NASA SP-7037 (277)
April 1992

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

NASA STI PROGRAM
SCIENTIFIC & TECHNICAL INFORMATION

NASA SP-7037 (277)
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A CONTINUING BIBLIOGRAPHY WITH INDEXES

National Aeronautics and Space Administration
Scientific and Technical Information Program
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INTRODUCTION

This issue of *Aeronautical Engineering—A Continuing Bibliography* (NASA SP-7037) lists 467 reports, journal articles, and other documents originally announced in March 1992 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA).*

Accession numbers cited in this issue are:

STAR (N-10000 Series)	N92-13926 — N92-15961
IAA (A-10000 Series)	A92-17255 — A92-20826

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 publication 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.

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

A cumulative index for 1992 will be published in early 1993.

Information on availability of documents listed, addresses of organizations, and NTIS price schedules are located at the back of this issue.

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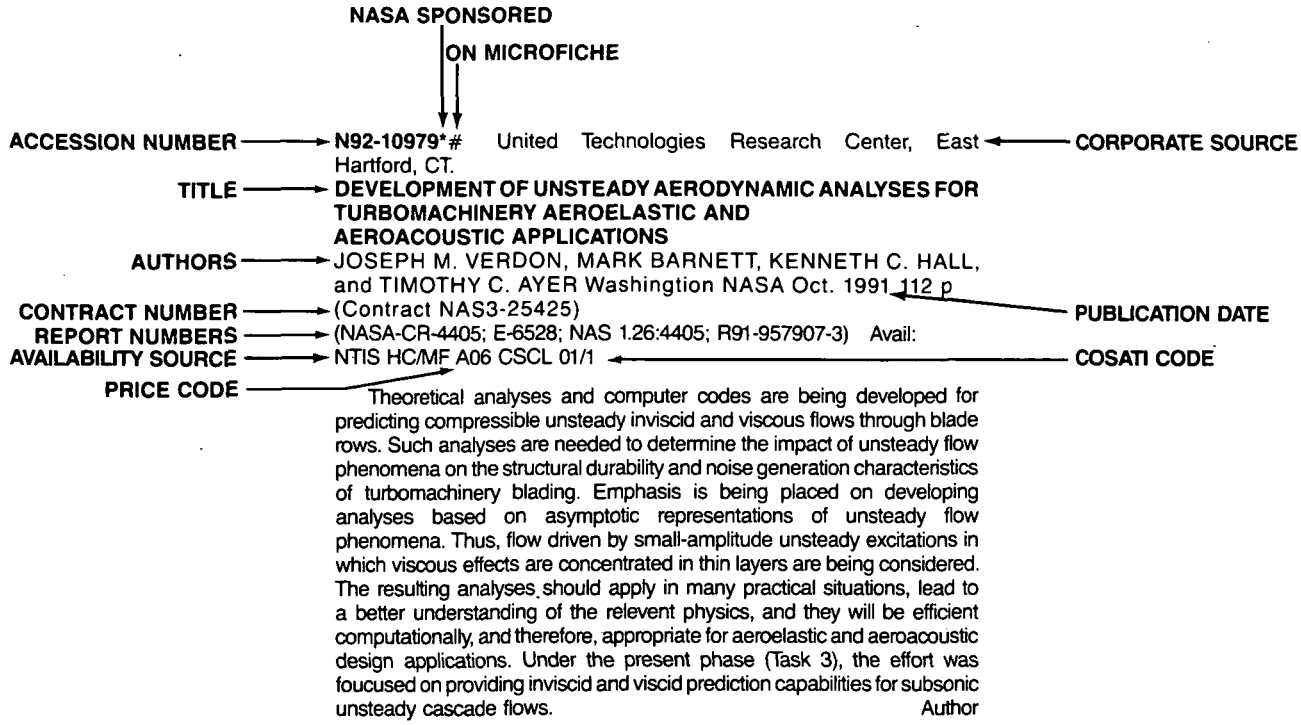
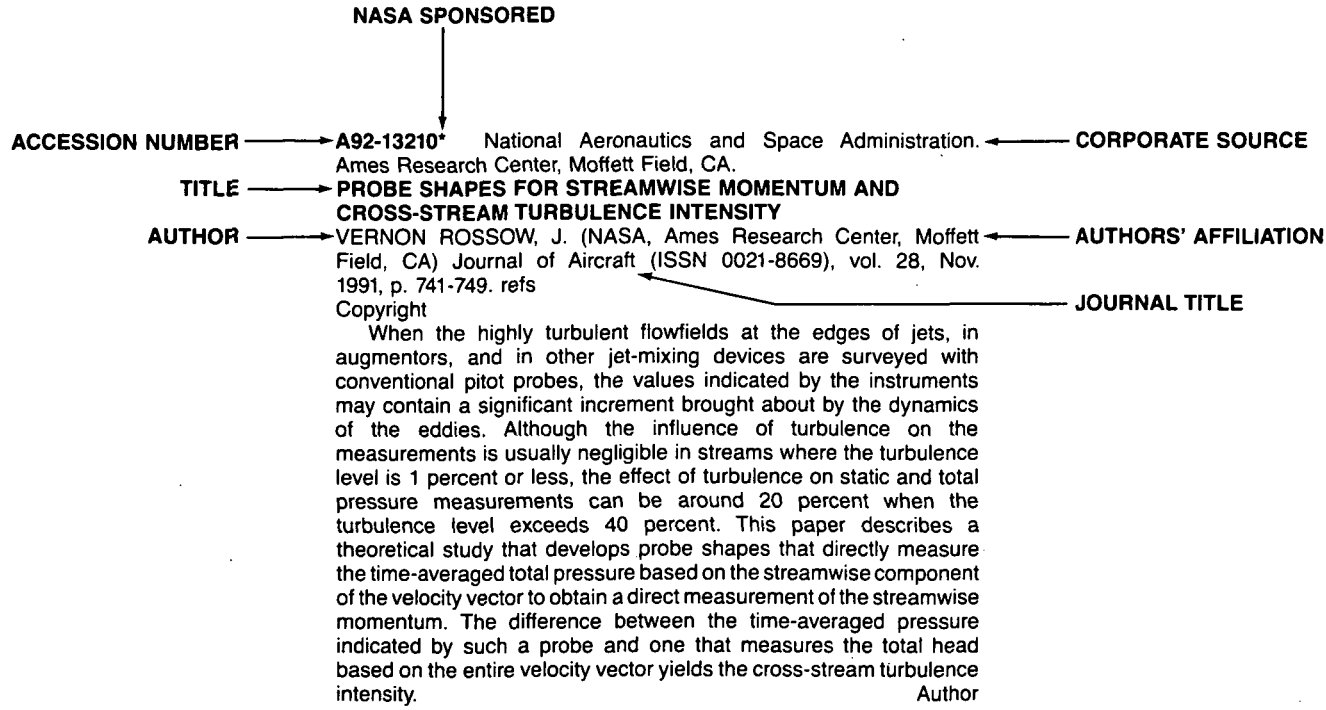
TYPICAL REPORT CITATION AND ABSTRACT



TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT



AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 277)

APRIL 1992

01

AERONAUTICS (GENERAL)

A92-17294
NATIONAL RESEARCH PROGRAM FOR NONDESTRUCTIVE INSPECTION OF AGING AIRCRAFT
CHRIS SEHER (FAA, Technical Center, Atlantic City, NJ) and ALFRED L. BROZ (FAA, Burlington, MA) Materials Evaluation (ISSN 0025-5327), vol. 49, Dec. 1991, p. 1547-1550.

A national research program called National Aging Aircraft Research Program (NAARP) is being developed by the Federal Aviation Administration to ensure that the structural integrity of high-flight-time aircraft is properly maintained. The NAARP consists of six subprograms each of which deals with one of the six factors that affect the aircraft maintenance system: corrosion, fatigue and fracture, maintenance and repair, flight loads, human factors, and nondestructive inspection. The methods used by the program to achieve each of its objectives are discussed. I.S.

A92-17854#
POTENTIAL HYPERSONIC VEHICLES APPLICATIONS
GERARD LARUELLE (Aerospatiale, Les Mureaux, France) and PHILIPPE RAMETTE (Dassault Aviation, Saint-Cloud, France) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 8 p. refs
(AIAA PAPER 91-5086) Copyright

Applications of the vehicles are given including missiles, reconnaissance, commercial transportation, military aircraft, and airbreathing space launchers. The convergence of technological and economic issues is considered along with need in justifying the importance of the aircraft and spacecraft. Key technological issues include propulsion systems, resistant materials, low-mass structures, and guidance equipment for the thermal environment. Hypersonic missiles and reconnaisance vehicles are described and include the Scorpion airbreathing missile, and commercial applications include the Concorde and the Alliance aircrafts. Technological advances are cited for developing space launchers, and design studies are mentioned for advanced SSTO and TSTO launchers such as the Taranis, Oriflamme, and STS 2000. C.C.S.

A92-20023
AGING AIRCRAFT PROGRAMME ENTAILS MAJOR EFFORT AND EXPENSE
RAY WALDER (International Air Transport Association, Montreal, Canada) ICAO Journal (ISSN 0018-8778), vol. 46, Nov. 1991, p. 6-8.
Copyright

The extensive program initiated by the Airworthiness Assurance Task Force formed by ATA to address a number of continuing airworthiness issues related to aircraft aging is presented. Some of the general issues addressed include fatigue testing or teardown of samples of long-service aircraft, establishing a new corrosion prevention and repair program with extensive reporting procedures, and appropriate changes to maintenance programs. The continuing airworthiness of commuter aircraft is also under review, utilizing many of the criteria developed for the larger transport category aircraft. R.E.P.

A92-20145
A PERSPECTIVE ON AEROSPACE CFD
DEAN R. CHAPMAN (Stanford University, CA) Aerospace America (ISSN 0740-722X), vol. 30, Jan. 1992, p. 16-19, 58.
Copyright

An overview is presented of CFD development with emphasis on the computational technology of large eddy simulation (LES) for aerospace research. Though wind tunnel data are still the primary source of flow simulations for fighter aircraft design, LES offers the potential for accurately simulating all of the complex transitional and turbulent flows, although the required computer power is not presently available. The key to LES expectations is experimental data showing the small scales of turbulence to be essentially universal, or at least correlatable, and therefore amenable to reasonably accurate modeling. R.E.P.

A92-20146
CFD HELPS THE AIR FORCE FLY RIGHT
LARRY P. DAVIS and ALLAN C. SCHELL (USAF, Washington, DC) Aerospace America (ISSN 0740-722X), vol. 30, Jan. 1992, p. 22-26.
Copyright

The USAF overall CFD programs, balanced among basic research, applied research, design applications, and test and evaluation are presented. Consideration is given to the development of EAGLE, a code consisting of surface and volume grid generation codes coupled with an inviscid flow solution code capable of handling complex geometries utilizing a blocked grid structure. Attention is given to the Air Force science and technology program in the area of weather prediction. Other developments include the Socrates Monte Carlo code, which predicts the transport, chemical reactions, and signatures of effluents from spacecraft. R.E.P.

N92-13926# Executive Resource Associates, Inc., Arlington, VA.
GENERAL AVIATION ACTIVITY AND AVIONICS SURVEY, CALENDAR YEAR 1989 Annual Report
1989 469 p Prepared in cooperation with Adsystech, Inc., Silver Spring, MD
(PB91-179234; FAA-AMS-420) Avail: NTIS HC/MF A20 CSCL 01B

The results of the Annual General Aviation Activity and Avionics Survey are presented. The survey is conducted by the FAA to obtain information on the activity and avionics of the United States registered general aviation aircraft fleet. Breakdowns of active aircraft, annual flight hours, average flight hours, and other statistics by manufacture/model groups, aircraft type, state, and region of based aircraft and primary use are presented. Also included are fuel consumption, lifetime airframe hours, avionics, engine hours, miles flown estimates, tables for detailed analysis of the avionics capability of the general aviation fleet, estimates of the number of landings, IFR hours flown, and grade of fuel consumed by the general aviation fleet. GRA

N92-13927# Federal Aviation Administration, Washington, DC. Office of Management Systems.
FAA STATISTICAL HANDBOOK OF AVIATION: CALENDAR YEAR 1989
1989 142 p
(PB91-202051; FAA-AMS-420) Avail: NTIS HC/MF A07 CSCL 01B

Statistical information pertaining to the Federal Aviation Administration, the National Airspace System, airports, airport activity, aircraft accidents, aeronautical production and imports/exports, and a glossary of the terms used in the publication are presented. GRA

N92-13928*# Pennsylvania State Univ., University Park. Dept. of Aerospace Engineering.
THIRD INTERNATIONAL CONFERENCE ON INVERSE DESIGN CONCEPTS AND OPTIMIZATION IN ENGINEERING SCIENCES (ICIDES-3)
GEORGE S. DULIKRAVICH, ed. 1991 608 p Conference held in Washington, DC, 23-25 Oct. 1991 Sponsored in cooperation with NASA, Washington, NSF, and ONR
(NASA-CR-188125; NAS 1.26:188125) Avail: NTIS HC/MF A99 CSCL 01B

Papers from the Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES) are presented. The papers discuss current research in the general field of inverse, semi-inverse, and direct design and optimization in engineering sciences. The rapid growth of this relatively new field is due to the availability of faster and larger computing machines.

N92-13991# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
INTERNATIONAL AVIATION (SELECTED ARTICLE)
25 Jul. 1991 19 p Transl. into ENGLISH from Guoji Hangkong (China), no. 3, 49-51, 1990 p 42
(AD-A240986; FTD-ID(RS)T-0167-91) Avail: NTIS HC/MF A03 CSCL 01/3

A discussion of China's role in the future of commercial and military aircraft manufacturing is presented. The discussion is given in two parts. The first part describes the relative advantages of delta wing aircraft. The second part gives a description of the state of aircraft manufacturing in the West (United States, United Kingdom, France, and Germany) and then goes on to discuss the need for modernization in China's aircraft industry. GRA

N92-13992# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
INTERNATIONAL AVIATION (SELECTED ARTICLE)
18 Jul. 1991 22 p Transl. into ENGLISH from Guoji Hangkong (China), no. 10, 49 1989 p 34-36
(AD-A240987; FTD-ID(RS)T-0170-91) Avail: NTIS HC/MF A03 CSCL 21/5

This translation of the Chinese journal, International Aviation, contains two articles. The first article is a discussion of the development of China's first generation augmented turbofan, the WS6. The second article is a description of China's first-generation full-pressure helmet, the TK-4. GRA

N92-13993# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
INTERNATIONAL AVIATION (SELECTED ARTICLES)
11 Sep. 1991 53 p Transl. into ENGLISH from Guoji Hangkong (China), no. 8, 1990 p 8-17
(AD-A241119; FTD-ID(RS)T-0461-91) Avail: NTIS HC/MF A04 CSCL 01/3

The results of ten years of Chinese research on aircraft aeroelastics are presented. The subjects discussed are: the development of the computer study of aerodynamics and wind tunnel testing technology, aerodynamic research by the Beijing Aerodynamic Institute, research on complex flows by the Institute of Fluid Mechanics of the Beijing University of Aeronautics and Astronautics,and a type of new model exciter system used in research on aircraft chatter. GRA

N92-14966# David Taylor Research Center, Bethesda, MD.
AVIATION DIAGNOSTICS AND MAINTENANCE (ADAM) SYSTEM PRELIMINARY CONCEPT OF OPERATION AND FUNCTIONAL DESCRIPTION Final Report, Oct. 1990 - Sep. 1991
RAYMOND P. LEBEAU, MARK T. KRAMER, JAMES R. CARLBERG, MICHAEL S. DEPRIEST, and HARVEY A. EIKEL Sep. 1991 76 p
(AD-A242598; DTRC-91/017) Avail: NTIS HC/MF A05 CSCL 12/7

The Aviation Diagnostics and Maintenance (ADAM) System is an initiative to acquire, store, distribute, and use technical maintenance information for aircraft in a digitized, integrated, and task-oriented format. The initiative is consistent with DoD Computer-aided Acquisition and Logistics Support (CALS) direction and provides tools for Statistical Process Control (SPC) under Total Quality Management (TQM) concepts. While oriented toward new technology aircraft, segments of the concept have applicability to the existing Naval Aviation inventory. ADAM consists of a maintenance system equipped with state of the art hardware/software through which complete, current and consistent data will be made automatically available in electronic format to all maintenance technicians and production managers, thereby improving maintenance performance and unit readiness with reduced Life Cycle Costs (LCC). The ADAM system incorporates expert system diagnostic techniques, which interface with the aircraft's Built In Test (BIT) data, to generate subsets of optimized maintenance task information for fault isolation and repair processes. This maintenance task information will be available to the technician on both workcenter display devices and on portable display devices which can be used at the work site. GRA

02

AERODYNAMICS

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

A92-17429* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EIGENVALUE CALCULATION PROCEDURE FOR AN EULER/NAVIER-STOKES SOLVER WITH APPLICATION TO FLOWS OVER AIRFOILS
APARAJIT J. MAHAJAN (NASA, Lewis Research Center, Cleveland; Toledo, University, OH; Duke University, Durham, NC), EARL H. DOWELL, and DONALD B. BLISS (Duke University, Durham, NC) Journal of Computational Physics (ISSN 0021-9991), vol. 97, Dec. 1991, p. 398-413. refs
(Contract NAG3-724)
Copyright

A Lanczos procedure is presently applied to a Navier-Stokes (N-S) solver for eigenvalues and eigenvectors associated with the small-perturbation analysis of the N-S equations' finite-difference representation for airfoil flows; the matrix used is very large, sparse, real, and nonsymmetric. The Lanczos procedure is shown to furnish complete spectral information for the eigenvalues, as required for transient-stability analysis of N-S solvers. O.C.

A92-17501
CFD APPLICATION TO 2D/3D FLOW FIELDS IN SCRAMJET ENGINE
TOSHIRO FUJIMORI, MASAFUMI KAWAI, TAKAKO SUZUKI, YASUNORI ANDO, and YASUNORI OHMORI Ishikawajima-Harima Engineering Review (ISSN 0578-7904), vol. 31, July 1991, p. 221-226. In Japanese. refs

CFD plays a major role in the research and development of

hypersonic flight vehicles on the premise that numerical approaches provide simulations of various conditions, including supersonic combustion for which no ground test capability exists. The 2D/3D CFD codes have been developed to simulate the supersonic/hypersonic turbulent reacting flow in supersonic combustion ramjet (Scramjet) engines. The TVD scheme is used to capture shocks, and a finite reaction-rate mode of hydrogen-air combustion is utilized. The current results for the components of Scramjet engines are presented; i.e., inlet, combustor and nozzle by using the CFD codes. Validation of these results are compared with existing experimental and computational results. Author

A92-17502
SUPERSONIC INLET FLOW COMPUTATION
SHIN-ICHI KURODA Ishikawajima-Harima Engineering Review (ISSN 0578-7904), vol. 31, July 1991, p. 227-229. In Japanese. refs

Supersonic inlet plays the role of partial or whole air-compression process in supersonic/hypersonic air-breathing engines and is a key factor of the engine performance. The ultimate purpose of the present study is to clarify the complex supersonic inlet flow structure by using the computational fluid dynamics (CFD) and thereby contribute to the development of the inlet. In the present paper, a preliminary computation is performed for the flowfield about the experimental inlet model which is designed at Mach number 3.0 and has a bleed chamber. To handle the complex body configuration, a zonal method with slightly overlapped grid is adopted. The Fortified Navier-Stokes approach is used as the interface scheme, which connects each zone with high accuracy and permits the movement of discontinuities across the zonal boundary. Author

A92-17817#
THREE DIMENSIONAL HYPERSONIC INLETS - LOW SPEED PERFORMANCE
MARK R. ANDERSON and PAUL J. ORTWERTH (Rockwell International Corp., Rocketdyne Div., Canoga Park, CA) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 8 p. refs
(AIAA PAPER 91-5021) Copyright

Sidewall compression inlets for hypersonic vehicles offer the potential for high efficiency compression with low distortion. An investigation into three-dimensional inlet performance was conducted to examine lift, drag, spill and starting ability in the low speed range. The Inlet Marching Program (IMP) provided the means by which the analysis was conducted. The inviscid quasi-two-dimensional format of the code provided the accuracy and computational efficiency necessary to make multiple runs needed to determine inlet starting points and design trade studies. Validation of the code by comparison to experimental data and more rigorous CFD solutions are shown. Results of the analysis show strong effects on inlet starting from leading edge sweep and sidewall angle. Author

A92-17822# North Carolina State Univ., Raleigh.
EFFECT OF NOSE SHAPE ON THREE-DIMENSIONAL STAGNATION REGION STREAMLINES AND HEATING RATES
BASIL HASSAN, FRED R. DEJARNETTE (North Carolina State University, Raleigh), and E. V. ZOBY (NASA, Langley Research Center, Hampton, VA) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 16 p. Research supported by USAF and U.S. Navy. refs
(Contract NAGW-1072; NCC1-1002)
(AIAA PAPER 91-5032) Copyright

A new method for calculating the three-dimensional inviscid surface streamlines and streamline metrics using Cartesian coordinates and time as the independent variable of integration has been developed. The technique calculates the streamline from a specified point on the body to a point near the stagnation point by using a prescribed pressure distribution in the Euler equations. The differential equations, which are singular at the stagnation point, are of the two point boundary value problem type. Laminar heating rates are calculated using the axisymmetric analog concept for three-dimensional boundary layers and approximate solutions to the axisymmetric boundary layer equations. Results for elliptic conic forebody geometries show that location of the point of maximum heating depends on the type of conic in the plane of symmetry and the angle of attack, and that this location is in general different from the stagnation point. The new method was found to give smooth predictions of heat transfer in the nose region where previous methods gave oscillatory results. Author

A92-17826#
NUMERICAL AND EXPERIMENTAL STUDY OF JET IMPINGEMENT OR INTERACTION EFFECTS AT HYPERSONIC AND SUPERSONIC SPEEDS
C. Y. WANG and Z. H. WANG (Changsha Institute of Technology, People's Republic of China) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 12 p. refs
(AIAA PAPER 91-5038) Copyright

