984 - Nov. 1985
R. F. TAYLOR, R. A. BROCKMAN, and V. G. DOMINIC Sep. 1986 89 p
(Contract F33615-84-C-3406)
(AD-A174035; UDR-TR-86-03; AFWAL-TR-86-3047) Avail: NTIS HC A05/MF A01 CSCL 01C

This report documents the extension and application of a computer code for the Automated Design of Damage RESistant Structures (ADDRESS). The program is operable on the VAX-11/780 computer system under the VMS operating system. Extensions to the code over previous work includes the automated selection of damage locations via a sensitivity analysis, linking of design variables for more realistic damage tolerant member sizes, the introduction of standard material sizes in the output design, and the incorporation of a Sturm sequence check for determining frequencies in a given range. Applications are made to typical finite element models of lifting surfaces and to truss structures to validate the code for larger problems. By use of a setup procedure special purpose versions of the code can be made which include user specified upper bounds for key variables such as total number of nodes, elements, and degrees of freedom. Disk storage is the only limiting factor for large problems, rather than program dimension specifications. All large-scale calculations are performed out of core. GRA

N87-19018# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
A PERSPECTIVE OF MATHEMATICAL SIMULATION AND OPTIMIZATION TECHNIQUES IN COMPUTER AIDED DESIGN
R. F. VANDENDAM 18 Dec. 1985 26 p Presented at the Second International Conference on Computer Applications in Production and Engineering, Copenhagen, Denmark, 20-23 May 1986
(NLR-MP-85088-U; B8677588; ETN-87-99510) Avail: NTIS HC A03/MF A01

The use of mathematical simulation and optimization techniques by designers is discussed. The principles underlying these techniques are outlined. Aerospace applications are presented to illustrate their usefulness in design processes and the integration of these design methods into structured systems for computer aided design is considered. ESA

N87-19029# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
THE CAD ENVIRONMENT OF THE NATIONAL AEROSPACE LABORATORY NLR, THE NETHERLANDS
W. LOEVE, F. J. HEEREMA, and J. J. P. VANHULZEN 23 Jan. 1986 21 p Presented at the Second International Conference on Computer Applications in Production and Engineering, Copenhagen, Denmark, 20-23 May 1986
(NLR-MP-86005-U; B8677587; ETN-87-99512) Avail: NTIS HC A02/MF A01

A computer aided design infrastructure for aerospace applications is described. The main components of the infrastructure are facilities for data management, method management, and user interfaces, all implemented on a computer and terminal network. The facilities for data management and user interfaces gained widespread acceptance by application system developers and end users. The facilities for method management are in initial state of development and are supported by a wide range of applications. The computer and terminal network gives access to data and methods from virtually any location at two sites. ESA

N87-19031# Army Concepts Analysis Agency, Bethesda, Md.
AAAI (AMERICAN ASSOCIATION ON ARTIFICIAL INTELLIGENCE) WORKSHOP ON AI (ARTIFICIAL INTELLIGENCE) SIMULATION
ARTHUR GERSTENFELD, RICHARD MODJESKI, Y. V. REDDY, and MARILYN STELZNER Aug. 1986 177 p Workshop held in Philadelphia, Pa., 11 August 1986
(AD-A174053) Avail: NTIS HC A09/MF A01 CSCL 09B

The First Artificial Intelligence (AI) and simulation workshop was held during the National Conference on Artificial Intelligence on August 11, 1986 at the University of Pennsylvania (Wharton Hall). Topics addressed included: air traffic control; knowledge engineering; symbolic explanation systems; model validation; cognition constraints; command, control, and communication systems; electronic troubleshooting; robotics; automatic programming system; petri nets; and parallel processing. B.G.