The base transverse jet in supersonic crossflow and the jet impingement on obstacle have several applications for aerospace vehicles. Numerical methods and experiment used to analyze above problems are described. Plane two-dimensional and axisymmetrical flowfields have been calculated with MacCormack explicit scheme and implicit vector flux splitting finite volume method. NS and Euler equations are solved. Adopting multiprocessor parallel calculation methods, the computational efficiency is promoted obviously. It is shown that the Mach number of nozzle exit and oncoming flow, the ratio of exit pressure and ambient, the jet mass flow, and the distance between the nozzle exit and the obstacle are the main factors to affect the features of flowfield. The results measured in supersonic wind tunnel for jet impinging solid obstacle are given, in which the Mach number is 2.0 and 3.728. Surface pressure distribution is shown. The hypersonic gun tunnel is introduced briefly. The plan which is going to be performed is presented. Author

A92-17841#
A LIFTING LINE THEORY FOR SUPERSONIC FLOW APPLICATIONS
I. JADIC (Institute of Applied Mathematics, Bucharest, Romania) and V. N. CONSTANTINESCU (Polytechnical Institute, Bucharest, Romania) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 10 p. refs
(AIAA PAPER 91-5058) Copyright

The paper is devoted to the study of a supersonic lifting line theory (SLLT) intended to provide both a means of aerodynamic calculation and a testbench for the validation of the control point position for the related constant pressure panel methods. The model is based on the small perturbations assumption. A constant distribution of bound vortices is assumed along the chord while the spanwise load distribution is calculated by means of trigonometrical series, formally similar to the subsonic methods. The calculated aerodynamic coefficients are in good agreement to the reference data, the precision being compatible with the small perturbations assumption. The control point position obtained is shown to vary as a function of aspect ratio from 100 percent to 88 percent of the local chord. Author

A92-17842#
ENGINEERING METHOD FOR CALCULATING SURFACE PRESSURES AND HEATING RATES ON VEHICLES WITH EMBEDDED SHOCKS
D. B. LANDRUM, FRED R. DEJARNETTE (North Carolina State University, Raleigh), and BRET L. BOMAN (McDonnell Aircraft Co., Saint Louis, MO) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 12 p. refs
(Contract F33615-87-C-3402)
(AIAA PAPER 91-5060) Copyright

An engineering method is described which includes embedded shock waves in three-dimensional surface pressure and heat transfer calculations. Embedded shocks are determined to exist in the flow based on the surface pressure change across discontinuities in the vehicle geometry and oblique shock wave relations. Maslen's approximate technique is used to obtain flowfield

properties ahead of the embedded shock. Surface pressures downstream of the shock are calculated by a new Embedded Newtonian pressure method. The importance of accurately modeling the surface geometry including discontinuities is discussed and the ASTUD, QUICK, and spline techniques are compared. Code predictions of pressures and heating rates are compared to experimental data for a generic hypersonic vehicle design. In general the comparison is good, especially considering the complexity of the geometries modeled and the approximate nature of the method. Also, a substantial reduction in solution time and user interaction in comparison to more exact CFD techniques is discussed. These advantages make the approximate method a useful tool in a preliminary design environment.
Author

A92-17857*# Air Force Academy, CO.
EFFECTS OF UNSTEADY SHOCK IMPINGEMENT ON HIGH-SPEED GASEOUS MIXING
C. W. WOOD (U.S. Air Force Academy, Colorado Springs, CO) and J. A. SCHETZ (Virginia Polytechnic Institute and State University, Blacksburg) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 15 p. Research supported by NASA. refs
(AIAA PAPER 91-5091) Copyright

Tests are performed to determine the effects of impinging oscillating shocks of different frequencies on a 15 deg downstream angled, underexpanded, sonic helium jet injected into a supersonic airflow. Information on mixing, penetration, total pressure loss, and turbulence structure from these tests is employed to estimate mixing control achieved by adding an oscillating shock to the helium injection flow field. The principal result of this study is that impingement of an oscillating shock on a high-speed shear layer can be utilized to control the rate of mixing. R.E.P.

A92-18352
THREE-DIMENSIONAL SOLUTION-ADAPTIVE GRID GENERATION ON COMPOSITE CONFIGURATIONS
YEN TU (USAF, Armament Laboratory, Eglin AFB, FL) and JOE F. THOMPSON (Mississippi State University, Mississippi State) AIAA Journal (ISSN 0001-1452), vol. 29, Dec. 1991, p. 2025, 2026. Abridged. Previously cited in issue 06, p. 756, Accession no. A90-19799. refs

A92-18353
COMPLEX VARIABLE BOUNDARY ELEMENT METHOD FOR EXTERNAL POTENTIAL FLOWS
M. MOKRY (National Research Council of Canada, Ottawa) AIAA Journal (ISSN 0001-1452), vol. 29, Dec. 1991, p. 2027, 2028. Abridged. Previously cited in issue 06, p. 755, Accession no. A90-19694. refs
Copyright

A92-18358* Technion - Israel Inst. of Tech., Haifa.
NUMERICAL PREDICTION OF SUBSONIC TURBULENT FLOWS OVER SLENDER BODIES AT HIGH INCIDENCE
DAVID DEGANI (Technion - Israel Institute of Technology, Haifa), LEWIS B. SCHIFF, and YUVAL LEVY (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 29, Dec. 1991, p. 2054-2061. Previously cited in issue 08, p. 1100, Accession no. A90-22163. refs
Copyright

A92-18361
THREE-DIMENSIONAL LINEAR STABILITY APPROACH TO TRANSITION ON WINGS AND BODIES OF REVOLUTION AT INCIDENCE
TUNCER CEBECI, H. H. CHEN, D. ARNAL, and T. T. HUANG (California State University, Long Beach) AIAA Journal (ISSN 0001-1452), vol. 29, Dec. 1991, p. 2077-2085. Research supported by U.S. Navy. refs
Copyright

The calculation of transition on an infinite swept wing at several angles of incidence for several sweep angles and on a body of revolution at one incidence is investigated with the exp-n method based on the eigenvalue formulation of Cebeci and Stewartson in which the relationship between the two wavenumbers alpha and beta are determined by making use of the saddle-point method. The method, which is based on the solution of the boundary-layer and Orr-Sommerfeld equations by a finite difference procedure, is evaluated in terms of measurements reported for the flow around a swept wing equipped with a cambered leading edge and attached to a half fuselage and for the flow around a prolate spheroid at 10-deg incidence. It is shown to be convenient to use, particularly because the neutral stability curves (zarfs) facilitate the calculation and avoid uncertainties associated with the choice of magnitude and location of the critical frequencies. In general, the calculated values of the onset of transition are in good agreement with measured values.
Author

A92-18363
CONTROL OF HYPERSONIC AERODYNAMIC FORCES WITH SURFACE BLOWING
A. F. MESSITER, T. C. ADAMSON, JR. (Michigan, University, Ann Arbor), and M. D. MATARRESE AIAA Journal (ISSN 0001-1452), vol. 29, Dec. 1991, p. 2094-2104. Research supported by U.S. Army. Previously cited in issue 08, p. 1108, Accession no. A90-23710. refs
Copyright

A92-18365
CONFINED NORMAL-SHOCK/TURBULENT-BOUNDARY-LAYER INTERACTION FOLLOWED BY AN ADVERSE PRESSURE GRADIENT
M. SAJBEN, M. J. MORRIS, T. J. BOGAR, and J. C. KROUTIL (McDonnell Douglas Research Laboratories, Saint Louis, MO) AIAA Journal (ISSN 0001-1452), vol. 29, Dec. 1991, p. 2115-2123. Previously cited in issue 09, p. 1279, Accession no. A89-25299. refs
Copyright

A92-18367
EXPERIMENTAL INVESTIGATION OF COANNULAR JET FLOW WITH SWIRL ALONG A CENTERBODY
M. O. FREY and F. B. GESSNER (Washington, University, Seattle) AIAA Journal (ISSN 0001-1452), vol. 29, Dec. 1991, p. 2132-2140. Previously cited in issue 16, p. 2484, Accession no. A90-38751. refs
(Contract AF-AFOSR-85-0273)
Copyright

A92-18372* Old Dominion Univ., Norfolk, VA.
PREDICTION OF STEADY AND UNSTEADY ASYMMETRIC VORTICAL FLOWS AROUND CIRCULAR CONES
OSAMA A. KANDIL, TIN-CHEE WONG (Old Dominion University, Norfolk, VA), and C. H. LIU (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 29, Dec. 1991, p. 2169-2178. Previously cited in issue 06, p. 760, Accession no. A90-19940. refs
(Contract NAS1-18584)
Copyright

A92-18385
STRATIFIED FLOW AROUND AN AXISYMMETRIC BODY AT SMALL ANGLE OF ATTACK
H. E. GILREATH (Johns Hopkins University, Laurel, MD) AIAA Journal (ISSN 0001-1452), vol. 29, Dec. 1991, p. 2259-2262. refs
(Contract N00039-89-C-5301)
Copyright

Available analytical methods do not permit the lift coefficient C(L) of an axisymmetric body to be established within a factor of 2.5. Results are presented which indicate that the use of a median C(L) value, in conjunction with a simple horseshoe vortex lift model, yields a workable prediction of the maximum amplitude of

lift-generated internal waves when linear propagation theory is applied. The maximum wake height and extent of collapse are virtually the same for lifting and nonlifting cases. O.C.

A92-18387
SIMILARITY SOLUTIONS FOR SUPERSONIC AXISYMMETRIC FLOWS
HAMDI T. HEMDAN (King Saud University, Riyadh, Saudi Arabia) AIAA Journal (ISSN 0001-1452), vol. 29, Dec. 1991, p. 2264-2266. refs
Copyright

New similarity solutions are presented which are based on the recently developed hypersonic theory of Hemdan (1989). Good results are obtained for pointed-nose slender axisymmetric bodies at zero incidence. The analysis relies on a recent formulation of hypersonic small-disturbance theory; the equations are presently reduced to ordinary differential equations. A smaller number of unknown functions is used, and the equations are easily tractable by further analytical study. O.C.

A92-18680
NOISE-DRIVEN FLOW
L. HUANG (Cambridge, University, England) Journal of Sound and Vibration (ISSN 0022-460X), vol. 151, Nov. 22, 1991, p. 55-61. Research supported by University of Cambridge.
Copyright

The unsteady field induced in a duct by supersonically travelling waves, when analyzed from a 'wave-fixed' co-ordinate system, becomes the problem of supersonic flow over wavy walls. The mean drag on the confined flow due to the waves and its effect on the flow are of interest. It is shown that for a regularly profiled wavy wall the wave strength remains finite according to linear theory at all axial positions; but for the case of a randomly deformed wall the wave energy increases linearly with downstream distance. One can thus deduce that the mean flow would slow down and give up part of its kinetic energy to waves. Equivalently, it is predicted that random supersonic waves would induce strong acoustic streaming in the direction of wave travel. Author

A92-18769
INFLUENCES OF WIND TUNNEL PARAMETERS ON AIRFOIL CHARACTERISTICS AT HIGH SUBSONIC SPEEDS
H. SCHEITLE and S. WAGNER (Muenchen, Universitaet der Bundeswehr, Neubiberg, Federal Republic of Germany) Experiments in Fluids (ISSN 0723-4864), vol. 12, Dec. 1991, p. 90-96. refs
Copyright

The influences of several wind tunnel parameters on airfoil characteristics are experimentally investigated in a transonic wind tunnel. Quantified as Mach number errors, they show decisive effects and confirm that they have to be taken into consideration in a valuation of test results. Differences in data gained in measurements of several wind tunnels can be partly explained thereby. Author

A92-18770
BASE PRESSURE MEASUREMENTS ON A CONE AT MACH NUMBERS FROM M SUB INFINITY = 5 TO 7
M. TANNER (DLR, Institut fuer Theoretische Stroemungsmechanik, Goettingen, Federal Republic of Germany) Experiments in Fluids (ISSN 0723-4864), vol. 12, Dec. 1991, p. 113-118. refs
Copyright

Results of base pressure measurements performed on a blunt cone in the Ludwieg-Tube facility at the DLR in Goettingen at Mach numbers from M sub infinity = 4.49 to 6.83 are presented. The angle of incidence was varied between 0 and 15 deg. The results show that the base pressure coefficient increases with increasing Mach number, as is also known from other investigations. At these high Mach numbers the base pressure is practically independent of the angle of incidence up to 15 deg. This is in agreement with findings by Pick (1972), which show that the base pressure for M sub infinity is 5.30 and that 6.34 begins to increase with an angle of incidence greater than 20 deg. A comparison with results from earlier free-flight measurements show that the present base pressures agree relatively well with the older ones obtained at very great Reynolds numbers. P.D.

A92-18771
LARGE CHORD TURBINE CASCADE TESTING AT ENGINE MACH AND REYNOLDS NUMBER
D. J. MEE (Oxford, University, England) Experiments in Fluids (ISSN 0723-4864), vol. 12, Dec. 1991, p. 119-124. Research supported by Ministry of Defence Procurement Executive and Rolls-Royce, PLC. refs
Copyright

A technique is presented for producing a flow through a linear cascade of turbine blades of large chord which gives the pressure distribution around a blade the same as that obtained in an infinite cascade for Mach and Reynolds numbers typical of gas turbine operating conditions. Results of experiments with a cascade of three blades of large chord are compared with results from a cascade of nine blades of smaller chord to confirm the validity of the technique. Experiments are performed on the large-chord cascade to examine surface phenomena with high spatial resolution. Boundary layer scales are also increased and profiles on both suction and pressure surfaces of the blade are obtained. Author

A92-18900
ANALYSIS OF SPIRALING VORTICAL FLOWS AROUND SLENDER DELTA WINGS MOVING IN AN INVISCID MEDIUM
A. DAS (DLR, Institut fuer Entwurfsaerodynamik, Brunswick, Federal Republic of Germany) Zeitschrift fuer angewandte Mathematik und Mechanik (ISSN 0044-2267), vol. 71, no. 11, 1991, p. 465-471. refs
Copyright

Euler and Navier-Stokes equations are used to study the physics of vortical flows around delta wings with sharp leading and trailing edges, focusing on the interrelations between the pressure forces and the required radial acceleration for setting in the spiraling flow field. It is concluded that the radial accelerations needed to establish the spiraling flow have to be brought in by the resulting entropy gradients or loss of total pressure. Data obtained for the vortex core reveal the cause of vortex breakdown above the wing, which is mainly initiated by the adverse pressure gradient near the trailing edge, leading to two saddle points. One point causes flow reversal and opposing axisymmetric dipole fields and the other leads to high radial fluxes outwards. O.G.

A92-19068
HYPERSONIC FLOWS OVER SLENDER CIRCULAR CONES AT SMALL ANGLES OF ATTACK
HAMDI T. HEMDAN (King Saud University, Riyadh, Saudi Arabia) Acta Astronautica (ISSN 0094-5765), vol. 25, Dec. 1991, p. 747-756. refs
Copyright

This paper presents a perturbation theory for hypersonic flows past pointed-nose slender bodies of revolution at small angles of attack. The theory presents the counterpart of other theories on two-dimensional flow, axisymmetric flow, and flow past delta wings, in the case of bodies of revolution. Further restricting the analysis to Newtonian flow, a straightforward perturbation in the angle of attack is applied to the equations obtained and the resulting equations are solved only for circular cones. A striking feature of this approach is the absence of a vortical layer and a uniformallly valid solution at body surface and all over the flowfield. In spite of the yaw angle, conical streamlines at cone surface are predicted which bend around toward the leeward plane. Results obtained for the surface pressure and the shock wave of a circular cone compare very well with other approximate calculations and experiment. Author

A92-19110
THREE-DIMENSIONAL CALCULATION OF LOW-FREQUENCY UNSTEADY TRANSONIC FLOW IN AXIAL TURBINE STAGES [DREIDIMENSIONALE BERECHNUNG DER NIEDERFREQUENT INSTATIONAEREN, TRANSSONISCHEN STROEMUNG IN AXIALTURBINENSTUFEN]
JUERGEN F. MAYER, VEIT SCHABER, and HEINZ STETTER (Stuttgart, Universitaet, Federal Republic of Germany) Forschung im Ingenieurwesen (ISSN 0015-7899), vol. 57, Nov. 1991, p. 165-171. In German. Research supported by Bundesministerium fuer Wirtschaft. refs
Copyright

A finite volume method has been developed for the study of the unsteady processes resulting from the inhomogeneous flow fields in the runners of axial turbine stages. The method permits the three-dimensional frictionless calculation of low-frequency unsteady flows. The varying flow quantities around the perimeter are modeled as corotating rotor blade systems under time-dependent boundary conditions. The resulting cascade pressure distributions are used to determine the cyclic stress amplitudes resulting from the dynamic loads. C.D.

A92-19611
EFFECT OF SUCTION ON THE STABILITY OF SUPERSONIC BOUNDARY LAYERS. I - SECOND-MODE WAVES. II - FIRST-MODE WAVES
A. A. AL-MAAITAH (Mutah University, Al-Karak, Jordan), A. H. NAYFEH, and J. A. MASAD (Virginia Polytechnic Institute and State University, Blacksburg) ASME, Transactions, Journal of Fluids Engineering (ISSN 0098-2202), vol. 113, Dec. 1991, p. 591-601. refs
(Contract N00014-85-K-0011; NR PROJECT 432-5201)
Copyright

The present study investigates the effect of suction on the second (Mach) mode of instability in supersonic and hypersonic 2D boundary layers. The results show that suction has a stabilizing effect on these waves: it reduces the peak amplification and shifts it toward a higher frequency. In the presence of suction, the most amplified Mach mode remains 2D. The effectiveness of suction in stabilizing Mack waves decreases as the Mach number increases. The effect of suction on the first mode of instability of compressible 2D boundary layers is examined. Suction is found to be more effective in stabilizing the viscous instability, and hence it is more effective at low Mach numbers. Suction decreases the amplification rates at all frequencies and narrows down the band of unstable frequencies. For a given frequency, suction decreases the amplification rates at all streamwise locations. Variations of the growth rates of the most amplified first-mode waves with mass flux are found to be almost linear. P.D.

A92-20201* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
STATIC AEROELASTIC ANALYSIS FOR GENERIC CONFIGURATION WING
IN LEE (Korea Advanced Institute of Science and Technology, Daejon, Republic of Korea), HIROKAZU MIURA, and MLADEN K. CHARGIN (NASA, Ames Research Center, Moffett Field, CA) Journal of Aircraft (ISSN 0021-8669), vol. 28, Dec. 1991, p. 801, 802. Abridged. refs
Copyright

A static aeroelastic analysis capability that calculates flexible air loads for generic configuration wings was developed. It was made possible by integrating a finite element structural analysis code (MSC/NASTRAN) and a panel code of aerodynamic analysis based on linear potential flow theory. The framework already built in MSC/NASTRAN was used, and the aerodynamic influence coefficient matrix was computed externally and inserted in the NASTRAN by means of a DMAP program. It was shown that deformation and flexible air loads of an oblique wing configuration including asymmetric wings can be calculated reliably by this code both in subsonic and supersonic speeds. Author

A92-20205
FLOW SEPARATION PATTERNS OVER AN F-14A AIRCRAFT WING
TSZE C. TAI (U.S. Navy, David W. Taylor Naval Ship Research and Development Center, Bethesda, MD) Journal of Aircraft (ISSN 0021-8669), vol. 28, Dec. 1991, p. 818-827. Research supported by U.S. Navy. Previously cited in issue 07, p. 978, Accession no. A91-22497. refs

A92-20211* High Technology Corp., Hampton, VA.
NUMERICAL SOLUTION OF THE BOUNDARY-LAYER EQUATIONS FOR A GENERAL AVIATION FUSELAGE
YONG-SUN WIE (High Technology Corp., Hampton, VA) and JULIUS E. HARRIS (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 28, Dec. 1991, p. 861-868. Previously cited in issue 06, p. 756, Accession no. A90-19786. refs
(Contract NAS1-18240)
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A92-20212
INVISCID DRAG PREDICTION FOR TRANSONIC TRANSPORT WINGS USING A FULL-POTENTIAL METHOD
J. VAN DER VOOREN and A. J. VAN DER WEES (National Aerospace Laboratory, Amsterdam, Netherlands) Journal of Aircraft (ISSN 0021-8669), vol. 28, Dec. 1991, p. 869-875. Research supported by Netherlands Agency for Aerospace Programs. Previously cited in issue 06, p. 760, Accession no. A90-19926. refs
Copyright

A92-20214
EVALUATION OF EULER SOLVERS FOR TRANSONIC WING-FUSELAGE GEOMETRIES
SHREEKANT AGRAWAL, SON F. CREASMAN, and ROBERT B. LOWRIE (McDonnell Aircraft Co., Saint Louis, MO) Journal of Aircraft (ISSN 0021-8669), vol. 28, Dec. 1991, p. 885-891. Research supported by McDonnell Douglas Corp. Previously cited in issue 21, p. 3292, Accession no. A90-45935. refs
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A92-20218
INCOMPRESSIBLE STEADY AERODYNAMICS USING A STANDARD FINITE ELEMENT CODE
S. DE ROSA and G. PEZZULLO (Centro Italiano Ricerche Aerospaziali, Capua, Italy) Journal of Aircraft (ISSN 0021-8669), vol. 28, Dec. 1991, p. 911-913. refs
Copyright

Attention is given to a simple solution of the steady incompressible aerodynamic fields around a body, based on an extension of the conventional approach for scalar fields that uses the standard structural FEM code to lifting flowfields. This approach, which enlists standard preprocessing tools developed for structural problems in the solution of aerodynamic problems, is applicable to general 3D bodies and multicomponent airfoils in virtue of its realization of an unstructured mesh. O.C.

A92-20304
FLAT-ENDED CIRCULAR CYLINDER IN HYPERSONIC RAREFIED FLOW
J. K. HARVEY, M. C. CELENLIGIL, R. G. DOMINY, and M. R. GILMORE (Imperial College of Science, Technology, and Medicine, London, England) Journal of Thermophysics and Heat Transfer (ISSN 0887-8722), vol. 6, Jan.-Mar. 1992, p. 35-43. Research supported by Ministry of Defence Procurement Executive. Previously cited in issue 18, p. 2762, Accession no. A89-43225. refs
Copyright

A92-20306* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THREE-DIMENSIONAL THERMAL STRUCTURAL ANALYSIS OF A SWEPT COWL LEADING EDGE SUBJECTED TO SKEWED SHOCK-SHOCK INTERFERENCE HEATING

SANDRA P. POLESKY, PRAMOTE DECHAUMPHAI, CHRISTOPHER E. GLASS (NASA, Langley Research Center, Hampton, VA), and AJAY K. PANDEY (Lockheed Engineering and Sciences Co., Hampton, VA) Journal of Thermophysics and Heat Transfer (ISSN 0887-8722), vol. 6, Jan.-Mar. 1992, p. 48-54. Previously cited in issue 16, p. 2478, Accession no. A90-38412. refs
Copyright

A92-20378* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ENGINEERING CALCULATIONS OF THREE-DIMENSIONAL INVISCID HYPERSONIC FLOWFIELDS
CHRISTOPHER J. RILEY (NASA, Langley Research Center, Hampton, VA) and FRED R. DEJARNETTE (North Carolina State University, Raleigh) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 28, Nov.-Dec. 1991, p. 628-635. Previously cited in issue 06, p. 801, Accession no. A91-19421. refs
Copyright

A92-20379
WEDGE-INDUCED TURBULENT BOUNDARY-LAYER SEPARATION ON A ROUGHENED SURFACE AT MACH 6.0
P. J. DISIMILE (Cincinnati, University, OH) and N. E. SCAGGS (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 28, Nov.-Dec. 1991, p. 636-645. Research sponsored by USAF. Previously cited in issue 21, p. 3249, Accession no. A89-47630. refs
Copyright

A92-20488
NUMERICAL CALCULATION OF SUBSONIC AND SUPERSONIC AERODYNAMIC LOADS AROUND COMPLEX CONFIGURATION VEHICLE
HENGYUAN YAN and QUAN ZHENG (Northwestern Polytechnical University, Xian, People's Republic of China) Northwestern Polytechnical University, Journal (ISSN 1000-2758), vol. 9, Dec. 1991, p. 90-96. In Chinese. refs

A unified method for evaluating the forces of subsonic and supersonic steady and unsteady potential flows was developed using the Green function method. The unified method incorporates two special features. First, it makes it possible to avoid singularity of the leading edge by introducing the concept of joint flow field (which is a combination of positive and negative flow fields) is introduced enabling an accurate calculation of the induced drag. Secondly, large quantities of corner point geometric parameters are supplied as computer input. The computer displays based on computer drawings, show the vehicle configuration in different directions and can thus reveal errors hidden in the input of the parameters. Numerical results show that the method can be applied to calculations of aerodynamic loads of a vehicle. I.S.

A92-20649
MODEL OSCILLATIONS AT HIGH ANGLE OF ATTACK IN A LOW SPEED WIND TUNNEL TEST
TSAIR G. HUANG, JERRY M. CHEN (National Chunghsing University, Taichung, Republic of China), and QUEN Y. SHEEN (Chung-Shan Institute of Science and Technology, Taichung, Republic of China) IAF, International Astronautical Congress, 42nd, Montreal, Canada, Oct. 5-11, 1991. 6 p. refs
(IAF PAPER ST-91-001) Copyright

At high angle of attack, asymmetric vortices may occur near the forebody that lead to the generation of significant side forces and moment. As the angle of attack further increases, these asymmetric vortices may become unsteady and induce lateral and longitudinal model oscillations in a widn tunnel test. The model oscillations will cause poor data repeatability. Results of an experiment conducted in a 7 x 10-foot closed circuit, low speed wind tunnel show that oscillatory amplitude increases with increasing angle of attack. It is also found that the maximum oscillatory amplitude occurs in the case of zero sideslip. The model configuration and Mach number may influence the amplitude as well. However, in general, they have little effect on the oscillatory characteristics. Author

A92-20726* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
MEASUREMENTS OF THE FLOW AROUND A LIFTING-WING/BODY JUNCTION
D. H. WOOD and R. V. WESTPHAL (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 30, Jan. 1992, p. 6-12. refs
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Detailed measurements of all three mean velocity components and five of the six Reynolds stresses have been made around a model of a lifting-wing/body junction. The body was the flat working section floor of a small blower wind tunnel. Measurements of the surface pressure distribution on the NACA 0012 wing showed that the lift coefficient at the body surface was reduced by only 16 percent from the freestream value. It is shown that the near constancy of the bound vorticity requires the formation of aixal vorticity within the body boundary layer. This vorticity was concentrated in the two legs of the necklace vortex formed near the leading edge of the wing. The magnitude of the vorticity was always greater in the leg that developed on the suction surface. By four chord lengths downstream of the trailing edge, the turbulence structure of the suction leg was qualitatively similar to that of a single vortex imbedded in a turbulent boundary layer. Author

A92-20727
EXPLICIT NAVIER-STOKES COMPUTATION OF CASCADE FLOWS USING THE K-EPSILON TURBULENCE MODEL
ROBERT F. KUNZ (GM Technical Center, Warren, MI) and BUDUGUR LAKSHMINARAYANA (Pennsylvania State University, University Park) AIAA Journal (ISSN 0001-1452), vol. 30, Jan. 1992, p. 13-22. refs
(Contract DAAL03-86-G-0044)
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A fully explicit two-dimensional flow solver, based on a four-stage Runge-Kutta scheme, has been developed and used to predict two-dimensional viscous flow through turbomachinery cascades for which experimental data are available. The formulation is applied to the density-weighted time-averaged Navier-Stokes equations. Several features of the technique improve the ability of the code to predict high Reynolds number flows on highly stretched grids. These include a low Reynolds number compressible form of the k-epsilon turbulence model, anisotropic scaling of artificial dissipation terms, and locally varying timestep evaluation based on hyperbolic and parabolic stability considerations. Comparisons between computation and experiment are presented for both a supersonic and a low-subsonic compressor cascade. These results indicate that the code is capable of predicting steady two-dimensional viscous cascade flows over a wide range of Mach numbers in reasonable computation times. Author

A92-20733
GENUINELY UPWIND ALGORITHMS FOR THE MULTIDIMENSIONAL EULER EQUATIONS
C. LACOR and CH. HIRSCH (Brussels, Free University, Belgium) AIAA Journal (ISSN 0001-1452), vol. 30, Jan. 1992, p. 56-63. Previously cited in issue 18, p. 2752, Accession no. A89-41842. refs
Copyright

A92-20735* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
UPWIND SCHEME FOR SOLVING THE EULER EQUATIONS ON UNSTRUCTURED TETRAHEDRAL MESHES
NEAL T. FRINK (NASA Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 30, Jan. 1992, p. 70-77. refs
Copyright-

An upwind scheme is presented for solving the

three-dimensional Euler equations on unstructured tetrahedral meshes. Spatial discretization is accomplished by a cell-centered finite-volume formulation using flux-difference splitting. Higher-order differences are formed by a multidimensional linear reconstruction process. The solution gradients required for the higher-order differenes are computed by a novel approach that yields highly resolved solutions in regions of smooth flow while avoiding oscillations across shocks without explicitly applying a limiter. Solutions are advanced in time by a three-stage Runge-Kutta time-stepping scheme with convergence accelerated to steady state by local time stepping and implicit residual smoothing. Transonic solutions are presented for two meshes around the ONERA M6 wing and demonstrate substantial accuracy and insensitivity to mesh size. Author

A92-20736
NEWTON'S METHOD SOLVER FOR HIGH-SPEED VISCOUS SEPARATED FLOWFIELDS
PAUL D. ORKWIS and D. S. MCRAE (North Carolina State University, Raleigh) AIAA Journal (ISSN 0001-1452), vol. 30, Jan. 1992, p. 78-85. refs
(Contract DAAL03-86-G-0039)
Copyright

A new method for calculating the 2D, laminar Navier-Stokes equations is presented. The method uses Newton's method for nonlinear systems of equations to find steady-state solutions. The Navier-Stokes equations are approximated by finite differences using Roe's flux difference splitting. Second-order accuracy is attained by using Spekreijse's interpolation with Van Albada's limiter. The exact Newton's method Jacobian matrix is inverted by using recent sparse matrix routines. The symbolic manipulation package MACSYMA is used to develop and write the FORTRAN code. Numerical results are presented for flat plate and wedge type attached and separated viscous flow at high supersonic Mach numbers. Author

A92-20737
NONEQUILIBRIUM HYPERSONIC INVISCID STEADY FLOWS
M. VALORANI, M. ONOFRI, B. FAVINI, and F. SABETTA (Roma I, Universita, Rome, Italy) AIAA Journal (ISSN 0001-1452), vol. 30, Jan. 1992, p. 86-93. Previously cited in issue 09, p. 1285, Accession no. A89-25532.
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A92-20738* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
INSTABILITIES OF FLOWS OVER BODIES AT LARGE INCIDENCE
DAVID DEGANI (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 30, Jan. 1992, p. 94-100. Previously cited in issue 06, p. 760, Accession no. A90-19937. refs
Copyright

A92-20739
SONIC EDDY - A MODEL FOR COMPRESSIBLE TURBULENCE
ROBERT E. BREIDENTHAL (Washington, University, Seattle) AIAA Journal (ISSN 0001-1452), vol. 30, Jan. 1992, p. 101-104. Previously cited in issue 06, p. 759, Accession no. A90-19876. refs
(Contract AF-AFOSR-87-0366)
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A92-20742
ASYMMETRIC SEPARATED FLOWS AT SUPERSONIC SPEEDS
M. J. SICLARI (Grumman Corporate Research Center, Bethpage, NY) AIAA Journal (ISSN 0001-1452), vol. 30, Jan. 1992, p. 124-133. Previously cited in issue 08, p. 1103, Accession no. A90-22233. refs
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A92-20747* Toledo Univ., OH.
TIME DOMAIN FLUTTER ANALYSIS OF CASCADES USING A FULL-POTENTIAL SOLVER
MILIND A. BAKHLE, T. S. R. REDDY, and THEO G. KEITH, JR. (Toledo, University, OH) AIAA Journal (ISSN 0001-1452), vol. 30, Jan. 1992, p. 163-170. Previously cited in issue 11, p. 1606, Accession no. A90-29374. refs
(Contract NSG-3139)
Copyright

A92-20760
FORMATION OF SHOCKS WITHIN AXISYMMETRIC NOZZLES
E. LOTH, J. BAUM, and R. LOHNER (U.S. Navy, Naval Research Laboratory, Washington, DC) AIAA Journal (ISSN 0001-1452), vol. 30, Jan. 1992, p. 268-270. Previously cited in issue 16, p. 2486, Accession no. A90-38782. refs

A92-20761
TURBULENT BOUNDARY-LAYER CHARACTERISTICS OVER A FLAT-PLATE/WEDGE CONFIGURATION AT MACH 6
P. J. DISIMILE (Cincinnati, University, OH) and N. E. SCAGGS (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) AIAA Journal (ISSN 0001-1452), vol. 30, Jan. 1992, p. 270-272. Previously cited in issue 21, p. 3286, Accession no. A90-45870. refs

A92-20762* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SURFACE FLOW PATTERNS ON AN OGIVE-CYLINDER AT INCIDENCE
DAVID DEGANI, MURRAY TOBAK, and G. G. ZILLIAC (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 30, Jan. 1992, p. 272-274. refs
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A set of photographs has been obtained which documents the oil-imaged surface flow patterns of an ogive-cylinder at angles-of-attack between 30 and 85 deg, and Reynolds number of 26,000. Attention is given to the possibility that the bistable nature of the flow within the 50-65 deg angle-of-attack range is linked to the coincident appearance of foci in the surface flow patterns, in view of the suggestion that these foci act as the anchor points allowing the forebody vortical structures to roll up and form the forebody's trailing vortex system. O.C.

N92-13951*# Deutsche Airbus G.m.b.H., Bremen (Germany, F.R.). Dept. of Aerodynamics.
APPLICATION OF DIRECT INVERSE ANALOGY METHOD (DIVA) AND VISCOUS DESIGN OPTIMIZATION TECHNIQUES
E. GREFF, D. FORBRICH, and H. SCHWARTEN *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 307-324 1991
Avail: NTIS HC/MF A99 CSCL 01A

A direct-inverse approach to the transonic design problem was presented in its initial state at the First International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-1). Further applications of the direct inverse analogy (DIVA) method to the design of airfoils and incremental wing improvements and experimental verification are reported. First results of a new viscous design code also from the residual correction type with semi-inverse boundary layer coupling are compared with DIVA which may enhance the accuracy of trailing edge design for highly loaded airfoils. Finally, the capabilities of an optimization routine coupled with the two viscous full potential solvers are investigated in comparison to the inverse method. Author

N92-13953*# Shanghai Inst. of Mechanical Engineering (China). Lab. of Turbomachinery Aerodynamics.
VARIATIONAL FORMULATION OF HYBRID PROBLEMS FOR FULLY 3-D TRANSONIC FLOW WITH SHOCKS IN ROTOR
GAO-LIAN LIU *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 337-346 1991 Sponsored in part by the National Natural Science Foundation, Peoples

Republic of China
Avail: NTIS HC/MF A99 CSCL 01A

Based on previous research, the unified variable domain variational theory of hybrid problems for rotor flow is extended to fully 3-D transonic rotor flow with shocks, unifying and generalizing the direct and inverse problems. Three variational principles (VP) families were established. All unknown boundaries and flow discontinuities (such as shocks, free trailing vortex sheets) are successfully handled via functional variations with variable domain, converting almost all boundary and interface conditions, including the Rankine Hugoniot shock relations, into natural ones. This theory provides a series of novel ways for blade design or modification and a rigorous theoretical basis for finite element applications and also constitutes an important part of the optimal design theory of rotor bladings. Numerical solutions to subsonic flow by finite elements with self-adapting nodes given in Refs., show good agreement with experimental results. Author

N92-13960*# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.
AIRFOIL OPTIMIZATION WITH EFFICIENT GRADIENT CALCULATIONS
THOMAS SORENSEN *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 433-444 1991 Sponsored in part by MIT and NSF
Avail: NTIS HC/MF A99 CSCL 20N

The viscous airfoil design analysis code XFOIL was extended to allow optimization using conformal mapping coefficients as design variables. The optimization technique used was the Steepest Descent method applied to a Penalty Function. The gradients of the aerodynamic variables with respect to the design variables were cheaply calculated as by-products of XFOIL's integral boundary layer Newton solver. The speed of the optimization process further increased by updating the Newton system boundary layer variables after each optimization step using the available gradient information. Two examples are presented. Author

N92-13961*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace and Ocean Engineering.
DESIGN OPTIMIZATION OF TRANSONIC AIRFOILS
C.-Y. JOH, B. GROSSMAN, and R. T. HAFTKA *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 445-456 1991
(Contract NSF DMC-86-15336)
Avail: NTIS HC/MF A99 CSCL 01A

Numerical optimization procedures were considered for the design of airfoils in transonic flow based on the transonic small disturbance (TSD) and Euler equations. A sequential approximation optimization technique was implemented with an accurate approximation of the wave drag based on the Nixon's coordinate straining approach. A modification of the Euler surface boundary conditions was implemented in order to efficiently compute design sensitivities without remeshing the grid. Two effective design procedures producing converged designs in approximately 10 global iterations were developed: interchanging the role of the objective function and constraint and the direct lift maximization with move limits which were fixed absolute values of the design variables. Author

N92-13969*# Beijing Univ. (China). Inst. of Fluid Mechanics.
AN INVERSE METHOD WITH REGULARITY CONDITION FOR TRANSONIC AIRFOIL DESIGN
ZIQIANG ZHU, ZHIXUN XIA, and LIYI WU *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 541-552 1991
Avail: NTIS HC/MF A99 CSCL 01A

It is known from Lighthill's exact solution of the incompressible inverse problem that in the inverse design problem, the surface pressure distribution and the free stream speed cannot both be prescribed independently. This implies the existence of a constraint on the prescribed pressure distribution. The same constraint exists at compressible speeds. Presented here is an inverse design method for transonic airfoils. In this method, the target pressure distribution contains a free parameter that is adjusted during the computation to satisfy the regularity condition. Some design results are presented in order to demonstrate the capabilities of the method. Author

N92-13970*# Xian Jiaotong Univ. (China).
STUDY OF A NEW AIRFOIL USED IN REVERSIBLE AXIAL FANS
CHAOJUN LI, BAOSUO WEI, and CHUANGANG GU *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 553-562 1991
Avail: NTIS HC/MF A99 CSCL 01A

The characteristics of the reverse ventilation of axial flow are analyzed. An s shaped airfoil with a double circular arc was tested in a wind tunnel. The experimental results showed that the characteristics of this new airfoil in reverse ventilation are the same as those in normal ventilation, and that this airfoil is better than the existing airfoils used on reversible axial fans. Author

N92-13974*# Tsinghua Univ., Bejing (China).
THE RESEARCH PROGRESS ON HODOGRAPH METHOD OF AERODYNAMIC DESIGN AT TSINGHUA UNIVERSITY
ZUOYI CHEN and JINGRONG GUO *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 599-606 1991
Avail: NTIS HC/MF A99 CSCL 01A

Progress in the use of the Hodograph method of aerodynamic design is discussed. It was found that there are some restricted conditions in the application of Hodograph design to transonic turbine and compressor cascades. The Hodograph method is suitable not only to the transonic turbine cascade but also to the transonic compressor cascade. The three dimensional Hodograph method will be developed after obtaining the basic equation for the three dimensional Hodograph method. As an example of the Hodograph method, the use of the method to design a transonic turbine and compressor cascade is discussed. Author

N92-13979# Toronto Univ., Downsview (Ontario). Inst. for Aerospace Studies.
COMPUTATIONAL FLUID DYNAMICS
D. W. ZINGG, J. J. GOTTLIEB, G. W. JOHNSTON, P. A. SULLIVAN, D. BERGERON, C. P. T. GROTH, D. F. HAWKEN, H. MURTY, T. NELSON, C. WALSH et al. *In its* Activities of the University of Toronto Institute for Aerospace Studies p 68-70 1989
Avail: NTIS HC/MF A06

A review is presented of University of Toronto Institute of Aerospace Studies theoretical research on computational techniques for the analysis of fluid dynamics problems. In a study of the limits of applicability of boundary-layer equations for transonic airfoil computations, a generalized form of these equations is solved on a fine grid near the airfoil. The solution is embedded into a coarse-grid Navier-Stokes solution, resulting in a very efficient computational method. A new procedure which avoids the need for iteration has been developed for interpolation on a structured, curvilinear, 2-dimensional grid. Euler computations of airfoil flows using the ARC2D code have been compared with analytical solutions. A technique has been developed using Richardson extrapolation which improves the accuracy of numerical solutions to the Euler equations. A new exact Riemann solver has been invented for use in the random-choice method (RCM) for solving hyperbolic conservation laws in 1 space dimension. Studies are also being conducted on the actual convergence rate of the RCM. Two adaptive numerical methods of solving partial differential equations have been studied in depth. An axisymmetric model of tube collapse has been developed, coupled to a 1-dimensional fluid flow model, and applied to the study of tracheal collapse. CISTI

N92-13994 Duke Univ., Durham, NC.
ANALYTICAL/NUMERICAL MATCHING AND PERIODIC INVERSION: TWO ADVANCES IN FREE WAKE ANALYSIS Ph.D. Thesis
WAYNE OWEN MILLER 1990 211 p
Avail: Univ. Microfilms Order No. DA9122430

Free wake methods are used for the analysis of potential fluid dynamics with embedded vorticity. The vorticity convects with the fluid and induces a velocity field defined by the Biot-Savart law. Free wake methods define vortex dynamics and the induced velocity field by discretizing the vorticity into elements and following their convection. The application of interest to this research was rotorcraft wakes. The scope of the research was wakes that can be modeled by vortex filaments with finite cores, which are used alone to model vortex tubes, or in groups to model vortex sheets. Vortex filaments are discretized into elements which are simple curves that are fit to the filament. This research used the vortex particle, which is the lowest order and most efficient element, but it is only accurate at a distance from the filament. The accuracies of higher order elements were also compared. Analytical/Numerical Matching is a free wake method which improves computational efficiency without compromising accuracy. A wake of N vortex elements requires O (N exp 2) element evaluations, but only O (N) elements are in the near field of a filament. The ANM method uses vortex particles to efficiently generate a solution which is accurate in the far field. The near field is resolved by superimposing an analytical correction. The method is four times faster than previous methods, and an order of magnitude gain is possible. The method was linearized to improve efficiency and open new analysis options. Periodic Inversion is a solution method for rotor wakes in steady flight which enforces their ideal periodic behavior. Periodic Inversion is not a time marching method, and therefore avoids poor convergence behavior at low advance ratios. A unique set of periodic variables was developed for the method, and the resulting problem is in the form of a linear system which is iteratively solved for corrections to a full period of wake. The method was used to study wakes in hover and at low speeds, where free wake solutions have not previously been obtained. The method should allow coupling with panel methods and blade dynamics, and allow for stability analysis of the wake. Dissert. Abstr.