N87-19961# Bristol Univ. (England). Dept. of Aeronautical Engineering.
THE APPLICATION OF PARALLEL PROCESSING TO REAL TIME FLIGHT SIMULATION USING THE OCCAM LANGUAGE B.S. Thesis
JAMES M. M. PLACE and ROBERT I. SMITH Jun. 1986 60 p
(BU-350; ETN-87-99211) Avail: NTIS HC A04/MF A01

A simulation of the longitudinal motion of a Boeing 747 aircraft was designed using the programming OCCAM. A parallel processing structure was constructed. A 2 x 2 square array of transputer microprocessors is used, although the results are applicable to larger arrays of processors. A generalized communication system linking the processors in the array was formulated in OCCAM. It allows simulation models to be split up into separate parallel components with the minimum consideration for data transfer and sequencing between the concurrent elements. Time response results show the dynamic model to be working successfully. The study was completed on a multiuser VAX11/780 which sequentially schedules the separate designated parallel processes. As a result the simulations were not executed in real time, although the application of the work is to real time systems. ESA

N87-19981# Lawrence Livermore National Lab., Calif.
INTEGRATION OF COMMUNICATIONS WITH THE INTELLIGENT GATEWAY PROCESSOR
V. E. HAMPEL 1986 19 p Presented at the Seminar on Integrated Power Plant Computer Communications, San Francisco, Calif., 25 Aug. 1986
(Contract W-7405-ENG-48)
(DE87-002386; UCRL-95277; CONF-8608110-2) Avail: NTIS MF A01

The Intelligent Gateway Processor (IGP) software is being used to interconnect users equipped with different personal computers and ASCII terminals to mainframe machines of different make. This integration is made possible by the IGP's unique user interface and networking software. Prototype systems of the table-driven, interpreter-based IGP have been adapted to very different programmatic requirements and have demonstrated substantial increases in end-user productivity. Procedures previously requiring days can now be carried out in minutes. The IGP software has been under development by the Technology Information Systems (TIS) program at Lawrence Livermore National Laboratory (LLNL) since 1975 and is in use by several federal agencies since 1983. The Air Force is prototyping applications which range from automated identification of spare parts for aircraft to office automation and the controlled storage and distribution of technical orders and engineering drawings. Other applications of the IGP are the Information Management System (IMS) for aviation statistics in the Federal Aviation Administration (FAA), the Nuclear Criticality Information System (NCIS) and a nationwide Cost Estimating System (CES) in DOE, the library automation network of the Defense Technical Information Center (DTIC), and the modernization program in the Office of the Secretary of Defense (OSD). DOE

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PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

A87-31109*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
MEASURED NOISE OF A SCALE MODEL HIGH SPEED PROPELLER AT SIMULATED TAKEOFF/APPROACH CONDITIONS
RICHARD P. WOODWARD (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting, 25th, Reno, NV, Jan. 12-13, 1987. 21 p. Previously announced in STAR as N87-16588. refs
(AIAA PAPER 87-0526)

A model high-speed advanced propeller, SR-7A, was tested in the NASA Lewis 9 x 15 foot anechoic wind tunnel at simulated takeoff/approach conditions of 0.2 Mach number. These tests were in support of the full-scale Propfan Text Assessment (PTA) flight program. Acoustic measurements were taken with fixed microphone arrays and with an axially translating microphone probe. Limited aerodynamic measurements were also taken to establish the propeller operating conditions. Tests were conducted with the propeller alone and with three down-stream wing configurations. The propeller was run over a range of blade setting angles from 32.0 deg. to 43.6 deg., tip speeds from 183 to 290 m/sec (600 to 950 ft/sec), and angles of attack from -10 deg. to + 15 deg. The propeller alone BPF tone noise was found to increase 10 dB in the flyover plane at 15 deg. propeller axis angle of attack. The installation of the straight wing at minimum spacing of 0.54 wing chord increased the tone noise 5 dB under the wing of 10 deg. propeller axis angle of attack, while a similarly spaced inboard upswept wing only increased the tone noise 2 dB. Author

A87-31110*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
STRUCTUREBORNE NOISE CONTROL IN ADVANCED TURBOPROP AIRCRAFT
IRVIN J. LOEFFLER (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting, 25th, Reno, NV, Jan. 12-15, 1987. 21 p. Previously announced in STAR as N87-16587. refs
(AIAA PAPER 87-0530)