N92-13995*# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
DEFINITION OF THE UNSTEADY VORTEX FLOW OVER A WING/BODY CONFIGURATION Final Technical Report, 21 May - 20 Nov. 1991
S. G. LIOU, B. DEBRY, J. LENAKOS, J. CAPLIN, and N. M. KOMERATH 20 Nov. 1991 131 p
(Contract NAG1-1278)
(NASA-CR-180083; NAS 1.26:180083; GITAER-91-6) Avail: NTIS HC/MF A07 CSCL 01/1

A problem of current interest in computational aerodynamics is the prediction of unsteady vortex flows over aircraft at high angles of attack. A six-month experimental effort was conducted at the John H. Harper Wind Tunnel to acquire qualitative and quantitative information on the unsteady vortex flow over a generic wing-body configuration at high angles of attack. A double-delta flat-plate wing with beveled edges was combined with a slender sharp-nosed body-of-revolution fuselage to form the generic configuration. This configuration produces a strong attached leading edge vortex on the wing, as well as sharply-peaked flow velocity spectra above the wing. While it thus produces flows with several well-defined features of current interest, the model was designed for efficiency of representation in computational codes. A moderate number of surface pressure ports and two unsteady pressure sensors were used to study the pressure distribution over the wing and body surface at high angles of attack; the unsteady pressure sensing did not succeed because of inadequate signal-to-noise ratio. A pulsed copper vapor laser sheet was used to visualize the vortex flow over the model, and vortex trajectories, burst locations, mutual induction of vortex systems from the forebody, strake, and wing, were quantified. Laser Doppler velocimetry was used to quantify all 3 components of the time-average velocity in 3 data planes perpendicular to the freestream direction. Statistics of the instantaneous velocity were used to study intermittency and fluctuation intensity. Hot-film anemometry was used to study the fluctuation energy content in the velocity field, and the spectra of these fluctuations. In addition, a successful attempt was made to measure velocity spectra, component by component, using laser velocimetry, and these were compared with spectra measured by hot-film anemometry at several locations. Author

N92-13996*# West Virginia Univ., Morgantown. Dept. of Mechanical and Aerospace Engineering.
THE EFFECTS OF WINGLETS ON LOW ASPECT RATIO WINGS AT SUPERSONIC MACH NUMBERS M.S. Thesis Report Feb. 1989 - Apr. 1991
JAMES A. KEENAN and JOHN M. KUHLMAN Washington NASA. Langley Research Center Nov. 1991 347 p
(Contract NAG1-951)
(NASA-CR-4407; NAS 1.26:4407) Avail: NTIS HC/MF A15 CSCL 01/1

A computational study was conducted on two wings, of aspect ratios 1.244 and 1.865, each having 65 degree leading edge sweep angles, to determine the effects of nonplanar winglets at supersonic Mach numbers. A Mach number of 1.62 was selected as the design value. The winglets studied were parametrically varied in alignment, length, sweep, camber, thickness, and dihedral angle to determine which geometry had the best predicted performance. For the computational analysis, an available Euler marching technique was used. The results indicated that the possibility existed for wing-winglet geometries to equal the performance of wing-alone bodies in supersonic flows with both bodies having the same semispan. The first wing with winglet used NACA 1402 airfoils for the base wing and was shown to have lift-to-pressure drag ratios within 0.136 percent to 0.360 percent of the NACA 1402 wing-alone. The other base wing was a natural flow wing which was previously designed specifically for a Mach number of 1.62. The results obtained showed that the natural wing-alone had a slightly higher lift-to-pressure drag than the natural wing with winglets. Author

N92-13997*# Titan Systems, Inc., Princeton, NJ. A.R.A.P. Group.
A UNIFIED VISCOUS THEORY OF LIFT AND DRAG OF 2-D THIN AIRFOILS AND 3-D THIN WINGS
JOHN E. YATES Washington NASA. Langley Dec. 1991 96 p
(Contract NASA ORDER L-74809-C)
(NASA-CR-4414; NAS 1.26:4414) Avail: NTIS HC/MF A05 CSCL 01/1

A unified viscous theory of 2-D thin airfoils and 3-D thin wings is developed with numerical examples. The viscous theory of the load distribution is unique and tends to the classical inviscid result with Kutta condition in the high Reynolds number limit. A new theory of 2-D section induced drag is introduced with specific applications to three cases of interest: (1) constant angle of attack; (2) parabolic camber; and (3) a flapped airfoil. The first case is also extended to a profiled leading edge foil. The well-known drag due to absence of leading edge suction is derived from the viscous theory. It is independent of Reynolds number for zero thickness and varies inversely with the square root of the Reynolds number based on the leading edge radius for profiled sections. The role of turbulence in the section induced drag problem is discussed. A theory of minimum section induced drag is derived and applied. For low Reynolds number the minimum drag load tends to the constant angle of attack solution and for high Reynolds number to an approximation of the parabolic camber solution. The parabolic camber section induced drag is about 4 percent greater than the ideal minimum at high Reynolds number. Two new concepts, the viscous induced drag angle and the viscous induced separation potential are introduced. The separation potential is calculated for three 2-D cases and for a 3-D rectangular wing. The potential is calculated with input from a standard doublet lattice wing code without recourse to any boundary layer calculations. Separation is

indicated in regions where it is observed experimentally. The classical induced drag is recovered in the 3-D high Reynolds number limit with an additional contribution that is Reynold number dependent. The 3-D viscous theory of minimum induced drag yields an equation for the optimal spanwise and chordwise load distribution. The design of optimal wing tip planforms and camber distributions is possible with the viscous 3-D wing theory. Author

N92-13998*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A STUDY ON VORTEX FLOW CONTROL ON INLET DISTORTION IN THE RE-ENGINED 727-100 CENTER INLET DUCT USING COMPUTATIONAL FLUID DYNAMICS
BERNHARD H. ANDERSON, PAO S. HUANG, WILLIAM A. PASCHAL, and ENRICO CAVATORTA (Dee-Howard Co., San Antonio, TX.) 1992 13 p Presented at the 30th Aerospace Sciences Meeting and Exhibit, Reno, NV, 6-9 Jan. 1992; sponsored by AIAA
(NASA-TM-105321; E-6679; NAS 1.15:105321; AIAA-92-0152)
Avail: NTIS HC/MF A03 CSCL 01/1

Computational fluid dynamics was used to investigate the management of inlet distortion by the introduction of discrete vorticity sources at selected locations in the inlet for the purpose of controlling secondary flow. These sources of vorticity were introduced by means of vortex generators. A series of design observations were made concerning the importance of various vortex generator design parameters in minimizing engine face circumferential distortion. The study showed that vortex strength, generator scale, and secondary flow field structure have a complicated and interrelated influence on the engine face distortion, over and above the initial geometry and arrangement of the generators. The installed vortex generator performance was found to be a function of three categories of variables: the inflow conditions, the aerodynamic characteristics associated with the inlet duct, and the design parameters related to the geometry, arrangement, and placement of the vortex generators within the outlet duct itself. Author

N92-13999*# Pennsylvania State Univ., University Park. Dept. of Aerospace Engineering.
ANALYSIS AND DESIGN OF PLANAR AND NON-PLANAR WINGS FOR INDUCED DRAG MINIMIZATION Annual Progress Report
K. MORTARA, DENNIS M. STRAUSSFOGEL, and MARK D. MAUGHMER Dec. 1991 56 p
(Contract NAG1-1198)
(NASA-CR-189509; NAS 1.26:189509) Avail: NTIS HC/MF A04 CSCL 01/1

The goal of the work was to develop and validate computational tools to be used for the design of planar and non-planar wing geometries for minimum induced drag. Because of the iterative nature of the design problem, it is important that, in addition to being sufficiently accurate for the problem at hand, they are reasonably fast and computationally efficient. Toward this end, a method of predicting induced drag in the presence of a non-rigid wake is coupled with a panel method. The induced drag prediction technique is based on the Kutta-Joukowski law applied at the trailing edge. Until recently, the use of this method has not been fully explored and pressure integration and Trefftz-plane calculations favored. As is shown in this report, however, the Kutta-Joukowski method is able to give better results for a given amount of effort than the more common techniques, particularly when relaxed wakes and non-planar wing geometries are considered. Using these tools, a workable design method is in place which takes into account relaxed wakes and non-planar wing geometries. It is recommended that this method be used to design a wind-tunnel experiment to verify the predicted aerodynamic benefits of non-planar wing geometries. Author

N92-14001*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
LEWICE/E: AN EULER BASED ICE ACCRETION CODE
MARK G. POTAPCZUK 1992 25 p Presented at the 30th Aerospace Sciences Meeting and Exhibit, Reno, NV, 6-9 Jan. 1992; sponsored by AIAA
(NASA-TM-105389; E-6778; NAS 1.15:105389; AIAA-92-0037)
Avail: NTIS HC/MF A03 CSCL 01/1

A new version of the LEWICE ice accretion computer code was developed which calculates the ice growth on two dimensional surfaces, incorporating the effects of compressibility through the solution of the Euler equations. The code is modular and contains separate stand-alone program elements that create a grid, calculate the flow field parameters, calculate the droplet trajectory paths, determine the amount of ice growth, and plot results. This code increases the applicability of ice accretion predictions by allowing calculations at higher Mach numbers. The new elements of the code are described. Calculated results are compared to experiment for several cases, including a LEWICE example case and a thin airfoil section at a Mach number of 0.58. Author

N92-14002*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ANALYSIS OF AN ADVANCED DUCTED PROPELLER SUBSONIC INLET
CHANTHY IEK, DONALD R. BOLDMAN, and MOUNIR IBRAHIM (Cleveland State Univ., OH.) 1992 18 p Proposed for presentation at the 30th Aerospace Sciences Meeting and Exhibit, Reno, NV, 6-9 Jan. 1992; sponsored by AIAA
(NASA-TM-105393; E-6784; NAS 1.15:105393; AIAA-92-0274)
Avail: NTIS HC/MF A03 CSCL 01/1

A time marching Navier-Stokes code called PARC (PARC2D for 2-D/axisymmetric and PARC3D for 3-D flow simulations) was validated for an advanced ducted propeller (ADP) subsonic inlet. The code validation for an advanced ducted propeller (ADP) subsonic inlet. The code validation was implemented for a non-separated flow condition associated with the inlet operating at angles-of-attack of 0 and 25 degrees. The inlet test data were obtained in the 9 x 15 ft Low Speed Wind Tunnel at NASA Lewis Research Center as part of a cooperative study with Pratt and Whitney. The experimental study focused on the ADP inlet performance for take-off and approach conditions. The inlet was tested at a free stream Mach number of 0.2, at angles-of-attack between O and 35 degrees, and at a maximum propeller speed of 12,000 RPM which induced a corrected air flow rate of about 46 lb/sec based on standard day conditions. The computational grid and flow boundary conditions (BC) were based on the actual inlet geometry and the funnel flow conditions. At the propeller face, two types of BC's were applied: a mass flow BC and a fixed flow properties BC. The fixed flow properties BC was based on a combination of data obtained from the experiment and calculations using a potential flow code. Comparison of the computational results with the test data indicates that the PARC code with the propeller face fixed flow properties BC provided a better prediction of the inlet surface static pressures than the predictions when the mass flow BC was used. For an angle-of-attack of 0 degrees, the PARC2D code with the propeller face mass flow BC provided a good prediction of inlet static pressures except in the region of high pressure gradient. With the propeller face fixed flow properties BC, the PARC2D code provided a good prediction of the inlet static pressures. For an angle-of-attack of 25 degrees with the mass flow BC, the PARC3D code predicted statis pressures which deviated significantly from the test data; however, with the fixed flow properties BC, a good comparison with the test data was obtained. Author

N92-14968*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
WIND TUNNEL INVESTIGATION OF VORTEX FLOWS ON F/A-18 CONFIGURATION AT SUBSONIC THROUGH TRANSONIC SPEED
GARY E. ERICKSON Washington Dec. 1991 166 p
(NASA-TP-3111; L-16799; NAS 1.60:3111) Avail: NTIS HC/MF A08 CSCL 01/1

A wind tunnel experiment was conducted in the David Taylor Research Center 7- by 10-Foot Transonic Tunnel of the wing leading-edge extension (LEX) and forebody vortex flows at subsonic

and transonic speeds about a 0.06-scale model of the F/A-18. The primary goal was to improve the understanding and control of the vortical flows, including the phenomena of vortex breakdown and vortex interactions with the vertical tails. Laser vapor screen flow visualizations, LEX, and forebody surface static pressures, and six-component forces and moments were obtained at angles of attack of 10 to 50 degrees, free-stream Mach numbers of 0.20 to 0.90, and Reynolds numbers based on the wing mean aerodynamic chord of 0.96 x 10(exp 6) to 1.75 x 10(exp 6). The wind tunnel results were correlated with in-flight flow visualizations and handling qualities trends obtained by NASA using an F-18 High-Alpha Research Vehicle (HARV) and by the Navy and McDonnell Douglas on F-18 aircraft with LEX fences added to improve the vertical tail buffet environment. Key issues that were addressed include the sensitivity of the vortical flows to the Reynolds number and Mach number; the reduced vertical tail excitation, and the corresponding flow mechanism, in the presence of the LEX fence; the repeatability of data obtained during high angle-of-attack wind tunnel testing of F-18 models; the effects of particle seeding for flow visualization on the quantitative model measurements; and the interpretation of off-body flow visualizations obtained using different illumination and particle seeding techniques. Author

N92-14969*# Arizona State Univ., Tempe. Dept. of Mechanical and Aerospace Engineering.
NUMERICAL SIMULATION OF SWEPT-WING FLOWS Progress Report
HELEN L. REED Dec. 1991 55 p
(Contract NAG1-1158)
(NASA-CR-189457; NAS 1.26:189457) Avail: NTIS HC/MF A04 CSCL 01/1

Efforts of the last six months to computationally model the transition process characteristics of flow over swept wings are described. Specifically, the crossflow instability and crossflow/Tollmien-Schlichting wave interactions are analyzed through the numerical solution of the full 3D Navier-Stokes equations including unsteadiness, curvature, and sweep. This approach is chosen because of the complexity of the problem and because it appears that linear stability theory is insufficient to explain the discrepancies between different experiments and between theory and experiment. The leading edge region of a swept wing is considered in a 3D spatial simulation with random disturbances as the initial conditions.

N92-14972# Ballistic Research Labs., Aberdeen Proving Ground, MD.
TRANSONIC NAVIER-STOKES COMPUTATIONS FOR A SPINNING BODY OF REVOLUTION Final Report, Jul. 1989 - Jul. 1991
JUBARAJ SAHU Sep. 1991 43 p
(Contract DA PROJ. 1L1-61102-AH-43)
(AD-A241015; BRL-TR-3265) Avail: NTIS HC/MF A03 CSCL 20/9

A zonal, implicit, time-marching Navier-Stokes computational technique has been used to compute three dimensional transonic flow fields over a projectile. Flow field computations have been performed at M = 0.94 for spin rates of 0 and 4900 rpm and at angles of attack, alpha = 0,4, and 10 degrees. All the computations have been performed on the Cray-2 supercomputer. Details of the flow field such as Mach number contours and surface pressure distributions are presented. Computer surface pressures are compared with available experimental data for the same conditions and the same configuration. Computer results show the large circumferential pressure distribution over the boattail region as well as the nonlinear effect of the angle of attack. Aerodynamic force and moment coefficients (normal force, pitching moment, Magnus force, and Magnus moment) have been obtained from the computed pressures and are compared with the data. The computed results are generally in good agreement with the data at a low angle of attack for both nonspinning and spinning conditions. At a high angle of attack, the agreement is good for the nonspinning case and is less satisfactory for the spinning case. GRA

N92-14973# European Space Agency, Paris (France).
AEROTHERMODYNAMICS FOR SPACE VEHICLES
B. BATTRICK, ed. Jul. 1991 570 p In ENGLISH and FRENCH The 1st European Symposium was held in Noordwijk, Netherlands, 28-30 May 1991; sponsored by ESTEC, AAAF/CNES and DGLR/DARA/DLR
(ESA-SP-318; ISBN-92-9092-114-5; ETN-92-90680) Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

Papers concerning the development of aerothermodynamics for space vehicles, covering problems of high speed flight for advanced launchers, reentry vehicles and planetary landers are presented. The focus of the symposium was the new technology of 'aerothermodynamics', which includes classical aerodynamics, thermodynamics, and thermochemistry. The applications presented and discussed covered external flow over vehicles and internal flow through vehicle propulsion systems, at speeds ranging from the low subsonic, through transonic, to supersonic and hypersonic. The flight trajectories addressed included ascent to space from planetary surfaces, descent from space to planetary surfaces, flight through low density atmospheres, and aerobraking by atmospheric entry. ESA

N92-14974# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands). Propulsion and Aerothermodynamics Div.
AEROTHERMODYNAMIC CHALLENGES FOR ESA PROGRAMMES
W. BERRY *In its* Aerothermodynamics for Space Vehicles p 3-10 Jul. 1991
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

A history of aerothermodynamic activities in the European Space Resrach Organization/European Space Agency (ENRO/ESA) is given. Between 1964 and 1988 these were devoted to satellite aerodynamics for low Earth orbit missions and rocket engine exhaust plume dynamics. The creation of an aerodynamic capability at the European Space Research and Technology Center (ESTEC) is mentioned, and the programs involving substantial aerothermodynamics are listed. The aerothermodynamic challenges for future ESA mission in its science, Earth observation, and space transportation programs, are addressed, and design solutions offerred. Within the science programs the Cassini/Huygens, Rosetta, and Mars missions are considered. Within the Earth observation programs the Aristoteles mission is considered. Within the space transportation programs, Ariane-5, Hermes, and reusable winged launchers are considered. Design tools and engineering facilities needed for modern aerothermodyanmics are discussed; ESA's research and development activities in aerothermodynamics are addressed. One of these activities is to prepare and implement a Technology Research Program (TRP) designed to prepare the technology needed for Europe's space program. Activities in progress or planned within the TRP are addressed. They include development of Navier-Stokes algorithms, work in aerothermochemistry effects in hypersonic flows, work on parallel processing for aerothermodynamics, transition criteria in hypersonic flows, and work on measurement techniques in hypersonic flows. ESA

N92-14981# Aeronautical Research Inst. of Sweden, Bromma.
HYPERSONIC FLOW PAST DELTA WING FLOW SIMULATED BY NAVIER-STOKES SOLUTIONS
S. SRINIVASAN, P. ELIASSON, and A. RIZZI *In* ESA, Aerothermodyanmics for Space Vehicles p 73-78 Jul. 1991
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

Numerical simulations for the laminar hypersonic flow past a blunt edged delta wing were performed by solving the Navier-Stokes equations. These simulations were performed for four different

angles of attack: 0, 15, 25, and 30 degrees. The Navier-Stokes equations were solved using the explicit finite volume-four stage Runge-Kutta scheme. The intent is to reach a reasonable understanding of the computed flow fields, including flow separation, shear layers, vortices, shock waves, and entropy losses, and also to study the effect of the angle of attack on the flow features. It was observed that in the case of blunt edged delta wings at high angles of attack, the hypersonic flow is dominated by a shear layer that separates just past the blunt leading edge forming a more distributed vortical region over the wing, rather than a concentrated vortex structure as observed at lower speeds. The solutions are analyzed and compared with available experimental data. The computed results agree qualitatively with the experimental data but not quantitatively. ESA

N92-14985# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany, F.R.). Inst. for Experimental Fluid Mechanics.

SIMULATION REQUIREMENTS FOR RCS PLUME: FLOWFIELD INTERACTION MODELLING ON A WINGED REENTRY VEHICLE

T. POERTNER *In* ESA, Aerothermodynamics for Space Vehicles p 101-106 Jul. 1991 Sponsored by CNES

During the initial phase of reentry, the control over a winged vehicle is to be achieved by the Reaction Control System (RCS). For reasons of safety and performance, the reliable prediction of the actual efficiency of a planned RCS configuration is necessary. For the realistic configuration, the interference flowfield is so complex that extrapolations from either existing realistic or too greatly simplified configurations will not yield reliable quantitative prediction of RCS efficiency. As the problem is not accessible to theoretical analysis, efforts should be focused on experimental investigations using realistic models of the intended configurations. For this purpose, simulation requirements are derived based on Shuttle related NASA experience. ESA

N92-14986# Ecole Polytechnique Federale de Lausanne (Switzerland). Inst. of Hydraulic Machines and Fluid Mechanics.

A MULTIBLOCK FLOW SOLVER FOR INVISCID HYPERSONIC FLOWS

JAN B. VOS and C. M. BERGMAN (Royal Inst. of Tech., Stockholm, Sweden) *In* ESA, Aerothermodynamics for Space Vehicles p 109-114 Jul. 1991 Sponsored in part by Commission Suisse d'Encouragement des Recherches Scientifiques

The development of multiblock flow solvers on structured grids is considered. The present version of the solver solves the three dimensional Euler equations for transonic, supersonic, and hypersonic flows. The Euler equations are solved by the finite volume method using a space centered, explicit time marching scheme augmented by artificial dissipation terms. Equilibrium and nonequilibrium air chemistry were implemented. The multiblock solver is written on top of the MEL-COM data base system, and uses a dynamic memory manager to allocate the storage for the variables in each block. Results of multiblock calculations for the flow over a wedge and of single block calculations for the flow around the Hermes Manned Spaceplane at 76 km altitude are presented. ESA

N92-14987# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Inst. for Design Aerodynamics.

STEPS TOWARDS AN EFFICIENT AND ACCURATE METHOD SOLVING THE EULER EQUATIONS AROUND A RE-ENTRY CONFIGURATION AT SUPER- AND HYPERSONIC SPEED

J. SCHOENE, T. STREIT, and N. KROLL *In* ESA, Aerothermodynamics for Space Vehicles p 115-120 Jul. 1991 Sponsored in part by CNES

Modifications and extensions of a Euler code which enable efficient computations of accurate solutions for supersonic and moderate hypersonic flows are described. These modifications involve a more robust central spatial discretization as well as the implementation of an upwind biased discretization operator. In order to increase the efficiency of the code, a space marching technique is incorporated within regions with supersonic flow only. The resolution of the flow field in the domain of interest is enhanced through the adaptation of the far field to the bow shock. Numerical results of a Hermes type configuration at supersonic and moderate hypersonic speeds are presented. The accurate prediction of discontinuities using the upwind formulation is demonstrated. The advanatge of far field adaptation and space marching technique is verified. Comparisons with experimental data show that methods based on the equations of inviscid flow can predict flight mechanical derivatives with high accuracy. ESA

N92-14990# International Centre for Numerical Methods in Engineering, Barcelona (Spain).

FLOW AND TEMPERATURE COMPUTATIONS FOR SPACE VEHICLES USING ADAPTIVE FINITE ELEMENT TECHNIQUES

F. QUINTANA, E. ONATE, and J. MIQUEL CANET *In* ESA, Aerothermodynamics for Space Vehicles p 135-140 Jul. 1991 Sponsored in part by Instituto de Cooperacion Iberoamericana

Computations of the laminar Navier-Stokes equations in hypersonic cases are studied using an explicit finite element method with adaptive non-structured mesh techniques to capture, accurately, the strong variations of the boundary layer and shocks. A pressure switched artificial dissipation is added to prevent oscillations in the vicinity of discontinuities. Some of the problems solved are discussed. ESA

N92-14992# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany, F.R.). Inst. for Theoretical Fluid Mechanics.

BASE PRESSURE MEASUREMENTS ON A CONE AT HYPERSONIC MACH NUMBERS: A CONTRIBUTION TO AEROTHERMODYNAMICS FOR SPACE VEHICLES

M. TANNER *In* ESA, Aerothermodynamics for Space Vehicles p 149-153 Jul. 1991

Base pressure measurements performed in a 6.8 degrees cone at Mach number from M infinity = 4.99 to 6.83 at angles of incidence from alpha = 0 to 15 degrees in turbulent flow are described. The results show that the base pressure is for these Mach numbers practically independent of the angle of incidence alpha for these relatively small alpha values. The results are approximately in agreement with those achieved during free flight measurements at full scale Reynolds numbers indicating that in turbulent flow the base pressure does not depend on the Reynolds number. In a discussion concerning some theoretical methods for the prediction of base pressure it is shown that the author's theory gives results, which are in very good agreement with experiments. ESA

N92-14993# Cranfield Inst. of Tech., Bedford (England). College of Aeronautics.