Structureborne noise is discussed as a contributor to propeller aircraft interior noise levels that are nonresponsive to the application of a generous amount of cabin sidewall acoustic treatment. High structureborne noise levels may jeopardize passenger acceptance of the fuel-efficient high-speed propeller transport aircraft designed for cruise at Mach 0.65 to 0.85. These single-rotation tractor and counter-rotation tractor and pusher propulsion systems will consume 15 to 30 percent less fuel than advanced turbofan systems. Structureborne noise detection methodologies and the importance of development of a structureborne noise sensor are discussed. A structureborne noise generation mechanism is described in which the periodic components or propeller swirl produce periodic torques and forces on downstream wings and airfoils that are propagated to the cabin interior as noise. Three concepts for controlling structureborne noise are presented: (1) a stator row swirl remover, (2) selection of a proper combination of blade numbers in the rotor/stator system of a single-rotation propeller, and the rotor/rotor system of a counter-rotation propeller, and (3) a tuned mechanical absorber. Author

A87-31141*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
COMMENTS ON THE AEROACOUSTICS OF HELICOPTER ROTORS
F. FARASSAT (NASA, Langley Research Center, Hampton, VA) AHS, National Specialists' Meeting on Aerodynamics and Aeroacoustics, Arlington, TX, Feb. 25-27, 1987, Paper. 4 p.

Some techniques and procedures used in rotor aeroacoustics are examined. The advantages and disadvantages of using the acoustic analogy for noise prediction of helicopter rotors are discussed. The time domain and frequency domain approaches to rotor noise predictions are described. Consideration is given to steady and unsteady thickness noise, loading noise, and quadrupole noise. I.F.

A87-31142*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
MAIN ROTOR BROADBAND NOISE STUDY IN THE DNW
THOMAS F. BROOKS, MICHAEL A. MARCOLINI (NASA, Langley Research Center, Hampton, VA), and D. STUART POPE (PRC Kentron, Inc., Hampton, VA) AHS, National Specialists' Meeting on Aerodynamics and Aeroacoustics, Arlington, TX, Feb. 25-27, 1987, Paper. 12 p. FAA-Army-supported research. refs

An acoustics test of a 2/5 scale model BO-105 helicopter main rotor was conducted in the Duits-Nederlandse Windtunnel (DNW). A range of operating conditions was tested from hover to moderately high flight speeds for various climb and descent rates at different thrust settings. Diagnostic tests including rotor speed and blade geometry changes were made to better isolate and study particular broadband self noise sources. Acoustic data in the form of acoustic pressure time histories and power spectra are used to demonstrate the regions of importance of the different broadband noise sources and their sensitivity to operating conditions. To help interpret the data, comparisons are made to predictions of rotor broadband noise. The predictions are based on self noise data previously obtained from isolated airfoil sections and the use of the NASA ROTONET program to define rotor performance and to sum contributions of noise from individual blade segments. An important result herein is the identification and articulation of a previously unheralded rotor broadband noise source. This source is blade-turbulent wake interaction (BWI) noise which dominates the spectra in the mid-frequencies for off-peak blade-vortex interaction (BVI) noise flight conditions. Author

A87-31143*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
ACOUSTIC RESULTS OF THE BLADE-VORTEX INTERACTION ACOUSTIC TEST OF A 40 PERCENT MODEL ROTOR IN THE DNW
RUTH M. MARTIN (NASA, Langley Research Center, Hampton, VA) and WOLF R. SPLETTSTOESSER (DFVLR, Brunswick, West Germany) AHS, National Specialists' Meeting on Aerodynamics and Aeroacoustics, Arlington, TX, Feb. 25-27, 1987, Paper. 19 p. FAA-Army-supported research. refs

Acoustic data of a 40 percent scale model of the 4-bladed B0-105 main rotor, measured in a large test section aeroacoustic wind tunnel, are presented. Rotor blade-vortex interaction (BVI) noise data were acquired using a traversing in-flow microphone array in the low to moderate speed flight range. Results are presented which document the flight conditions for maximum BVI impulsive noise; assess the acoustic farfield by BVI noise; map the directivity of BVI impulsive noise in a large plane below and upstream of the rotor; illustrate the temporal characteristics of the BVI signals as a function of tip-speed-ratio; and show the existence of retreating side BVI signals. The occurrence of a strongly focused radiation pattern, as opposed to a more omnidirectional pattern, was found to be very dependent on the rotor operating condition. Multiple interactions per blade were observed at the lowest speed cases, with broader impulsive content, while the higher speed cases exhibited fewer interactions per blade, with much sharper, higher amplitude acoustic signals. BVI acoustic signals were measured under the aft retreating quadrant of the rotor and found to originate from the retreating side of the rotor. Author