FLOW OVER A DELTA WING AT HYPERSONIC SPEEDS

H. BABINSKY and J. L. STOLLERY *In* ESA, Aerothermodynamics for Space Vehicles p 155-158 Jul. 1991

The flow over the lower surface of a simple hypersonic vehicle fitted with trailing edge flaps was studied by taking pressure measurements in a hypersonic gun tunnel at M = 8.2 and Re = 6,300,000/m. Flow visualization was carried out with Schlieren photographs and liquid crystals. All experiments indicated a large separated area due to the pressure rise on the flap. The large heating near the reattachment line was indicated by the liquid crystal experiments. The shape of the separated region proved to

be strongly influenced by the local state of the boundary layer. The presence of the forebody and the interaction of the bow shock with the boundary layer on the wing caused large changes in the local separation position. ESA

N92-14994# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.). Wind Tunnel Div.
EXPERIMENTAL STUDY OF HYPERSONIC SHOCK WAVE BOUNDARY LAYER INTERACTIONS BY MEANS OF INFRARED TECHNIQUE
A. HENCKELS, P. HERZOG, and F. MAURER *In* ESA, Aerothermodynamics for Space Vehicles p 159-164 Jul. 1991 Sponsored by DFG
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

Convective surface heating due to shock wave boundary layer interaction phenomena is a critical problem for the design of thermal protection systems of future hypersonic vehicles. Tunnel experiments are presented which demonstrate how interaction phenomena can be visualized by infrared thermovision; the infrared image indicates the position of flow separation and reattachement by the temperature pattern. The capability of the used measurement technique is demonstrated and thereby the nature of shock wave boundary layer interaction is studied. The three dimensional ramp flow field, an impinging shock wave boundary of a flat plate, and an axial corner configuration under 20 degrees angle of attack were investigated. All test runs were performed in a hypersonic blow down facility at Mach numbers 6.0 and 8.7 for laminar flow condition. One interesting result achieved is the evidence that Goertler vortices are generated on a flat plate due to shock wave boundary layer interaction. ESA

N92-14995# Societe d'Etudes et de Services pour Souffleries et Installations Aerothermodynamiques, Paris (France). Lab. d'Aerothermique.
EXPERIMENTAL INVESTIGATION OF TRANSVERSE JET EFFECTS RELATED TO HYPERSONIC SPACE VEHICLES
J. ALLEGRE, M. RAFFIN, and J. P. CARESSA (Centre National de la Recherche Scientifique, Meudon-Bellevue, France) *In* ESA, Aerothermodynamics for Space Vehicles p 165-170 Jul. 1991
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Some indication on the flow interaction process which is associated with jet controls is given. A few examples of flight results on reaction control jets were presented for the Space Shuttle Orbiter. Some comparisons, with preflight predictions extrapolated from wind tunnel data obtained at lower Mach numbers and at a higher density, show some discrepancies mainly for the early stage of reentry. Experiments were carried out under rarefied hypersonic flow conditions on delta wings with trailing edge jet spoilers. Quantitative data show the jet effects in the measured aerodynamic coefficients. For the strong interaction flow regime and at various wing angles of attack, experimental results demonstrate the jet spoiler efficiency as compared with a solid spoiler efficiency. At a Mach number of 20 and under rarefied flow conditions, some preliminary experimental investigations were initiated on the Hermes model equipped with pitch reaction jet controls. It was found that at high altitudes, the flow rarefaction leads to very low efficiencies of control surfaces. For orbital flight conditions, jet control systems are than necessary to provide the required space vehicle maneuvering. Also, during the early phase of reentry, jets are used, sometimes in concert with control surfaces, to provide the vehicle aerodynamic control. ESA

N92-14996# Southampton Univ. (England). Dept. of Aeronautics and Astronautics.
INTERFERENCE HEATING NEAR FIN/BODY JUNCTIONS ON HYPERSONIC VEHICLES
Z. U. HAQ, G. T. ROBERTS, and R. A. EAST *In* ESA, Aerothermodynamics for Space Vehicles p 171-176 Jul. 1991 Sponsored by RAE
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Surface heat transfer and pressure data are presented for flat plate/fin configurations tested in an intermittent hypersonic wind tunnel at Mach 6.85. The heat transfer data were deduced from color images which show the response of thermochromic liquid crystals to the transient heating of the model of the flow. In particular, localized areas of high heat flux were apparent in the interference zones adjacent to the fin/body junction. The pressure data obtained for two fin configurations showed similar features, indicating some relationship between surface heat transfer and pressure. The influence of fin bluntness and sweep on the interference heating are described. ESA

N92-14998# Institut National de Recherche d'Informatique et d'Automatique, Valbonne (France).
NUMERICAL SIMULATIONS AROUND MODELS IN HYPERSONIC WIND TUNNELS
R. ABGRALL and A. MERLO *In* ESA, Aerothermodynamics for Space Vehicles p 189-195 Jul. 1991 Prepared in cooperation with Centre National de la Recherche Scientifique, Marseilles, France
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Some very preliminary results about the problem of extrapolating the results obtained in wind tunnel to real flight conditions are related. Two experiments are proposed (the geometry is axisymmetric in both cases). The first one is the simulation of the complete nozzle with a model inside. The conditions at infinity for the models are nonuniform, in chemical and vibrational nonequilibrium. In the second experiment, the same model with an appropriate scaling parameter is considered where the conditions at infinity are obtained with the same Mach number, velocity and binary scaling parameter but with a uniform flow at chemical and vibrational equilibrium. Since this is only a preliminary study, the flows are assumed to be inviscid. The physical and chemical model used is detailed. The numerical scheme is described and the two numerical experiments performed are discussed. ESA

N92-15000# Centro Italiano Ricerche Aerospaziali, Naples.
HIGH ENTHALPY NOZZLE FLOWS
G. RUSSO, SALVATORE BORRELLI, G. LEONE, and ANTONIO SCHETTINO *In* ESA, Aerothermodynamics for Space Vehicles p 209-220 Jul. 1991 Sponsored in part by Italian Space Agency and CNES
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High enthalpy nozzle flows such as those that will be generated in the Hermes related Scirocco plasma wind tunnel are dealt with. The analysis of physical phenomenologies is made by means of a calculation procedure. The chemical and vibrational nonequilibrim effects are evidentiated with respect to the specific nozzles performance and an attempt to generalize the results in terms of parametric dependencies is made. ESA

N92-15005# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Military Aircraft Div.
VERIFICATION AND APPLICATION OF THE NSFLEX METHOD FOR HYPERSONIC FLOW CONDITIONS
K. M. WANIE and M. A. SCHMATZ *In* ESA, Aerothermodynamics for Space Vehicles p 249-257 Jul. 1991
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

The need of hypersonic reentry and cruise vehicle design to calculate viscous flow past entire configurations with wings, fins, flaps and propulsion system represents one of the major challenges for computational fluid dynamics. There is, however, still a considerable lack of experience for hypersonic flow calculations and therefore an extensive testing and verification of the numerical methods and physical modeling is essential. The verification of the multiblock Navier-Stokes code NSFLEX and its application to hypersonic flow problems is thus focused upon. The governing

equations and the solution method are reviewed. The fundamental details of the multiblock incorporation, like indirect addressing and use of boundary indicators, are described. The verification is done by geometrically simple test cases. The capabilities of the method are demonstrtated for realistic hypersonic configurations. ESA

N92-15006# Fluid Gravity Engineering Ltd., Witley (England).
HYPERSONIC AEROTHERMODYNAMIC COMPUTATIONS USING A POINT-IMPLICIT TVD METHOD
M. P. NETTERFIELD *In* ESA, Aerothermodynamics for Space Vehicles p 259-266 Jul. 1991
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

Validation cases which are typical of hypersonic reentry problems are presented for a three dimensional Navier-Stokes code with fully coupled nonequilibrium thermochemistry. The code uses a Total Variation Diminishing (TVD) formulation for the inviscid fluxes, a point implicit relaxation method of time marching, and a 2 temperature thermodynamic model, with source terms also treated in a point implicit manner. The validation cases presented include the hypersonic laminar flow over a compression corner, and high enthalpy chemically reacting flow over a circular cylinder. ESA

N92-15008# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Military Aircraft Div.
VISCOUS SHOCK-LAYER EQUATIONS FOR THE CALCULATION OF REENTRY AEROTHERMODYNAMICS
ROLAND K. HOELD *In* ESA, Aerothermodynamics for Space Vehicles p 273-280 Jul. 1991
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

Three dimensional Viscous Shock Layer (VSL) equations, which are derived from the Navier-Stokes equations by an order of magnitude analysis, are presented. They hold for the windward flow field of reentry vehicles at hypersonic flow conditions. Rarefaction effects are modeled at the body surface and at the bow shock by slip boundary conditions. Results of the VSL code 'VISSLA' for equilibrium real gas calculations are discussed. The influence of the slip boundary conditions, coming along with growing Knudsen numbers of the higher altitudes of reentry trajectories, is demonstrated. Comparisons with other computationa fluid dynamic codes like 'NSFLEX' (Navier-Stokes calculation) show the accuracy of the VSL equations and verify the code. ESA

N92-15014# Centre National de la Recherche Scientifique, Chatenay-Malabry (France).
HYPERSONIC VISCOUS SHOCK LAYER IN THERMOCHEMICAL NONEQUILIBRIUM
F. THIVET, S. CANDEL, and M. Y. PERRIN *In* ESA, Aerothermodynamics for Space Vehicles p 325-333 Jul. 1991
Sponsored by Avions Marcel Dassault; Direction des Recherches, Etudes et Techniques; and CNRS
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The basic features of a hypersonic flow are reviewed and some models for equilibrium thermodynamic properties, chemical kinetics, and transport properties of air at high temperatures are presented. To precisely describe the stagnation regions of a typical reentry vehicle, the aerodynamics of the flow is reduced to the viscous shock layer approximation. An original and fast method is presented to solve the resulting free boundary parabolic system of equations based on Newton iterations on a fixed boundary domain. A vibrational nonequilibrium model is introduced in order to determine the sensitivity of the flow to this phenomenon. The relaxation equations resulting from the kinetic theory are presented. The relaxation times involved are calculated using an extension of the SSH theory and on some experimental data. The full coupling between vibrational and chemical nonequilibrium is taken into account. The influence of these phenomenon is made evident in results obtained for different geometries. ESA

N92-15016# Rome Univ. (Italy). Dipartimento di Meccanica e Aeronautica.
INFLUENCE OF CHEMICAL MODELING ON THE SOLUTION OF HYPERSONIC SHOCK LAYERS
F. SABETTA, B. FAVINI, and M. ONOFRI *In* ESA, Aerothermodynamics for Space Vehicles p 343-347 Jul. 1991
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

Hypersonic flows about ellipses at high angle of attack are analyzed by means of nonequilibrium, equilibrium, and inert gas with gamma = 1.2 models. It is shown that the proposed technique of chemical rate equation integration marching along streamlines allows the nonequilibrium model to accurately compute the stagnation point conditions where equilibrium must be attained. The comparison between the three model results indicates that the equilibrium model can not be considered an acceptable approximation in computing hypersonic flow fields, since it underpredicts the blowshock stand off distance and overpredicts the call temperature. The inert gas model with gamma = 1.2 can only be used as a crude approximation for evaluating the wall pressure. ESA

N92-15017# OHB-System G.m.b.H., Bremen (Germany, F.R.).
FALKE AND COBRA TECHNOLOGY DEVELOPMENT IN AERODYNAMICS AND AEROTHERMODYNAMICS
B. STECKEMETZ, J. EWALD, W. WIENSS, A. TEGTMEIER, C. FRIEBEL, and GEORG KOPPENWALLNER (Hyperschall-Technologie-Goettingen, Germany, F.R.) *In* ESA, Aerothermodynamics for Space Vehicles p351-358 Jul. 1991 Previously announced in IAA as A91-13281
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

Wind tunnel measurements and numerical methods are well established tools to simulate the actual flow around aerodynamically supported vehicles in atmospheric flight. There are, however, limitations e.g., in the transonic and hypersonic flight regime caused by noncompliance with similarity laws, viscosity and heat conductance effects, chemical kinetics, etc. which strongly influence the accuracy of measurements and numerical calculations. Major results of two projects are reported. Both projects aim at supporting wind tunnel measurements and numeric simulations by test flights under free flight conditions. The FALKE project mainly covers the transonic and lower supersonic flight conditions, whereas COBRA is intended to cover the hypersonic speed regime. ESA

N92-15020*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
AERODYNAMIC HEATING ON AFE DUE TO NONEQUILIBRIUM FLOW WITH VARIABLE ENTROPY AT BOUNDARY LAYER EDGE
P. C. TING, W. C. ROCHELLE, S. A. BOUSLOG, L. T. TAM (Lockheed Engineering and Sciences Co., Houston, TX.), C. D. SCOTT, and D. M. CURRY *In* ESA, Aerothermodynamics for Space Vehicles p 371-376 Jul. 1991
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders CSCL 01/2

A method of predicting the aerobrake aerothermodynamic environment on the NASA Aeroassist Flight Experiment (AFE) vehicle is described. Results of a three dimensional inviscid nonequilibrium solution are used as input to an axisymmetric nonequilibrium boundary layer program to predict AFE convective heating rates. Inviscid flow field properties are obtained from the Euler option of the Viscous Reacting Flow (VRFLO) code at the boundary layer edge. Heating rates on the AFE surface are generated with the Boundary Layer Integral Matrix Procedure (BLIMP) code for a partially catalytic surface composed of Reusable Surface Insulation (RSI) times. The 1864 kg AFE will fly an aerobraking trajectory, simulating return from geosynchronous Earth orbit, with a 75 km perigee and a 10 km/sec entry velocity. Results of this analysis will provide principal investigators and thermal analysts with aeroheating environments to perform experiment and thermal protection system design. ESA

N92-15025# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Div. de Thermophysique.
HYPERSONIC INVISCID FLOW FIELD SIMULATIONS AROUND REENTRY VEHICLES WITH FLAP DEFLECTION
J. L. DACOSTA *In* ESA, Aerothermodynamics for Space Vehicles p 407-412 Jul. 1991

The study of the reentry phase of spacecrafts like the European Hermes Spaceplane needs the determination of complex three dimensional flows. In order to simulate such hypersonic flows, a multidomain Euler code, named FLU3M, was developed. This code is based upon an explicit/implicit finite volume method of MUSCL type using structured grids. Calculations can be performed either by a time dependent method for subsonic region of the flow, or by space marching procedure for supersonic regions. The hypersonic flowfield around Hermes configurations is investigated. Computations are performed at a freestream Mach number of 10 and 25, for 30 degrees angle of attack and without any sideslip. The simulation is realized under perfect gas or equilibrium air assumption. The aims of the paper are mainly to show the feasibility of three dimensional computations around complex geometries including flap deflection and real ras effects, and to evaluate accurately the flap efficiency. ESA

N92-15031# Hyperschall-Technologie-Goettingen (Germany, F.R.).
BEHAVIOUR AND MODELLING OF THE AEROTHERMODYNAMICS OF BALLISTIC ENTRY VEHICLES IN THE HIGH ALTITUDE FLOW REGIMES
GEORG KOPPENWALLNER and DIETER JOHANNSMEIER *In* ESA, Aerothermodynamics for Space Vehicles p 461-467 Jul. 1991

Special aerodynamic methods, which allow fast aerodynamic performance prediction, are needed for initial design and trajectory calculations. During reentry the flow behavior changes from free molecular through the rarefied regimes to continuum hypersonic. In addition the Mach number decreases from 25 down to low hypersonic. A semiempirical method was adopted to develop formulae for the aerodynamic data prediction. The approach applies the axisymmetric bodies and allows the prediction of lift and drag during the hypersonic entry phase. The bridging between free molecular and continuum flow is based on experiments and on Newtonian and free molecular theory. ESA

N92-15032# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany, F.R.). Inst. for Experimental Fluid Mechanics.
APPLICABILITY OF BRIDGING METHODS TO HYPERSONIC RAREFIED FLOW AERODYNAMICS OF REENTRY VEHICLES
ROLF-D. BOETTCHER *In* ESA, Aerothermodynamics for Space Vehicles p 469-476 Jul. 1991

Local bridging methods for transition flow aerodynamics are applied to several shapes including Hermes. Results are compared to wind tunnel data and analyzed with respect to method applicability limits. The conclusion drawn states the necessity of tailoring the methods to the specific configuration under investigation, in close cooperation with wind tunnel experiments. ESA

N92-15035# Aerospatiale, Les Mureaux (France). Theoretical Aerodynamic Branch.
TRANSITIONAL FLOWS AROUND RE-ENTRY BODIES
JEAN-FRANCOIS PALLEGOIX *In* ESA, Aerothermodynamics for Space Vehicles p 491-496 Jul. 1991 Sponsored by Avions Marcel Dassault

Flow calculations as solutions of the Boltzmann equation, using the Direct Simulation Monte Carlo (DSMC) method, are presented. The code used was developed in order to calculate flows around complex three dimensional bodies like Hermes. The algorithms for moving molecules and searching for their impact on the wall are based on simple criteria, furthermore the code is fully vectorized. Four calculations on Hermes shape and two other calculations are presented and compared with wind tunnel data, in terms of aerodynamic coefficients or heat transfer. For each calculation, the number of cells and molecules is given, together with storage and Central Processing Unit (CPU) requirements. The discrepancies between calculations and measurements are checked with a simulation of the nonuniformity in the wind tunnel flow. ESA

N92-15039*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AEROTHERMODYNAMICS FOR UNITED STATES ADVANCED PROGRAMS
WILLIAM M. PILAND *In* ESA, Aerothermodynamics for Space Vehicles p 515-533 Jul. 1991

A series of graphics relating to aerothermodynamics is presented. They following topics are shown: space transportation architecture options and systems, vehicle shapes and design goals, aerothermodynamics (including hypersonic entry), computational fluid dynamics, ground based testing, aeroassist environment, and airbreathing propulsion. ESA

N92-15040# Aerospatiale, Les Mureaux (France). Theoretical Aerodynamic Branch.
COMPUTATION OF AERODYNAMIC COEFFICIENTS ON HERMES-ARIANE5 CONFIGURATION
CHRISTOPHE GRASSIN *In* ESA, Aerothermodynamics for Space Vehicles p 537-542 Jul. 1991 Sponsored by CNES

A numerical prediction of aerothermodynamic coefficients, for the Hermes-Ariane configuration, based on structured-nonstructured Euler solvers is presented. The application is performed for Mach number 1.47 and an angle of attack of 3 degrees. Results are found to compare well with experimental data. ESA

N92-15041# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
GRID IMPACT ON 3D HYPERSONIC FLOWS
J. HAEUSER, H. WONG, J. GRAWE, and W. BERRY *In its* Aerothermodynamics for Space Vehicles p 543-548 Jul. 1991

Four, three dimensional (3D), Euler solutions for the Hermes configuration are presented and the impact of the distance of the first layer of points, from the surface, on the pitching moments and lift coefficients is investigated. Results are given. It was shown that for Euler solutions of three dimensional vehicles the computational grid has a strong impact on some of the aerodynamic parameters, which by far exceed the design margins. Therefore, three dimensional solutions have to be checked for grid dependence. This situation is aggravated when a Navier-Stokes solver is used to calculate heat fluxes. Here a special feature of the grid can be used to interactively convert an Euler grid into a Navier-Stokes grid by removing or adding grid lines using a specified distribution to capture the boundary layer. A set of 100,000 points can be deleted/added in a few minutes. ESA

N92-15042# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
AEROTHERMODYNAMIC CHALLENGES OF THE SAENGER SPACE-TRANSPORTATION SYSTEM
E. H. HIRSCHEL *In* ESA, Aerothermodynamics for Space Vehicles

p 549-558 Jul. 1991
 Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

The two stage to orbit Saenger space transportation system is considered. The technology development concentrates first on the needs of the lower stage. Its requirements for aerothermodynamics and propulsion integration are sketched. The aerothermodynamic design challenge is discussed. The design tools and the design methodology are reviewed. The validation of both the computational and the experimental methods, as well as the test of vehicle components, like the inlet and control surfaces, make the experimental vehicle Hytex mandatory. Contents and workplan of the technology program 'Aerothermodynamics and propulsion integration' are laid out. Selected results from the current work are presented. ESA

N92-15045# Naval Postgraduate School, Monterey, CA.
PRELIMINARY INVESTIGATION OF THE SHOCK-BOUNDARY LAYER INTERACTION IN A SIMULATED FAN PASSAGE M.S. Thesis
CHRISTOPHER C. COLLINS Mar. 1991 129 p
(AD-A242656) Avail: NTIS HC/MF A07 CSCL 20/4

A two dimensional, two passage simulation of the relative flow through a transonic fan at M = 1.4 was designed with a view to providing an apparatus in which to assess the effectiveness of passive vortex generator techniques in alleviating shock-boundary layer interaction effects. The design of the model and the results of six test runs in the transonic cascade blowdown wind tunnel are described. Schlieren photographs of the shock structure were obtained at back pressures lower than the design value. The back-pressure control valve was identified as being critical to completing the experimental simulation. The flow through the cascade geometry was computed at design pressure ratio using an Euler code. Modifications to the grid are recommended before thin-layer Navier-Stokes calculations are performed. GRA

N92-15047*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
PROGRESS WITH MULTIGRID SCHEMES FOR HYPERSONIC FLOW PROBLEMS Final Report
R. RADESPIEL (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany, F.R.) and R. C. SWANSON Dec. 1991 43 p Submitted for publication
(Contract NAS1-18605)
(NASA-CR-189579; ICASE-91-89; NAS 1.26:189579) Avail: NTIS HC/MF A03 CSCL 01/1

Several multigrid schemes are considered for the numerical computation of viscous hypersonic flows. For each scheme, the basic solution algorithm uses upwind spatial discretization with explicit multistage time stepping. Two level versions of the various multigrid algorithms are applied to the two dimensional advection equation, and Fourier analysis is used to determine their damping properties. The capabilities of the multigrid methods are assessed by solving three different hypersonic flow problems. Some new multigrid schemes based on semicoarsening strategies are shown to be quite effective in relieving the stiffness caused by the high aspect ratio cells required to resolve high Reynolds number flows. These schemes exhibit good convergence rates for Reynolds numbers up to 200 x 10(exp 6) and Mach numbers up to 25.
Author

N92-15048*# Eloret Corp., Sunnyvale, CA.
EXPERIMENTAL RESEARCH OF THE AERODYNAMICS OF NOZZLES AND PLUMES AT HYPERSONIC SPEEDS Final Technical Report, 1 Aug. 1988 - 31 Dec. 1991
EARL R. KEENER 7 Jan. 1992 42 p
(Contract NCC2-553)
(NASA-CR-187316; NAS 1.26:187316) Avail: NTIS HC/MF A03 CSCL 01/1

The purpose was to experimentally characterize the flow field created by the interaction of a single expansion ramp nozzle (SERN) flow with a hypersonic external stream. Data were obtained from a generic nozzle/afterbody model in the 3.5 Foot Hypersonic Wind Tunnel of the NASA Ames Research Center. The model design and test planning were performed in close cooperation with members of the National Aero-Space Plane (NASP) computational fluid dynamics (SFD) team, so that the measurements could be used in CFD code validation studies. Presented here is a description of the experiment, the extent of the measurements obtained, and the experimental results.
Author

N92-15049*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THE BENCHMARK AEROELASTIC MODELS PROGRAM: DESCRIPTION AND HIGHLIGHTS OF INITIAL RESULTS
ROBERT M. BENNETT, CLINTON V. ECKSTROM, JOSE A. RIVERA, JR., BRYAN E. DANSBERRY, MOSES G. FARMER, and MICHAEL H. DURHAM Dec. 1991 13 p Presented at the AGARD Structures and Materials Panel Specialists' Meeting on Transonic Unsteady Aerodynamics and Aeroelasticity, San Diego, CA, 9-11 Oct. 1991
(NASA-TM-104180; NAS 1.15:104180; AGARD-PAPER-25)
Avail: NTIS HC/MF A03 CSCL 01/1

An experimental effort was implemented in aeroelasticity called the Benchmark Models Program. The primary purpose of this program is to provide the necessary data to evaluate computational fluid dynamic codes for aeroelastic analysis. It also focuses on increasing the understanding of the physics of unsteady flows and providing data for empirical design. An overview is given of this program and some results obtained in the initial tests are highlighted. The tests that were completed include measurement of unsteady pressures during flutter of rigid wing with a NACA 0012 airfoil section and dynamic response measurements of a flexible rectangular wing with a thick circular arc airfoil undergoing shock boundary layer oscillations. Author

N92-15050*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A FAST IMPLICIT UPWIND SOLUTION ALGORITHM FOR THREE-DIMENSIONAL UNSTRUCTURED DYNAMIC MESHES
JOHN T. BATINA Dec. 1991 8 p Presented at the AIAA 30th Aerospace Sciences Meeting and Exhibit, Reno, NV, 6-9 Jan. 1992
(NASA-TM-104186; NAS 1.15:104186) Avail: NTIS HC/MF A02 CSCL 01/1

A fast implicit upwind algorithm for the solution of the time-dependent Euler equations is presented for aerodynamic analysis involving unstructured dynamic meshes. The spatial discretization of the scheme is based on the upwind approach of Roe, referred to as flux-difference splitting (FDS). The FDS approach is naturally dissipative and captures shock waves and contact discontinuities sharply. The temporal discretization of the scheme involves an implicit time-integration using a two-sweep Gauss-Seidel relaxation procedure. The procedure is computationally efficient for either steady or unsteady flow problems. A detailed description is given of the implicit upwind solution algorithm along with results which assess the capability. The results are presented for the NACA 0012 airfoil and for the Boeing 747 aircraft. The 747 geometry includes the fuselage, wing, horizontal and vertical tails, under-wing pylons, and flow-through engine nacelles. Euler solutions for the 747 aircraft on an unstructured tetrahedral mesh containing approximately 100,000 cells were obtained to engineering accuracy in less than one hour CPU time on a Cray-2 computer. Author

N92-15051*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
RESULTS OF AN ICING TEST ON A NACA 0012 AIRFOIL IN THE NASA LEWIS ICING RESEARCH TUNNEL
JAIWON SHIN and THOMAS H. BOND 1992 21 p Presented at the 30th Aerospace Sciences Meeting and Exhibit, Reno, NV, 6-9 Jan. 1992; sponsored by AIAA
(NASA-TM-105374; E-6761; NAS 1.15:105374; AIAA-92-0647)
Avail: NTIS HC/MF A03 CSCL 01/1

Tests were conducted in the Icing Research Tunnel (IRT) at

the NASA Lewis Research Center to document the current capability of the IRT, focused mainly on the repeatability of the ice shape over a range of icing conditions. Measurements of drag increase due to the ice accretion were also made to document the repeatability of drag. Surface temperatures of the model were obtained to show the effects of latent-heat release by the freezing droplets and heat transfer through the ice layer. The repeatability of the ice shape was very good at low temperatures, but only fair at near freezing temperatures. In general, drag data shows good repeatability. Author

N92-15052*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A TURBULENCE MODEL FOR ICED AIRFOILS AND ITS VALIDATION
JAIWON SHIN, HSUN H. CHEN, and TUNCER CEBECI (California State Univ., Long Beach.) 1992 17 p Presented at the 30th Aerospace Sciences Meeting and Exhibit, Reno, NV, 6-9 Jan. 1992; sponsored by AIAA
(NASA-TM-105373; E-6760; NAS 1.15:105373; AIAA-92-0417)
Avail: NTIS HC/MF A03 CSCL 01/1

A turbulence model based on the extension of the algebraic eddy viscosity formulation of Cebeci and Smith developed for two dimensional flows over smooth and rough surfaces is described for iced airfoils and validated for computed ice shapes obtained for a range of total temperatures varying from 28 to -15 F. The validation is made with an interactive boundary layer method which uses a panel method to compute the inviscid flow and an inverse finite difference boundary layer method to compute the viscous flow. The interaction between inviscid and viscous flows is established by the use of the Hilbert integral. The calculated drag coefficients compare well with recent experimental data taken at the NASA-Lewis Icing Research Tunnel (IRT) and show that, in general, the drag increase due to ice accretion can be predicted well and efficiently. Author

03

AIR TRANSPORTATION AND SAFETY

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

A92-20024
F27 AGING AIRCRAFT PROGRAMME EMPHASIZES CORROSION PREVENTION
WOLF W. BRINGS ICAO Journal (ISSN 0018-8778), vol. 46, Nov. 1991, p. 9-14.
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An F27 aging aircraft working group (AAWG) was formed in 1990 to ensure the continued integrity of the F27 aircraft throughout its presently approved life of 90,000 flights. Basic issues addressed by the AAWG include the review of service actions dependent on special repetitive inspection, the review and recommendations for improvement to the corrosion prevention programs, and the review of supplemental inspection documents for effectiveness. Attention is given to a review of the structural integrity program, multiple repair areas, corrosion inspections, and the corrosion control program. R.E.P.

A92-20126
ANALYSIS TECHNIQUE FOR LIGHTNING ATTACHMENT ZONING OF AIRCRAFT
C. H. KING and T. P. OGDEN (Boeing Co., Seattle, WA) International Conference on Lightning and Static Electricity, University of Bath, England, Sept. 26-28, 1989. 5 p. refs

The design of aircraft lightning-protection systems is often based on aircraft zoning considerations which identify the most likely points of lightning attachment. Attention is presently given to a computer analysis technique which determines the probability of initial lightning attachment to aircraft surfaces on the basis of the 'rolling sphere' method. The method proceeds by envisioning a 25-m radius sphere which represents the severe case step-leader for lightning attachment as it rolls over the surface of the aircraft. The probability of attachment for each point is determined from geometrical considerations. O.C.

A92-20127
ON THE ACCURACY OF AN AIRCRAFT-BORNE AMBIENT ELECTRIC-FIELD MEASURING SYSTEM
K. L. HEWITT, J. KOSITSKY, R. A. MAFFIONE, and J. S. THAYER (SRI International, Menlo Park, CA) International Conference on Lightning and Static Electricity, University of Bath, England, Sept. 26-28, 1989. 9 p. refs

An investigation is conducted of the problems posed by the airborne measurement of electric fields, with emphasis on measurement-system accuracy. Airframe enhancement factors can be ascertained by placing a scale model of the aircraft in a uniform electrostatic field; these scale-model experiment results, which were verified on the basis of shapes with known solutions, can be used to estimate the scale-model enhancement factor errors. Attention is given to the enhancement factors of a NASA F-106B research aircraft, which were used in Monte Carlo simulations of error propagation. These simulations show that errors in the computed ambient field can rise exponentially when enhancement-factor errors exceed some threshold which is a function of the matrix equation and type of field computed. O.C.

A92-20129
ANALYSIS AND MODELING OF LIGHTNING STRIKES TO THE F106B, CVF580, AND C160 AIRCRAFT
TERENCE RUDOLPH, RODNEY A. PERALA, and RICHARD S. COLLIER (Electro Magnetic Applications, Inc., Lakewood, CO) International Conference on Lightning and Static Electricity, University of Bath, England, Sept. 26-28, 1989. 12 p. refs
(Contract DAAH01-85-DA-015)

Three-dimensional time domain finite difference models of the NASA F106B, FAA CV580, and French Transall C160 aircraft have been used to investigate in-flight transient lightning data. These models are linear and use transfer function techniques to determine lightning currents given a measured response at one point on the aircraft and attachment and detachment locations. Comparisons of measured and calculated waveforms are made for all three aircraft. Author

A92-20651
FAIR WEATHER CONVECTION AND LIGHT AIRCRAFT ACCIDENTS
LAI-CHEN CHIEN (National Central University, Chungli, Republic of China), W. C. LIANN, and T. K. YEH IAF, International Astronautical Congress, 42nd, Montreal, Canada, Oct. 5-11, 1991. 11 p. refs
(IAF PAPER ST-91-004) Copyright

The possible role of fair weather convection in initiating accidents of the light aircrafts is investigated. The role of dry convective gust is incorporated by modeling downdrafts and horizontal and vertical wind speed variance using statistical relationships for the atmosphere boundary layer. It is shown that light aircraft experience the variation in lift during flight in fair weather conditions. Author

A92-20720
FATAL OCCUPATIONAL INJURY RELATED TO HELICOPTERS IN THE UNITED STATES 1980-1985
CAROL CONROY, JULIE C. RUSSELL, WILLIAM E. CROUSE, THOMAS R. BENDER, and JUDITH A. HOLL (PHS; National Institute for Occupational Safety and Health, Morgantown, WV) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 63, Jan. 1992, p. 67-71. refs
Copyright

The characteristics of occupational traumatic fatalities caused by helicopters are examined with attention given to pilot experience, environmental circumstances, and demographic data. About 59

percent of the deaths are attributed to pilot error, and 16.5 percent are related to mechanical failure by the helicopters. It is suggested that helicopter pilots be isolated for a study to devise strategies for protecting the pilots from higher risks of death due to occupational exposure. C.C.S.

A92-20722
ANALYSIS OF CHANGES IN THE PILOT POPULATION AND GENERAL AVIATION ACCIDENTS
JAMES E. BRUCKART (U.S. Army, Aeromedical Research Laboratory, Fort Rucker, AL) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 63, Jan. 1992, p. 75-79. refs
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The decreasing number of accidents and the evolving pilot population are investigated in terms of cross-correlation including such parameters as age distribution, certification, and flying habits. FAA surveys and accident data are employed to study trends in pilot-age distribution, certification, aircraft use, flight planning, and weather conditions relevant to general aviation accidents. The mean pilot age increased from 35 to 40 in the span of time studied (1968-1987), and the numbers of pilots with certifications increased for both Air Transport Pilot and instrumentation. The accident experience expected for the period studied based on the 1968-1973 data predicts 40 percent more accidents than actually occurred, and adjusted accident rates show significant reductions in accidents in all age groups as compared to actual accident experience over the last 20 years. The results are positive confirmation of actual aviation-safety advances related to improved pilot performance. C.C.S.

N92-14006# National Transportation Safety Board, Washington, DC.
AIRCRAFT ACCIDENT REPORT: NORTHWEST AIRLINES, INC., FLIGHTS 1482 AND 299. RUNWAY INCURSION AND COLLISION, DETROIT METROPOLITAN/WAYNE COUNTY AIRPORT, ROMULUS, MICHIGAN, DECEMBER 3, 1990
25 Jun. 1991 178 p
(PB91-910405; NTSB/AAR-91/05; REPT-5416-B) Avail: NTIS HC/MF A09 CSCL 01/3

The runway collision of two Northwest Airlines aircraft is examined on a runway at the Detroit Metropolitan/Wayne County Airport, Romulus, MI, on 3 Dec. 1990. The safety issues discussed are airport marking and lighting, cockpit resource management, air traffic control procedures in low visibility conditions, flight attendant procedures during evacuation; and design of the DC-9 tailcone emergency release system. Safety recommendations concerning these issues were made to the FAA, the Detroit Metropolitan/Wayne County Airport, and Northwest Airlines, Inc. Author

N92-14007# Royal Aerospace Establishment, Farnborough (England). Aerospace Div.
LIGHTNING PROTECTION REQUIREMENTS FOR AIRCRAFT: A PROPOSED SPECIFICATION
G. A. M. ODAM, A. W. HANSON, and R. H. EVANS 16 May 1991 50 p Revised
(RAE-TM-FS(F)-632-REV-ISSUE-1; BR303122; ETN-92-90319)
Copyright Avail: NTIS HC/MF A03

The RAE/FS8 recommendation for a specification to define United Kingdom Ministry of Defence requirements for the lightning protection of aircraft is presented. The following are covered: background and advisory material, certification, design and testing requirements. ESA

N92-15053# Dayton Univ. Research Inst., OH. Structural Integrity Div.
STUDY OF THE ENGINE BIRD INGESTION EXPERIENCE OF THE BOEING 737 AIRCRAFT Final Report, Oct. 1986 - Sep. 1989
PETER W. HOVEY, DONALD A. SKINN, and JOSEPH J. WILSON Oct. 1991 196 p
(Contract DTFA03-88-C-00024)
(DOT/FAA/CT-89/16; DOT/FAA/CT-89/29; DOT/FAA/CT-90/28; UDR-TR-90-108) Avail: NTIS HC/MF A09

The objective of this report is to determine the relationship of bird weight, number of birds ingested, geographic location, season, time of day, phase of flight, and engine type to the frequency of bird ingestion events and the extent of engine damage, if any, resulting from the ingested birds. The statistical analysis of reported bird ingestions experienced by commercial B737 airplanes worldwide over a 3-year reporting period is used to summarize the service threat and level of engine damage experienced by these airplanes. The findings of the analysis will be helpful in defining minimum engine design requirements for resistance to damage as a result of bird ingestions. Moreover, this study will provide a comparison between the experience of a contemporary high bypass ratio turbofan engine (CFM56) and an older low bypass ratio turbofan engine with a smaller inlet (JT8D) exposed to similar aircraft-bird ingestion environments. Author

N92-15054# Cranfield Inst. of Tech., Bedford (England). Applied Psychology Unit.
PASSENGER KNOWLEDGE OF AIRLINE SAFETY INFORMATION
P. J. FENNELL, J. R. HARRIS, and H. C. MUIR Nov. 1988 32 p
(CRANFIELD-AERO-9111; ISBN-1-871564-31-X; ETN-92-90704)
Avail: NTIS HC/MF A03; Coll. of Aeronautics, Cranfield Inst. of Technology, Cranfield, Bedford MK43 0AL, England, HC 8 sterling pounds

Five hundred passengers participated in an investigation into their knowledge of the preflight briefing and the safety card information. A tendency was observed for passengers to overestimate their ability to recall some aspects of the preflight briefing and safety card. Males had a higher score on questions regarding safety information than females, although this difference may be due to the fact that the majority of business passengers are male. Some aspects of the preflight briefing and the safety card information were identified as requiring clarification in order to ensure that all passengers are to utilize the information correctly in an emergency. 79.9 percent of passengers pay attention to the briefing on most flights, and 59.7 percent read the card on most flights. It is suggested that these percentages are likely to overestimate the actual percentage of passengers who pay attention. Frequent passengers reported paying the least attention to briefings and safety cards, though they also had more knowledge of safety information than less frequent passengers. To ensure the safety of all passengers, it is important that both frequent and infrequent passengers are motivated to pay more attention to safety information and to increase their knowledge. Suggestions made by passengers regarding methods which they believe could increase attention are included. ESA

N92-15055# National Transportation Safety Board, Washington, DC.
AIRCRAFT ACCIDENT/INCIDENT SUMMARY REPORT: MIDAIR COLLISION INVOLVING LYCOMING AIR SERVICES PIPER AEROSTAR PA-60 AND SUN COMPANY AVIATION DEPARTMENT BELL 412, MERION, PENNSYLVANIA, APRIL 4, 1991
17 Sep. 1991 29 p
(PB91-910407; NTSB/AAR-91/01/SUM) Avail: NTIS HC/MF A03 CSCL 01/3

An explanation is presented for the midair collision involving a Lycoming Air Services Piper Aerostar PA-60 and a Sun Company Aviation Dept. Bell 412. The safety issues discussed include pilot judgement, the training and checking of flight crews, the adequacy of the PA-60 flight manual, and FAA surveillance of the carrier. Author

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

A92-17422
NEW SITING TECHNIQUES FOR THE ILS GLIDE SLOPE
R. H. MCFARLAND (Ohio University, Athens) Navigation (ISSN 0028-1522), vol. 38, Fall 1991, p. 235-246. refs
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The most recent innovations relating to the contemporary Instrument Landing System glide slope are discussed in the context of need, and consequently goals, for providing greater capability, availability, and quality. Capability refers to obtaining acceptable performance at sites that have previously been judged terribly difficult or impossible. Availability is crucial because history shows that the most negative impact on flight safety comes from the absence of a glide slope, not the existence of a malfunctioning one or one that is operating poorly. Higher-quality beam structures are desired because of more automatic flight operations using the glide slope. Author

A92-18172
USE OF DISTANCE-MEASURING EQUIPMENT (DME) FOR CORRECTING ERRORS IN POSITION, VELOCITY, AND WIND MEASUREMENTS FROM AIRCRAFT INERTIAL NAVIGATION SYSTEMS
ALFRED R. RODI (Wyoming, University, Laramie), JAMES C. FANKHAUSER, and ROBIN L. VAUGHAN (NCAR, Boulder, CO) Journal of Atmospheric and Oceanic Technology (ISSN 0739-0572), vol. 8, Dec. 1991, p. 827-834. refs
(Contract NSF ATM-82-05776; NSF ATM-85-02517; NSF ATM-89-12555; NSF ATM-87-02993)
Copyright

Aircraft distance-measuring-equipment (DME) data are used to update position, velocity, and wind measurements from inertial navigation systems (INS) measurements. Data from conventional single-channel DME sets, suitably calibrated, are shown to be adequate to resolve the Schuler oscillation and correct INS positions to better than 1-km accuracy. The satellite-based Navstar global position system (GPS) is rapidly superseding other systems for external position reference. However, DME is reliable and very accurate and has been recorded on many research datasets. The principal limitation of the DME is that it is restricted to land-based navigation. The regression technique used does not necessitate multiple DME receivers or station switching and involves few restrictions on the collection of the data. However, the results improve when more that one station is used. Comparisons with other navigation systems (interferometer and loran) demonstrate the method's skill in resolving INS errors. Intercomparisons among several research aircraft flying in close formation support the method's usefulness in correcting biases in INS data. Author

A92-18482* California State Univ., Fullerton.
Z-BASIC ALGORITHM FOR COLLISION AVOIDANCE SYSTEM
ROGER G. DEAR (California State University, Fullerton) and YOSEF S. SHERIF (JPL, Pasadena, CA) IEEE Transactions on Systems, Man, and Cybernetics (ISSN 0018-9472), vol. 21, July-Aug. 1991, p. 915-921. refs
Copyright

A Z-Basic prediction algorithm for an aircraft ground-based collision avoidance system is presented. This system searches for mutually overlapping prediction intervals that are influenced by the aircrafts' maneuver capabilities and surveillance accuracy. Z-Basic provides a powerful, fast, interactive, simple to use, and inexpensive Basic compiler. The algorithm is applied to a typical terminal airspace situation. The computer program was executed on Macintosh+, and the execution was less than one minute. The program is easy to understand and implement. I.E.

A92-18505
NAVSAT - A CIVIL COMPLEMENT TO GPS AND GLONASS
M. HAUNSCHILD, N. NIKLASCH (MAN Technologie AG, Munich, Federal Republic of Germany), B. EISSFELLER (Kayser-Threde GmbH, Munich, Federal Republic of Germany), J. MERKEL, W. SCHAEFER (Stuttgart, Universitaet, Federal Republic of Germany), and S. LESCHIUTTA (Torino, Politecnico, Turin, Italy) IAF, International Astronautical Congress, 42nd, Montreal, Canada, Oct. 5-11, 1991. 16 p. refs
(IAF PAPER 91-490) Copyright

A satellite-navigation system is described in terms of its primary civil application, system design and structure, and predicted levels of user-equivalent range error. Navsat is designed to support small repeater-transponder navigation payloads on host satellites such as the Inmarsat. With signals that are compatible with GPS and Glonass, the Navsat can provide navigation-signal uplinks, satellite-position determination, communication, and time transfer in the case of intrasystem synchronization. The potential services to be provided by the Navsat system are similar to those of existing Inmarsat stations. Present developments include dynamic modeling with a Kalman filter, satellite-health monitoring, and transponder design. Navsat is intended to supplement existing navigation satellites and thereby solve the corresponding integrity problem for civil aviation requirements. C.C.S.

A92-19211
MIL-STD-1553 DATA BUS/PCM MULTIPLEXER SYSTEM
ERLE W. MALONE (Boeing Aerospace and Electronics, Seattle, WA) and PHILLIP BREEDLOVE (Loral Conic, San Diego, CA) IN: ITC/USA/'90; Proceedings of the International Telemetering Conference, Las Vegas, NV, Oct. 29-Nov. 2, 1990. Research Triangle Park, NC, Instrument Society of America, 1990, p. 125-133.
Copyright

A telemetry system which integrates MIL-STD-1553 bus data, dual-simplex bus data, vehicle performance data, and environmental sensor data multiplexing involves many interfacing constraints. The engineering design considerations and hardware constraints required to implement this system are presented in this paper. Author

A92-19214
COMPRESSION TECHNIQUES FOR VIDEO TELEMETRY
ALAN DEUTERMANN and RICHARD SCHAPHORST (Delta Information Systems, Inc., Horsham, PA) IN: ITC/USA/'90; Proceedings of the International Telemetering Conference, Las Vegas, NV, Oct. 29-Nov. 2, 1990. Research Triangle Park, NC, Instrument Society of America, 1990, p. 165-172.
Copyright

The basic differential PCM and variable length coding technique is compared with alternative coding techniques. Alternative compression techniques that are reviewed include transform coding, bit plane coding, and vector quantization. All candidate techniques are viewed as containing four elements: signal processing, signal conditioning, quantization, and variable length coding. The four techniques are evaluated and compared from the standpoint of picture quality and compression ratio. R.E.P.