A87-31144*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AIRCRAFT TURBOFAN NOISE
J. F. GROENEWEG and E. J. RICE (NASA, Lewis Research Center, Cleveland, OH) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 109, Jan. 1987, p. 130-141. Previously announced in STAR as N83-18405. refs

Turbofan noise generation and suppression in aircraft engines are reviewed. The chain of physical processes which connect unsteady flow interactions with fan blades to far field noise is addressed. Mechanism identification and description, duct propagation, radiation, and acoustic suppression are discussed. The experimental techniques of fan inflow static tests are discussed. Rotor blade surface pressure and wake velocity measurements aid in the determination of the types and strengths of the generation mechanisms. Approaches to predicting or measuring acoustic mode content, optimizing treatment impedance to maximize attenuation, translating impedance into porous wall structure, and interpreting far field directivity patterns are illustrated by comparisons of analytical and experimental results. The interdependence of source and acoustic treatment design to minimize far field noise is emphasized. Areas requiring further research are discussed, and the relevance of aircraft turbofan results to quieting other turbomachinery installation is addressed. S.L.

A87-31164*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SPECTRA OF NOISE AND AMPLIFIED TURBULENCE EMANATING FROM SHOCK-TURBULENCE INTERACTION
HERBERT S. RIBNER (NASA, Langley Research Center, Hampton, VA; Toronto, University, Downsview, Canada) AIAA Journal (ISSN 0001-1452), vol. 25, March 1987, p. 436-442. NSERC-supported research. Previously announced in STAR as N86-27970. refs

This work is a small extension of NACA studies of the early fifties that predicted amplification of turbulence on passing through a shock wave (observed for turbulent boundary layers), as well as the generation of intense noise (observed for supersonic jets). The first solved the basic gasdynamics problem of the interaction of an infinite planar shock with a single three-dimensional spectrum component of turbulence (an oblique sinusoidal shear wave). The second developed the comprehensive 3D spectrum analysis necessary to generalize the scenario to the interaction of a shock wave with convected homogeneous turbulence. Numerical calculations were carried out to yield curves (vs. Mach number) of rms sound pressure, temperature fluctuation, and two components of turbulent velocity downstream of the shock, for two cases of preshock turbulence. The present numerical study reproduces these for one case and provides in addition their one-dimensional power spectra (vs. wavenumber of frequency). Ratios of the several postshock spectra to the longitudinal preshock turbulence spectrum (4D) have been computed for a wide range of Mach numbers; curves vs. wavenumber are presented for two scenarios of preshock turbulence: isotropy and axisymmetry, both based on the von Karman 3D spectrum. Author

N87-19057*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NOISE REDUCTION FOR MODEL COUNTERROTATION PROPELLER AT CRUISE BY REDUCING AFT-PROPELLER DIAMETER
JAMES H. DITTMAR and DAVID B. STANG (Sverdrup Technology, Inc., Cleveland, Ohio) 1987 31 p Prepared for presentation at the 113th Meeting of the Acoustical Society of America, Indianapolis, Ind., 11-15 May 1987
(NASA-TM-88936; E-3378; NAS 1.15:88936) Avail: NTIS HC A03/MF A01 CSCL 20A

The forward propeller of a model counterrotation propeller was tested with its original aft propeller and with a reduced diameter aft propeller. Noise reductions with the reduced diameter aft propeller were measured at simulated cruise conditions. Reductions were as large as 7.5 dB for the aft-propeller passing tone and 15 dB in the harmonics at specific angles. The interaction tones, mostly the first, were reduced probably because the reduced-diameter aft-propeller blades no longer interacted with the forward propeller tip vortex. The total noise (sum of primary and interaction noise) at each harmonic was significantly reduced. The chief noise reduction at each harmonic came from reduced aft-propeller-alone noise, with the interaction tones contributing little to the totals at cruise. Total cruise noise reductions were as much as 3 dB at given angles for the blade passing tone and 10 dB for some of the harmonics. These reductions would measurably improve the fuselage interior noise levels and represent a definite cruise noise benefit from using a reduced diameter aft propeller. Author

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SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law, political science, and space policy; and urban technology and transportation.

A87-29483
ANNALS OF AIR AND SPACE LAW. VOLUME 10
NICOLAS MATEESCO MATTE, ED. (McGill University, Montreal, Canada) Montreal, McGill University, 1985, 626 p. In English and French. For individual items see A87-29484 to A87-29494.

Recent legal developments regarding conventions and treaties which guide the worldwide development of air transportation, civil, commercial and military satellite-based operations, and expanding space station programs are explored. Consideration is given to the assignment of liability for operators of transport terminals, aircraft operators and in Japan. Procedures developed by a neutral state to respond to intrusion into national airspace by a foreign aircraft are discussed. Various European programs to develop multinational DBS and radio broadcast satellites are described, with emphasis on the international implications of transnational media broadcasts. Finally, existing international legal conventions governing space station operations are identified. M.S.K.

A87-29485#
CUSTOM IN INTERNATIONAL AIR RELATIONS
JOSEPH Z. GERTLER (Canadian Transport Commission, International Air Transport Branch, Ottawa, Canada) IN: Annals of air and space law. Volume 10 . Montreal, McGill University, 1985, p. 63-81. refs

Patterns of national behavior which follow or are complementary to international rules governing civil air transport are discussed. The Warsaw Convention of 1929 is limited in some over its coverage, e.g., claims by outside parties due to the deaths of passengers, the interpretation of 'willful misconduct', etc. The Montreal Agreement of 1966 has had some effect in adjusting the limits of liability of carriers to reflect world economic changes since 1929. International unanimity was expressed in 1983 to condemn the use of force against civil aircraft, a written principle adopted by the ICAO after the Soviet destruction of the KAL 007 aircraft. It is noted that bilateral agreements are common among contracting states, although the agreements are subject to the judicial systems of the separate states. M.S.K.

A87-29486#
NATIONALITY AND REGISTRATION OF AIRCRAFT OPERATED BY JOINT AIR TRANSPORT OPERATING ORGANIZATIONS OR INTERNATIONAL OPERATING AGENCIES
MICHAEL MILDE (International Civil Aviation Organization, Legal Bureau, Montreal, Canada) IN: Annals of air and space law. Volume 10 . Montreal, McGill University, 1985, p. 133-153. refs

The landmark determination rendered by the Council of ICAO under the last sentence of Article 77 of the Chicago Convention in a case involving Arab Air Cargo is discussed. Article 77 permits

the formation and operation of a joint air service by multiple sovereign states. Arab Air Cargo was established in 1981 as a joint organization of Iraq and Jordan. The Council recognized that it is favorable for developing nations to have joint operations of modern aircraft as a means of cost-sharing and economic development. Furthermore, the joint or international registration of such aircraft is expected to facilitate the functioning of jointly operated air services. M.S.K.

A87-29487#
ARTICLE 17 OF THE WARSAW CONVENTION - AN ACCIDENT IS REQUIRED FOR RECOVERY
BARBARA REUKEMA (Southwestern University, Los Angeles, CA) IN: Annals of air and space law. Volume 10 . Montreal, McGill University, 1985, p. 191-208. refs

Article 17 of the Warsaw Convention assigns liability to the aircraft operator for bodily damage experienced by a passenger from external causes because of an accident occurring during operation of the aircraft. A person who suffered deafness in one ear due to a routine descent from higher altitudes in a landing approach maneuver sued for damages in 1980. The U.S. Supreme Court treated the word 'accident' as an unexpected event, an interpretation with precedents in international law. The plaintiff's case was summarily dismissed on the basis of the normality of cabin pressure changes in a landing approach. M.S.K.