A92-19216
TELEMETRY ANTENNA PATTERNS FOR SINGLE AND MULTI-ELEMENT ARRAYS
JAMES L. RIEGER (U.S. Navy, Naval Weapons Center, China Lake, CA) IN: ITC/USA/'90; Proceedings of the International Telemetering Conference, Las Vegas, NV, Oct. 29-Nov. 2, 1990. Research Triangle Park, NC, Instrument Society of America, 1990, p. 183-192. refs
Copyright

The use of multiple antennas (or multiport) antennas for vehicular telemetry causes patterns to result which are unknown and not well understood by the telemetry designer. When the antenna ports are separated by distances of more than a half wavelength, the resulting patterns are rarely what was intended. The antenna plotting program, an extension of an earlier University

of Utah antenna plotting routine, allows rapid creation of patterns for up to 30 (or more) antennas of like polarization displaced from each other in all three axes. Single-port antennas are modeled as compound antennas to produce the observed pattern, and combinations of these single-port antennas are then plotted. Case studies are shown for an aircraft and a missile body. Author

A92-19278
DESIGN AND IMPLEMENTATION OF A TOTAL FLIGHT TEST SYSTEM
KENNETH G. COONCE and GARY A. SCHUMACHER (Loral Data Systems, Sarasota, FL) IN: ITC/USA/'90; Proceedings of the International Telemetering Conference, Las Vegas, NV, Oct. 29-Nov. 2, 1990. Research Triangle Park, NC, Instrument Society of America, 1990, p. 833-842.
Copyright

This paper describes the overall system design and performance characteristics of a complete telemetry system for a new flight test center which Loral Data Systems is currently under contract to provide to a European government. The system encompasses subsystems for airborne data acquisition and flight line check-out, a mobile ground telemetry system, and a fixed facility. The fixed facility includes a ground telemetry system for real-time data processing and test control, and a data processing system for post-flight analysis. The system represents a fully integrated approach to flight test systems which addresses the end-to-end requirements from airborne data acquisition and real-time flight monitoring through aircraft performance and stability/control analysis. The architecture of the ground systems illustrates how preprocessing can be utilized to create powerful real-time telemetry systems even with modest general-purpose computer capability. Author

A92-19279
HIGH RATE PCM DATA RECEIVING, RECORDING AND RELYING
WILLIAM A. RICE and WILLIAM G. MONTANO (U.S. Army, Data Collection Div., White Sands Missile Range, NM) IN: ITC/USA/'90; Proceedings of the International Telemetering Conference, Las Vegas, NV, Oct. 29-Nov. 2, 1990. Research Triangle Park, NC, Instrument Society of America, 1990, p. 843-849.
Copyright

The paper examines specific applications at White Sands Missle Range (WSMR) concerning the certification of airborne telemetry packages to receive, relay, and record Pulse Code Modulations telemetry data. Two new methods are currently used at the Missile Range to relay high rate telemetry data: the lightwave fiber system, which has been employed in four telemetry links; and the digital microwave links from a transportable telemetry acquisition and relay system (TTARS) to Jig-67 and from Jig-67 to Jig-56. A.S.B.

N92-14009 Communications Gillies, Inc., Sainte Lambert (Quebec).
ELECTRONIC SYSTEMS IN TRANSPORTATION
MICHA AVNI, ed. (Transport Canada Aviation, Ottawa, Ontario) Montreal, Quebec Transport Canada Sep. 1989 133 p Canadian Conference on Electrical and Computer Engineering held in Montreal, Ontario, 17-20 Sep. 1989
(Contract CNT PROJ. 6902)
(TP-9983; CTN-91-60231) Avail: Transportation Development Centre, 200 Rene Levesque Blvd. West, West Tower, Ste 601, Montreal, PQ H2Z 1X4 Canada

Papers relating to electronic systems are given. Major topics include descriptions of work carried out under the auspices of Transport Canada's Transport Development Center, research into microwave landing systems, the use of electronic distance measuring equipment in automated aircraft control and landing, automated airport runway management, the use of electronic systems in search and rescue missions, airspace management systems, baggage inspection systems, and information systems development for marine, road, and rail transport.

N92-14012# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.).
IMAGE-SUPPORTED NAVIGATION FOR TESTING INSTRUMENT LANDING SYSTEMS
U. BROKOF and F. KNABE *In* Communications Gillies, Inc., Electronic Systems in Transportation p 10-13 Sep. 1989
Avail: Transportation Development Centre, 200 Rene Levesque Blvd. West, West Tower, Ste 601, Montreal, PQ H2Z 1X4 Canada

The testing of instrument landing systems (ILS) at airports is constrained by requirements of the International Civil Aviation Organization (ICAO) as well as safety and economic considerations. A new test system developed by the Cooperative Flight Measurement Systems Group of the German Aerospace Research Establishment is described. Basic navigation is done by an inertial navigation system. Multiple distance measuring equipment is incorporated to improve en route navigation. A video system connected to an image processor uses runway threshold markings to update position information to a high degree of accuracy during the approach. The system works without ground staff or special installations. Computation of calibration data is accomplished in flight following the approach. Simulations and flight tests indicate that the required accuracy for ICAO category III flights can be achieved with two video measurements at both ends of the runway. Three dimensional position data are computed continuously allowing approaches at different angles and curved approaches. The system is ready for test with microwave landing systems. CISTI

N92-14015# Allied-Signal Aerospace Co., Baltimore, MD.
MLS SYSTEM ERROR MODEL IDENTIFICATION AND SYNTHESIS
R. J. KELLY *In* Communications Gillies, Inc., Electronic Systems in Transportation p 22-28 Sep. 1989
Avail: Transportation Development Centre, 200 Rene Levesque Blvd. West, West Tower, Ste 601, Montreal, PQ H2Z 1X4 Canada

A technique is described which can in principle identify the error sources in navigation systems and can also perform the inverse operation of synthesizing an error generator whose output is statistically equivalent to the original error data. A methodology is described for identifying the microwave landing system (MLS) error components (both deterministic and random) from flight error records. After the model has been identified, the error components are synthesized to form an MLS error generator. The difficult step in the model development is identifying the random error components. A general technique is presented for developing a statistically equivalent MLS error generator using only a fraction of the data storage required to store the actual flight test data (400:1 data compression). This is an important consideration because the error generator must have in storage a library representative of MLS signals worldwide. The random error model is synthesized using the latest computer algorithms in system identification theory to develop autoregressive moving average (ARMA) models. It is also determined whether the random error model of flight data measured at a given runway is statistically equivalent to the signals generated at other airports. In other words, is there some invariant signal structure in the random error components which can be generalized to simplify the aircraft flight control system (AFCS) engineer's design task. Precision distance measuring equipment (DME/P) flight test data recently collected by the Federal Aviation Administration (FAA) is analyzed to demonstrate the System Identification methodology. The technique applies to all navigation systems. CISTI

N92-14018# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.).
DME GROWTH ELEMENTS AND THEIR USE WITH MLS
A. BECKER (Transport Canada Aviation, Ottawa, Ontario) *In* Communications Gillies, Inc., Electronic Systems in Transportation p 36-39 Sep. 1989
(Contract CNT PROJ. 6902)
Avail: Transportation Development Centre, 200 Rene Levesque Blvd. West, West Tower, Ste 601, Montreal, PQ H2Z 1X4 Canada

The TIME Reference Scanning Beam System, selected by

the International Civil Aviation Organization (ICAO) as the standard microwave landing system (MLS), provides vertical and horizontal guidance in an approach sector of plus or minus 60 deg. Development of a 360 deg azimuth element to be integrated with the MLS was recommended. This paper describes a distance measuring equipment (DME) based concept for this application. The system utilizes the unused pulse space in the conventional DME systems to provide a 360 deg guidance subsystem. The system provides aircraft with a 360 deg azimuth element to be integrated with the microwave landing system (MLS). When hardware components of precision DME (DME/P) technology are used, the azimuth 2 sigma error can be kept below 0.2 deg. This accuracy is quite satisfying for the envisaged application. After the aircraft has landed, the complete position of the aircraft can be detected with high accuracy. By using the full data link capability, the information needed for a roll guidance and airport surveillance system can be made available on the ground as well as in the air. CISTI

N92-14025# Aviation Planning Services Ltd., Montreal (Quebec).

A STRATEGY FOR EXPLOITING THE FULL POTENTIAL OF MLS BASED TERMINAL PROCEDURES IN CANADA

K. ROMI SINGH *In* Communications Gillies, Inc., Electronic Systems in Transportation p 63-68 Sep. 1989

Avail: Transportation Development Centre, 200 Rene Levesque Blvd. West, West Tower, Ste 601, Montreal, PQ H2Z 1X4 Canada

This paper describes the regulatory research conducted in Canada in order to define the airspace requirements for microwave landing system (MLS) based terminal procedures. In particular, the extent of research and the time frame required for the translation of research findings into regulatory standards is addressed. It briefly explores some of the incremental compatibilities that research should bring to the operation of commercial air carriers such as the capacity to facilitate more through-put in the air traffic control system. Constraints which have prevented full exploitation of MLS by commercial air carriers are discussed. A discussion of concerns voiced by the user community, especially pilots, on the proposed replacement of instrument landing systems by MLS is provided. A review of industry concerns, Canada-specific applications and issues, and a proposal for a research strategy for Canada is also included. Projects on curved path and/or segmented path approaches, advanced procedures at multi-airport metropolitan areas, general aviation and/or computer capacity enhancement, and assessment of reduced landing minima are of particular interest to Canada from an operational point of view. CISTI

N92-14028# Mitre Corp., McLean, VA.

AUTOMATED PROBLEM RESOLUTION PROTOTYPE IN AUTOMATED EN ROUTE AIR TRAFFIC CONTROL

C. VANESSA FONG *In* Communications Gillies, Inc., Electronic Systems in Transportation p 99-102 Sep. 1989

Avail: Transportation Development Centre, 200 Rene Levesque Blvd. West, West Tower, Ste 601, Montreal, PQ H2Z 1X4 Canada

Automated En Route Air Traffic Control (AERA) is part of the advanced automation system software currently being developed by the Federal Aviation Administration (FAA) to modernize the air traffic control system. Implementation of AERA involves three packages: AERA 1, AERA 2, and AERA 3. Automated problem resolution (APR) is a function within AERA 2 that generates resolution to conflicts detected by the automated problem detection function, and AERA 1 capability. In order to prepare APR algorithmic specifications for the advanced automation system, an APR prototype was developed in the FAA MITRE AERA 2 laboratory at the MITRE Corp. This prototype is a tool designed for evaluating rules and algorithms for resolving aircraft-aircraft and aircraft-space conflicts in both radar and nonradar environments. The evaluation is performed with FAA field evaluation personnel. The APR prototype is implemented in a Symbolics Lisp machine using the Knowledge Engineering Environment (KEE) expert systems shell. It has three major functions: conflict and resolution information display, problem detection, and resolution generation. This paper discusses the overall characteristics of the APR prototype and, specifically, the conflict and resolution information display, and the resolution generation capabilities of the prototype. CISTI

N92-14029# CompEngServ Ltd., Ottawa (Ontario).

A UNIQUE APPROACH TO AIRCRAFT CONFLICT RESOLUTION USING ARTIFICIAL INTELLIGENCE TECHNIQUES

I. G. SMITH, C. A. CRABB, G. R. RAM, and M. R. ATTISHA *In* Communications Gillies, Inc., Electronic Systems in Transportation p 103-106 Sep. 1989

Avail: Transportation Development Centre, 200 Rene Levesque Blvd. West, West Tower, Ste 601, Montreal, PQ H2Z 1X4 Canada

CompEngServ Ltd. has recently completed a project to develop and test a proof of concept, aircraft conflict resolution advisory system for non-radar airspace. This system, known as CORES (conflict resolution system), predicts losses of separation and presents ranked resolution alternatives. CORES deals with the difficult problem of convergence and has been successfully tested using a wide range of scenarios. The algorithm consists of three stages: (1) The initial resolution stage classifies the conflict as one of six different basic types and selects strategies to test accordingly. Strategies which induce no conflicts are selected. (2) The relax constraints stage, in which cases not resolved in stage one are subject to more extreme strategies in an attempt to discover a conflict free resolution. (3) If this fails the convergence stage is invoked. This stage examines all strategies which have previously failed because they induced one or more further conflicts. The goal of this stage is to suggest partial solutions which result in better overall airspace in terms of criticality and difficulty of induced conflicts. The system was successfully tested with a set of scenarios designed to exercise all stages of the algorithm. CISTI

N92-14033# Syms (Raymond A.) and Associates, Bridge Water, NJ.

OPERATIONAL SURVEY: VFR HELIPORT APPROACHES AND DEPARTURES Final Report

RAYMOND A. SYMS and RANDAL A. WIEDEMANN Aug. 1991 66 p Prepared for Systems Control Technology, Inc., Arlington, VA

(Contract DTFA01-87-C-00014)

(SCT-91RR-26; DOT/FAA/RD-90/5) Avail: NTIS HC/MF A04

A field survey about helicopter performance and operational considerations pertaining to heliport design issues is documented. Helicopter operators, manufacturers' flight instructors, and FAA Technical Center pilots were surveyed in an attempt to relate their actual visual flight rule (VFR) helicopter operating techniques to heliport airspace requirements. The opinions and information obtained from the 88 pilots surveyed from around the country represent 17 types of helicopter models operating at a broad spectrum of density altitudes. The specific data has been summarized and characterized so as to be representative of the civil helicopter industry. Results show a wide variation in opinion, even among pilots flying the same aircraft models, about what constitutes safe straight approach and departure distances, adequate acceleration distances, and realistic climb angles. Pilots opinions indicate that they can climb at higher angles than are indicated by the profiles presented in Helicopter Physical and Performance Data, DOT/FAA/RD-90-3, in order to clear close-in obstacles. However, in flying these higher angles, pilots are flying through portions of the height/velocity envelope that the FAA and the manufacturers recommend be avoided. During the formal review process a number of FAA officials concluded that in many instances the pilots perceived performance capabilities that exceeded the aircrafts' performance capabilities. Also, of concern were instances when the aircraft could perform the maneuver, but the steep climb/descent angles needed would substantially increase the risk of an accident. Author

N92-14034# Computer Technology Associates, Inc., McKee City, NJ.
EVALUATION OF TRIPLE SIMULTANEOUS PARALLEL ILS APPROACHES SPACED 4300 FEET APART, PHASE 4A Final Report, Apr. 1990 - Oct. 1991
LLOYD HITCHCOCK, TERENCE FISCHER, L. W. BENSEL, GLORIA YASTROP, RICKIE JONES, RENEE LUONGO, KIMBERLY REARDON, and BARBARA STARZEL-DEHEL Sep. 1991 139 p
(Contract DTFA03-89-C-00023)
(ACD-340; DOT/FAA/CT-91/6) Avail: NTIS HC/MF A07

This study was part of an ongoing effort to evaluate plans for increasing air traffic capacity and to evaluate the feasibility of using multiple simultaneous parallel Instrument Landing System (ILS) approaches. The objective was to evaluate the ability of experienced controllers to handle approach traffic during Instrument Meteorological Conditions (IMC). The proposed configuration consisted of triple parallel runways 10,000 ft long, spaced 4300 ft apart with even thresholds. The controllers were able to satisfactorily resolve more than 90 percent of the blunders in this simulation. Of the 244 blunders simulated, only 23 blunders resulted in aircraft violating the criterion miss distance of 500 ft. The controllers stated that they were able to maintain the 500-ft miss distance with the exception of a few 30 degree blunders (appendix A). The controllers indicated that a departure monitor position would be unnecessary because all of the functions of the departure monitor controller could be provided by local and departure control positions. Finally, the controllers reported that higher update rate radar sensors and improved displays would enhance their performance. The Multiple Parallel Technical Work Group (TWG), based on their observations during the simulations and their understanding of the contingencies that must be accounted for in such an operation, determined that triple simultaneous parallel approach operations spaced at 4300 ft would not be acceptable if controllers were required to use ASR-9 Radar and the Automated Radar Terminal System (ARTS) 3A displays. Author

N92-14036*# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
IMAGE-BASED RANGING AND GUIDANCE FOR ROTORCRAFT Final Report
P. K. A. MENON Dec. 1991 79 p
(Contract NCC2-575)
(NASA-CR-184829; NAS 1.26:184829) Avail: NTIS HC/MF A05 CSCL 17/7

Primary emphasis was on the development of vision-based navigation methods for rotorcraft nap-of-the-earth flight regime. A family of field-based ranging algorithms were developed. These ranging schemes are capable of handling both stereo and motion image sequences, and permits both translational and rotational camera motion. The algorithms require minimal computational effort and appear to be implementable in real time. A series of papers were presented on these ranging schemes, some of which are included in this report. A small part of the research effort was expanded on synthesizing a rotorcraft guidance law that directly uses the vision-based ranging data; this work is discussed. Author

N92-15058# Mitre Corp., Bedford, MA.
THE PROBLEM OF MULTIPLE SOLUTIONS IN AREA NAVIGATION AND COMPUTED CENTERLINE OPERATIONS WITH THE MICROWAVE LANDING SYSTEM Final Report
FREDERICK D. POWELL Aug. 1991 77 p
(Contract F19628-89-C-0001)
(AD-A242757; MTR-11023; ESD-TR-91-213) Avail: NTIS HC/MF A05 CSCL 17/7

In normal geometries of siting of the ground units, the Microwave Landing System (MLS) observations in the avionics of azimuth and elevation angles plus slant range from a Distance Measuring Equipment (DME) transponder yield a unique solution for the aircraft location. However, for some unconventional geometries of the ground units in a very few, preexisting installations, these observations can be consistent with two solutions for aircraft location within the MLS coverage volume. It appears that the basic MLS concept has not dealt with this multiple solutions situation, which is possible within the present international agreements. This report shows that the MLS avionics position reconstruction algorithms, which determine the aircraft location in Cartesian coordinates and are essential in area navigation, computed centerline approach, and ground operations, such as deceleration and turnoff, cannot tell which of the two solutions is true and which is false from internal data. The problem can be avoided by new constraints on the permitted sites for the MLS ground units, by restrictions on the aircraft flight paths, or by Kalman filters or equivalents in the avionics. These constraints, restrictions, and filters are defined. GRA

N92-15060*# Douglas Aircraft Co., Inc., Long Beach, CA.
MICROWAVE LANDING SYSTEM AUTOLAND SYSTEM ANALYSIS Final Report
J. B. FEATHER and B. K. CRAVEN Dec. 1991 62 p
(Contract NAS1-18028)
(NASA-CR-189551; NAS 1.26:189551; C1-1X2-TN-393) Avail: NTIS HC/MF A04 CSCL 17/7

The objective was to investigate the ability of present day aircraft equipped with automatic flight control systems to fly advanced Microwave Landing Systems (MLS) approaches. The tactical approach used to achieve this objective included reviewing the design and autoland operation of the MD-80 aircraft, simulating the MLS approaches using a batch computer program, and assessing the performance of the autoland system from computer generated data. The results showed changes were required to present Instrument Landing System (ILS) procedures to accommodate the new MLS curved paths. It was also shown that in some cases, changes to the digital flight guidance systems would be required so that an autoland could be performed. Author

N92-15061# Systems Control Technology, Inc., Arlington, VA.
ROTORCRAFT LOW ALTITUDE IFR BENEFIT/COST ANALYSIS: OPERATIONS ANALYSIS Interim Report No. 2
ROBERT K. ANOLL, LEN D. DZAMBA, LINDA J. LABELLE, RANDAHL N. LINDGREN, ROBERT B. NEWMAN, and DEBORAH J. PEISEN Dec. 1991 192 p
(Contract DTFA01-87-C-00014)
(SCT-90RR-44; DOT/FAA/DS-89/10) Avail: NTIS HC/MF A09

The Rotorcraft Master Plan advocates the establishment of additional communications, navigation, and surveillance (CNS) facilities, as well as the analysis and development of systems to satisfy the increasing demand for widespread instrument flight rules (IFR) rotorcraft operations within the National Airspace System (NAS). The objective of this study is to determine if there is an economic basis for improvement of these low altitude IFR services within the NAS in order to better support rotorcraft IFR operations. The findings of this study will aid FAA decisionmaking in that regard. In view of prior implementation decisions on Loran-C, the emphasis in this effort is on communications, surveillance, procedural changes, and avionics. This report is one of a series of three reports that address rotorcraft low altitude IFR benefit/cost analysis. This second interim report defines operational requirements and constraints for selected rotorcraft missions. A candidate list of 50 sites around the country, selected for their potential to benefit from increased low altitude IFR services, is presented. Radar and communications coverages in those areas are then identified. CNS improvements to be provided by implementation of the NAS plan, relevant FAA policies, air traffic control (ATC) procedures, and avionics improvements are analyzed for their potential to benefit low altitude rotorcraft IFR operations. A benefit/cost methodology to determine where the most benefits would accrue from improvements in rotorcraft low altitude IFR services or changes in ATC procedures is presented. Author

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AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A92-17876
CABIN STRUCTURAL VIBRATION AND NOISE FOR TRANSPORT AIRCRAFT
GENKICHI FUJIWARA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 39, no. 453, 1991, p. 497-503. In Japanese. refs

In this analysis of cabin structural vibration and noise of transport aircraft, evaluations of sound pressure level are addressed. Noise features such as engine vibration, multiple pure tone, and blade passing frequency are examined, and the vibration tolerance of human body is discussed. Y.P.Q.

A92-19606
NONLINEAR LANDING GEAR BEHAVIOR AT TOUCHDOWN
D. YADAV and R. P. RAMAMOORTHY (Indian Institute of Technology, Kanpur, India) ASME, Transactions, Journal of Dynamic Systems, Measurement, and Control (ISSN 0022-0434), vol. 113, Dec. 1991, p. 677-683. refs
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Landing gear dynamics for an aircraft is analyzed with a heave-pitch model having telescopic main gear and articulated nose gear using an oleopneumatic shock absorber. System equations are presented incorporating the effects of linkage dynamics, frictional forces, and nonlinearities in the tire, air spring, and damping forces. Sensitivity of the system response to variations in some shock strut parameters is investigated for the landing touchdown impact phase to bring about improvement in the performance. Author

A92-19819
DAMAGE TOLERANCE OF THE FIGHTER AIRCRAFT 37 VIGGEN. I - ANALYTICAL ASSESSMENT. II - EXPERIMENTAL VERIFICATION
BJORN PALMBERG, PER-OLOF BOMAN, MATS-OLOF OLSSON, and ANDERS F. BLOM (Aeronautical Research Institute of Sweden, Bromma) IN: Fatigue 90; Proceedings of the 4th International Conference on Fatigue and Fatigue Thresholds, Honolulu, HI, July 15-20, 1990. Vol. 4. Birmingham, England, Materials and Component Engineering Publications, Ltd., 1990, p. 2227-2238. Research supported by Defence Material Administration of Sweden. refs
Copyright

The damage tolerance of the 37 Viggen fighter aircraft is analyzed. Load spectra are presented along with the results stress analysis, fracture mechanics, and fatigue crack propagation. The results of analysis are successfully verified by a comparison with experimental results from damage-tolerance tests on the wing attachment frame of 37 Viggen and on the fin of a newer version of this aircraft, the JA 37 Viggen. It was found that the tested components were damage tolerant during the original fail safe design lives. I.S.