A87-29488#
AIR CARRIER'S PASSENGER LIABILITY IN JAPAN
TERUO SAKAMOTO (Japan Air Lines Co., Ltd., Legal Dept., Tokyo, Japan) IN: Annals of air and space law. Volume 10 . Montreal, McGill University, 1985, p. 227-238. refs

Japan maintains two commercial aircraft operator liability systems, one for domestic carriers and one for international carriers. For international operations, Japan is a party to the Warsaw Convention and the Hague Protocol, and Japan Air Lines is a signatory to the Montreal Accord. There is no specific set of regulations for liability for civil aircraft operations, which are subject to civil liability rules. Instead, the Minister of Transport approves conditions of carriage which regulate domestic air transport. The civil code can override the ministerial rules in cases. The amount of damages which may be awarded have been codified for the age, income, familial situation, funeral expenses, and mental suffering expected for various categories of individuals. M.S.K.

A87-29489#
LEGITIMATE RESPONSES TO AERIAL INTRUDERS - THE VIEW FROM A NEUTRAL STATE
JACOB SUNDBERG (Stockholms Universitet, Stockholm, Sweden) IN: Annals of air and space law. Volume 10 . Montreal, McGill University, 1985, p. 251-274. refs

Various instances of civil and commercial flights of aircraft over foreign lands are discussed to explore the evolution of regulations, and the practices of adhering to them, governing national responses to air intruders. A penal code approach attaches criminal stigma to any intruding aircraft, presenting the danger that the aircraft will be shot down or forced down and the crew and passengers incarcerated. The arrest or detention can be a police, rather than military, action, and may be to detain offenders of civil code in another country. Several communications and flying techniques are described for avoiding situations that lead to death and destruction, as happened with the KAL 007 and 902 flights. M.S.K.

A87-29645
THE COST EFFECTIVENESS OF WEIGHT REDUCTION BY ADVANCED MATERIAL SUBSTITUTION
PAUL W. SCOTT (Douglas Aircraft Co., Long Beach, CA) IN: New materials in civil aviation; Proceedings of the Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 13-16, 1986 . Warrendale, PA, Society of Automotive Engineers, Inc., 1986, p. 59-65.
(SAE PAPER 861850)

Generalized relationships are derived to analyze the cost effectiveness of weight reduction obtained by substitution of an advanced material of reduced density with no change in dimensions. These cost effectiveness relationships are applied to a preliminary assessment of aluminum-lithium (Al-Li) on an advanced derivative of the MD-80 transport aircraft. Author

A87-31145
EVALUATION OF TRANSPORT ALTERNATIVES
TOMISLAV JOVANOVIC (ZG-Prometni Institut, Ljubljana, Yugoslavia) Airport Forum (ISSN 0002-2802), vol. 16, Dec. 1986, p. 50-55.

A method for evaluating the effect of transportation system alternatives on the passenger population using questionnaires is proposed. The relation between the passenger population and transport systems is studied. The need to incorporate passenger reactions to transportation system changes into the planning of transportation systems is discussed. The structure of the questionnaire and when to implement the questionnaire are examined. The criteria for evaluating transportation systems include: (1) cost, (2) travel time, (3) punctuality and reliability, (4) convenience, (5) the possibility of making reservations, (6) safety, and (7) comfort. An example applying the questionnaire method to the evaluation of the airline and rail transportation systems between Ljubljana-Belgrade, Yugoslavia is presented. I.F.

N87-20145# Joint Publications Research Service, Arlington, Va.
NEWEST DEVELOPMENTS IN PLANNING, TESTING REPORTED
In its Japan report: Science and Technology (JPRS-JST-86-026) p 19-34 11 Sep. 1986 Transl. into ENGLISH of Kogiken Nyusu (Tokyo, Japan), May 1986 p 1-10
Avail: NTIS HC A05/MF A01

Major research for FY86 is outlined. The research items for FY86 total 134 and include research and development of a short takeoff and landing (STOL) aircraft; fanjet STOL aircraft; advanced turboprop (ATP) blade design; aerodynamic elasticity activity; noise reduction; space transport research; satellite design; artificial intelligence; gas turbines; and numerical simulator consolidation. B.G.

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GENERAL

A87-28399#
AEROSPACE HIGHLIGHTS 1986
Aerospace America (ISSN 0740-722X), vol. 24, Dec. 1986, p. 16-18, 20-37, 40-46 (32 ff.).

Topics discussed include materials advances, electric propulsion, applied aerodynamics, space operations and support, terrestrial energy systems, missile systems, management, interactive computer graphics, plasmadynamics and lasers, airbreathing propulsion, V/STOL aircraft, propellants and combustion, atmospheric flight mechanics, and aircraft design. Consideration is given to fluid dynamics, thermophysics, communications, aerospace maintenance, aeroacoustics, flight simulation, digital avionics, legal aspects, space sciences and astronomy, structural dynamics, marine systems, space

transportation, space processing, system effectiveness and safety, aerospace power systems, and astrodynamics. Specific attention is focused on ground testing, command, control, communications, and intelligence, liquid propulsion, guidance, navigation and control, life sciences and systems, space systems, air transportation, flight testing, the atmospheric environment, design engineering, lighter-than-air systems, software, solid rockets, structures, and general aviation. I.F.

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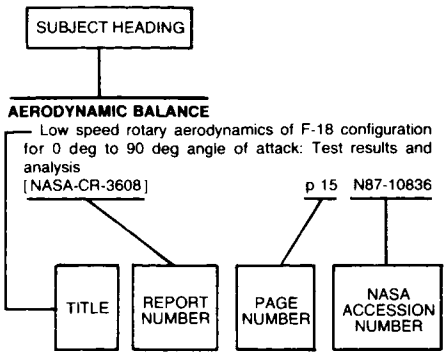

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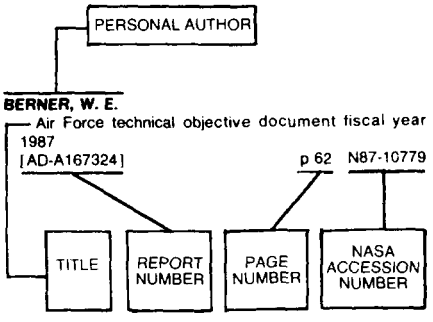

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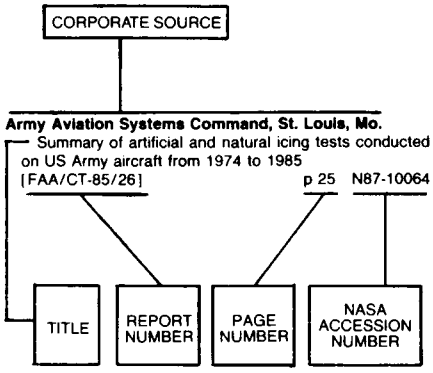

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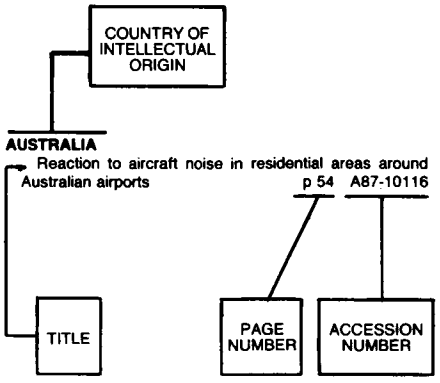

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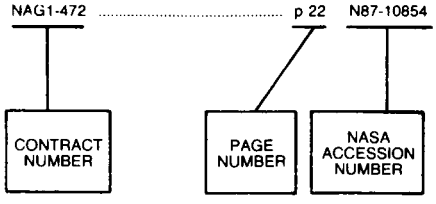

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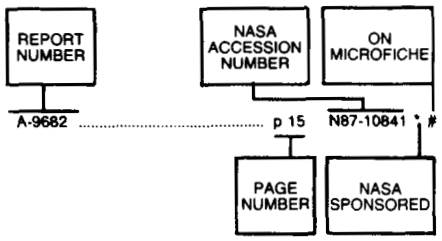

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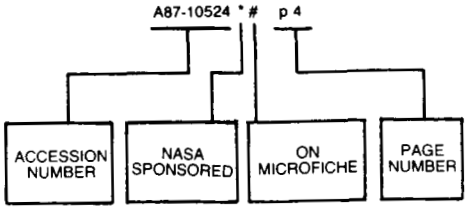

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