A92-19924
DORNIER 328 FIRST FLIGHT
MICHAEL MECHAM Aviation Week and Space Technology (ISSN 0005-2175), vol. 136, Jan. 6, 1992, p. 30-33.
Copyright

A review is presented of the design, development, and results of the initial test flights of the Do. 328 regional transport. The overhead wing design includes triangular tip planforms that reduce drag without reliance on winglets and approximates an ideal elliptical lift distribution along its span. By utilizing a combination of aerodynamics, propeller design, dampening, and a tuned fuselage, it is expected that 75 percent of the passengers will be subjected to no more than 78 decibels of noise. Consideration is given to a 48 passenger stretched version of the 30 seat basic aircraft that will require a 2,400 shp engine with an enlarged propeller. R.E.P.

A92-19925
EVALUATIONS OF X-29 HIGH-AOA REGIME SHOW PROMISE FOR FUTURE FIGHTERS
WILLIAM B. SCOTT and MICHAEL MECHAM Aviation Week and Space Technology (ISSN 0005-2175), vol. 136, Jan. 6, 1992, p. 50, 51.
Copyright

Recent flight tests prompted by the X-29's demonstrating that a forward-swept wing, integrated aerodynamics and a stabilizing digital flight control system could give fighters distinct maneuvering advantages at high angles of attack (AOA) are evaluated. Pilots were able to stabilize at angles of attack over 50 deg in an aircraft modified to incorporate a flow visualization and pressure measurement system to investigate high-AOA forebody flow characteristics. R.E.P.

A92-20000#
TECHNOLOGY IN THE LIVES OF AN AIRCRAFT DESIGNER
I. T. WAALAND (Northrop Advanced Technology and Design Center, Pico Rivera, CA) AIAA, Aircraft Design and Operations Meeting, Baltimore, MD, Sept. 23, 1991. 17 p.
(AIAA PAPER 91-3069) Copyright

An autobiographical account is given of the configurational design development history of U.S. tactical and strategic aircraft from the mid-1950s to the present. The configurational aerodynamics efforts detailed encompass the E-2 AEW carrier-based aircraft, the F-111B, the F-14A, the Space Shuttle, the F/A-18, and the B-2 stealth bomber. The increasing complexity of both aircraft and the design process is held to have significantly increased the isolation of engineering disciplines, precluding the most natural pathways to 'concurrent engineering'. O.C.

A92-20134
WHOLE AIRCRAFT LIGHTNING INDIRECT EFFECTS EVALUATION USING LOW LEVEL INJECTION TECHNIQUES
S. J. HOLDEN (Aeroplane and Armament Experimental Establishment, Salisbury, England), D. T. JORDAN (Royal Aerospace Establishment, Farnborough, England), and E. G. STEVENS (ERA Technology, Ltd., Leatherhead, England) International Conference on Lightning and Static Electricity, University of Bath, England, Sept. 26-28, 1989. 9 p. refs
Copyright

The responses of an aircraft and its cable bundles to free-field illumination from a transient EM field can be ascertained by means of a technique which uses the data acquired from low-level, swept-frequency carrier wave (LLSFCW) EM field-coupling measurements. An investigation has accordingly been conducted into techniques for injecting LLSFCW and transient currents into an aircraft that is enclosed in an external coaxial return conductor system, in order to evaluate return-conductor systems and compare the results of low level CW injection with high and low level pulse injection. Attention is given to the extrapolation of the low-level injection techniques for the clearance of aircraft for indirect lightning-strike effects. O.C.

A92-20136
THE USE OF FINITE DIFFERENCE ELECTROMAGNETIC ANALYSIS IN THE DESIGN AND VERIFICATION OF MODERN AIRCRAFT
B. I. WAHLGREN, M. G. BACKSTROM (Saab-Scania, AB, Linkoping, Sweden), R. A. PERALA, and P. M. MCKENNA (Electro Magnetic Applications, Inc., Lakewood, CO) International Conference on Lightning and Static Electricity, University of Bath, England, Sept. 26-28, 1989. 9 p. refs

The numerical EM modeling of aircraft and such interior elements as equipment bays and cabling has in the last decade reached a high stage of sophistication as a design and verification tool, in conjunction with high-speed large-memory computation

resources. Attention is presently given to illustrations of the usefulness and accuracy of such modeling in the case of lightning strikes, which are EM phenomena too complex to simulate through ground testing. The effects of lightning on 3D surfaces and carbon fiber-reinforced polymer composite structures of the JAS39 fighter are noted. O.C.

A92-20202* Texas A&M Univ., College Station.
DIRECT-INVERSE TRANSONIC WING-DESIGN METHOD IN CURVILINEAR COORDINATES INCLUDING VISCOUS INTERACTION
ROBERT R. RATCLIFF and LELAND A. CARLSON (Texas A & M University, College Station) Journal of Aircraft (ISSN 0021-8669), vol. 28, Dec. 1991, p. 803, 804. Abridged. Previously cited in issue 21, p. 3263, Accession no. A89-47663. refs
(Contract NAG1-619)
Copyright

A92-20203
FOUR DECADES OF TRANSONIC FIGHTER DESIGN
RAY WHITFORD (Cranfield Institute of Technology, Shrivenham, England) Journal of Aircraft (ISSN 0021-8669), vol. 28, Dec. 1991, p. 805-811. Previously cited in issue 22, p. 3649, Accession no. A88-51960. refs
Copyright

A92-20208
FLIGHT TEST OF A HALF-SCALE UNMANNED AIR VEHICLE
R. M. HOWARD (U.S. Naval Postgraduate School, Monterey, CA), J. C. TANNER, and D. F. LYONS Journal of Aircraft (ISSN 0021-8669), vol. 28, Dec. 1991, p. 843-848. Previously cited in issue 14, p. 2130, Accession no. A90-33890. refs

A92-20209
AIRCRAFT LANDING-INDUCED TIRE SPINUP
JOE PADOVAN (Akron, University, OH), AMIR KAZEMPOUR (Goodyear Tire and Rubber Co., Akron, OH), and YONG H. KIM (SAE, Aerospace Technology Conference and Exposition, Long Beach, CA, Oct. 1-4, 1990, SAE Paper 901910) Journal of Aircraft (ISSN 0021-8669), vol. 28, Dec. 1991, p. 849-854. Previously cited in issue 21, p. 3590, Accession no. A91-48594. refs
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N92-13929*# National Aerospace Lab., Amsterdam (Netherlands).
REVIEW OF AERODYNAMIC DESIGN IN THE NETHERLANDS
TH. E. LABRUJERE *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 1-30 1991
Avail: NTIS HC/MF A99 CSCL 01C

Aerodynamic design activities in the Netherlands, which take place mainly at Fokker, the National Aerospace Laboratory (NLR), and Delft University of Technology (TUD), are discussed. The survey concentrates on the development of the Fokker 100 wing, glider design at TUD, and research at NLR in the field of aerodynamic design. Results are shown to illustrate these activities. Author

N92-13930*# Tokyo Univ., Sagamihara (Japan). Inst. of Space and Astronautical Science.
AERODYNAMIC AIRCRAFT DESIGN METHODS AND THEIR NOTABLE APPLICATIONS: SURVEY OF THE ACTIVITY IN JAPAN
KOZO FUJII and SUSUMU TAKANASHI (National Aerospace Lab., Tokyo, Japan) *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 31-44 1991
Avail: NTIS HC/MF A99 CSCL 01C

An overview of aerodynamic aircraft design methods and their recent applications in Japan is presented. A design code which was developed at the National Aerospace Laboratory (NAL) and is in use now is discussed, hence, most of the examples are the result of the collaborative work between heavy industry and the National Aerospace Laboratory. A wide variety of applications in transonic to supersonic flow regimes are presented. Although design of aircraft elements for external flows are the main focus, some of the internal flow applications are also presented. Recent applications of the design code, using the Navier Stokes and Euler equations in the analysis mode, include the design of HOPE (a space vehicle) and Upper Surface Blowing (USB) aircraft configurations. Author

N92-13931*# Aviation Inst., Bucharest (Romania).
ON A GLOBAL AERODYNAMIC OPTIMIZATION OF A CIVIL TRANSPORT AIRCRAFT
G. SAVU and O. TRIFU *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 45-54 1991
Avail: NTIS HC/MF A99 CSCL 01C

An aerodynamic optimization procedure developed to minimize the drag to lift ratio of an aircraft configuration: wing - body - tail, in accordance with engineering restrictions, is described. An algorithm developed to search a hypersurface with 18 dimensions, which define an aircraft configuration, is discussed. The results, when considered from the aerodynamic point of view, indicate the optimal configuration is one that combines a lifting fuselage with a canard. Author

N92-13932*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INVERSE AIRFOIL DESIGN PROCEDURE USING A MULTIGRID NAVIER-STOKES METHOD
J. B. MALONE and R. C. SWANSON *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 55-66 1991
Avail: NTIS HC/MF A99 CSCL 01C

The Modified Garabedian McFadden (MGM) design procedure was incorporated into an existing 2-D multigrid Navier-Stokes airfoil analysis method. The resulting design method is an iterative procedure based on a residual correction algorithm and permits the automated design of airfoil sections with prescribed surface pressure distributions. The new design method, Multigrid Modified Garabedian McFadden (MG-MGM), is demonstrated for several different transonic pressure distributions obtained from both symmetric and cambered airfoil shapes. The airfoil profiles generated with the MG-MGM code are compared to the original configurations to assess the capabilities of the inverse design method. Author

N92-13933*# Boeing Computer Services Co., Seattle, WA.
A COMPARISON OF TWO CLOSELY-RELATED APPROACHES TO AERODYNAMIC DESIGN OPTIMIZATION
G. R. SHUBIN and P. D. FRANK *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 67-78 1991
Avail: NTIS HC/MF A99 CSCL 01C

Two related methods for aerodynamic design optimization are compared. The methods, called the implicit gradient approach and the variational (or optimal control) approach, both attempt to obtain gradients necessary for numerical optimization at a cost significantly less than that of the usual black-box approach that employs finite difference gradients. While the two methods are seemingly quite different, they are shown to differ (essentially) in that the order of discretizing the continuous problem, and of applying calculus, is interchanged. Under certain circumstances, the two methods turn out to be identical. We explore the relationship between these methods by applying them to a model problem for duct flow that has many features in common with transonic flow over an airfoil. We find that the gradients computed by the variational method can sometimes be sufficiently inaccurate to cause the optimization to fail. Author

N92-13948*# Warsaw Technical Univ. (Poland). Inst. of Applied Mechanics and Aviation Technology.
DESIGN OF 3-DIMENSIONAL COMPLEX AIRPLANE CONFIGURATIONS WITH SPECIFIED PRESSURE DISTRIBUTION VIA OPTIMIZATION
KRZYSZTOF KUBRYNSKI *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 263-280 1991
Avail: NTIS HC/MF A99 CSCL 01C

A subcritical panel method applied to flow analysis and aerodynamic design of complex aircraft configurations is presented. The analysis method is based on linearized, compressible, subsonic flow equations and indirect Dirichlet boundary conditions. Quadratic dipol and linear source distribution on flat panels are applied. In the case of aerodynamic design, the geometry which minimizes differences between design and actual pressure distribution is found iteratively, using numerical optimization technique. Geometry modifications are modeled by surface transpiration concept. Constraints in respect to resulting geometry can be specified. A number of complex 3-dimensional design examples are presented. The software is adopted to personal computers, and as result an unexpected low cost of computations is obtained. Author

N92-13949*# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany, F.R.). Inst. of Theoretical Fluid Mechanics.
EXTENDED MAPPING AND CHARACTERISTICS TECHNIQUES FOR INVERSE AERODYNAMIC DESIGN
H. SOBIECZKY and Y. J. QIAN *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 281-292 1991
Avail: NTIS HC/MF A99 CSCL 01C

Some ideas for using hodograph theory, mapping techniques and methods of characteristics to formulate typical aerodynamic design boundary value problems are developed. The inverse method of characteristics is shown to be a fast tool for design of transonic flow elements as well as supersonic flows with given shock waves. Author

N92-13954*# Pennsylvania State Univ., University Park. Dept. of Aerospace Engineering.
AERODYNAMIC SHAPE OPTIMIZATION OF ARBITRARY HYPERSONIC VEHICLES
GEORGE S. DULIKRAVICH and SCOTT G. SHEFFER *In its* Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 347-358 1991 Sponsored in part by Pennsylvania State Univ., University Park
Avail: NTIS HC/MF A99 CSCL 01C

A new method was developed to optimize, in terms of aerodynamic wave drag minimization, arbitrary (nonaxisymmetric) hypersonic vehicles in modified Newtonian flow, while maintaining the initial volume and length of the vehicle. This new method uses either a surface fitted Fourier series to represent the vehicle's geometry or an independent point motion algorithm. In either case, the coefficients of the Fourier series or the spatial locations of the points defining each cross section were varied and a numerical optimization algorithm based on a quasi-Newton gradient search concept was used to determine the new optimal configuration. Results indicate a significant decrease in aerodynamic wave drag for simple and complex geometries at relatively low CPU costs. In the case of a cone, the results agreed well with known analytical optimum ogive shapes. The procedure is capable of accepting more complex flow field analysis codes. Author

N92-13955*# Windsor Univ. (Ontario). Dept. of Mathematics and Statistics.
ANALYSIS AND DESIGN OF TRANSONIC AIRFOILS USING STREAMWISE COORDINATES
R. M. BARRON and C.-F. AN *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 359-370 1991
Avail: NTIS HC/MF A99 CSCL 01C

A new approach is developed for analysis and design of transonic airfoils. A set of full potential equivalent equations in von Mises coordinates is formulated from the Euler equations under the irrotationality and isentropic assumptions. This set is composed of a main equation for the main variable, y, and a secondary equations for the secondary variable, R. The main equation is solved by type dependent differencing combined with a shock point operator. The secondary equation is solved by marching from a non-characteristic boundary. Sample computations on NACA 0012 and biconvex airfoils show that, for the analysis problem, the present approach achieves good agreement with experimental C sub p distributions. For the design problem, the approach leads to a simple numerical algorithm in which the airfoil contour is calculated as part of the flow field solution. Author

N92-13958*# General Electric Co., Cincinnati, OH. Aircraft Engines.
AN INVERSE METHOD FOR THE AERODYNAMIC DESIGN OF THREE-DIMENSIONAL AIRCRAFT ENGINE NACELLES
R. A. BELL and R. D. CEDAR *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 405-417 1991
Avail: NTIS HC/MF A99 CSCL 01C

A fast, efficient and user friendly inverse design system for 3-D nacelles was developed. The system is a product of a 2-D inverse design method originally developed at NASA-Langley and the CFL3D analysis code which was also developed at NASA-Langley and modified for nacelle analysis. The design system uses a predictor/corrector design approach in which an analysis code is used to calculate the flow field for an initial geometry, the geometry is then modified based on the difference between the calculated and target pressures. A detailed discussion of the design method, the process of linking it to the modified CFL3D solver and its extension to 3-D is presented. This is followed by a number of examples of the use of the design system for the design of both axisymmetric and 3-D nacelles. Author

N92-13959*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
VORTEX GENERATOR DESIGN FOR AIRCRAFT INLET DISTORTION AS A NUMERICAL OPTIMIZATION PROBLEM
BERNHARD H. ANDERSON and RALPH LEVY (Scientific Research Associates, Inc., Glastonbury, CT.) *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 419-431 1991
Avail: NTIS HC/MF A99 CSCL 01C

Aerodynamic compatibility of aircraft/inlet/engine systems is a difficult design problem for aircraft that must operate in many different flight regimes. Takeoff, subsonic cruise, supersonic cruise, transonic maneuvering, and high altitude loiter each place different constraints on inlet design. Vortex generators, small wing like sections mounted on the inside surfaces of the inlet duct, are used to control flow separation and engine face distortion. The design of vortex generator installations in an inlet is defined as a problem addressable by numerical optimization techniques. A performance parameter is suggested to account for both inlet distortion and total pressure loss at a series of design flight conditions. The resulting optimization problem is difficult since some of the design parameters take on integer values. If numerical procedures could be used to reduce multimillion dollar development test programs to a small set of verification tests, numerical optimization could have a significant impact on both cost and elapsed time to design new aircraft. Author

N92-13981# Toronto Univ., Downsview (Ontario). Inst. for Aerospace Studies.
FLIGHT RESEARCH
J. H. DELEEUW and TAI QUACH et al. *In its* Activities of the

University of Toronto Institute for Aerospace Studies p 76-77 1989
Avail: NTIS HC/MF A06

A brief review of flight research carried out at the University of Toronto Institute for Aerospace Studies (UTIAS) is provided. Work has continued on helicopter parameter estimation in collaboration with the Flight Research Laboratory or the National Aeronautical Establishment. Under the auspices of the Advisory Group for Aeronautical Research Development (AGARD) Working Group 18, this project is to analyze with UTIAS algorithms the flight test data for three helicopters: the BO-105, the Puma, and the Apache. Recent work has concentrated on parameter estimation in the context of 6 degrees of freedom, linear models, using the time domain methods of step-wise regression, and maximum likelihood estimation. Attention was also given to the determination of the subset of all parameters in the model that are significant in describing the helicopter response for the particular maneuvres of the flight tests. This was done by a series of verification analyses, where model parameters obtained from one experiment were used for predicting the response for an independent experiment. A study of the criteria for helicopter model selection was carried out, which examined whether the flight dynamics of conventional maneuvers can be successfully modelled by a 6 degree of freedom model without determining the complete set of stability and control derivatives. CISTI

N92-14037*# United Technologies Research Center, East Hartford, CT.
HIGH TEMPERATURE STATIC STRAIN GAGE DEVELOPMENT Final Report, Jun. 1983 - Oct. 1990
C. O. HULSE, R. S. BAILEY, H. P. GRANT, W. L. ANDERSON, and J. S. PRZYBYSZEWSKI Aug. 1991 130 p
(Contract NAS3-23722)
(NASA-CR-189044; NAS 1.26:189044; R90-916528-80) Avail: NTIS HC/MF A07 CSCL 01/3

Final results are presented from a program to develop a thin film static strain gage for use on the blades and vanes of running, test stand gas turbine engines with goals of an 3 x 3 mm gage area and total errors of less than 10 pct. of + or - 2,000 microstrain after 50 hrs at 1250 K. Pd containing 13 Wt. pct. Cr was previously identified as a new strain sensor alloy that appeared to be potentially usable to 1250 K. Subsequently, it was discovered, in contrast with its behavior in bulk, that Pd-13Cr suffered from oxidation attack when prepared as a 4.5 micron thick thin film. Continuing problems with electrical leakage to the substrate and the inability of sputtered alumina overcoats to prevent oxidation led to the discovery that sputtered alumina contains appreciable amounts of entrapped argon. After the argon has been exsolved by heating to elevated temperatures, the alumina films undergo a linear shrinkage of about 2 pct. resulting in formation of cracks. These problems can be largely overcome by sputtering the alumina with the substrate heated to 870 K. With 2 micron thick hot sputtered alumina insulation and overcoat films, total 50 hr drifts of about 100 microstrain (2 tests) and about 500 microstrain (1 test) were observed at 1000 and 1100 K, respectively. Results of tests on complete strain gage systems on constant moment bend bars with Pd temperature compensation grids revealed that oxidation of the Pd grid was a major problem even when the grid was overcoated with a hot or cold sputtered alumina overcoat. Author

N92-14038*# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering
INTEGRATION OF DYNAMIC, AERODYNAMIC, AND STRUCTURAL OPTIMIZATION OF HELICOPTER ROTOR BLADES Final Report, 15 Oct. 1986 - 30 Nov. 1991
DAVID A. PETERS 30 Nov. 1991 22 p
(Contract NAG1-710)
(NASA-CR-189018; NAS 1.26:189018) Avail: NTIS HC/MF A03 CSCL 01/3

Summarized here is the first six years of research into the integration of structural, dynamic, and aerodynamic considerations in the design-optimization process for rotor blades. Specifically discussed here is the application of design optimization techniques for helicopter rotor blades. The reduction of vibratory shears and moments at the blade root, aeroelastic stability of the rotor, optimum airframe design, and an efficient procedure for calculating system sensitivities with respect to the design variables used are discussed. Author

N92-14039*# Textron Bell Helicopter, Fort Worth, TX.
TECHNOLOGY NEEDS FOR HIGH SPEED ROTORCRAFT (3) Final Report
JACK DETORE and SCOTT CONWAY Oct. 1991 110 p
(Contract NAS2-13072)
(NASA-CR-177592; A-92013; NAS 1.26:177592) Avail: NTIS HC/MF A06 CSCL 01/3

The spectrum of vertical takeoff and landing (VTOL) type aircraft is examined to determine which aircraft are most likely to achieve high subsonic cruise speeds and have hover qualities similar to a helicopter. Two civil mission profiles are considered: a 600-n.mi. mission for a 15- and a 30-passenger payload. Applying current technology, only the 15- and 30-passenger tiltfold aircraft are capable of attaining the 450-knot design goal. The two tiltfold aircraft at 450 knots and a 30-passenger tiltrotor at 375 knots were further developed for the Task II technology analysis. A program called High-Speed Total Envelope Proprotor (HI-STEP) is recommended to meet several of these issues based on the tiltrotor concept. A program called Tiltfold System (TFS) is recommended based on the tiltrotor concept. A task is identified to resolve the best design speed from productivity and demand considerations based on the technology that emerges from the recommended programs. HI-STEP's goals are to investigate propulsive efficiency, maneuver loads, and aeroelastic stability. Programs currently in progress that may meet the other technology needs include the Integrated High Performance Turbine Engine Technology (IHPTET) (NASA Lewis) and the Advanced Structural Concepts Program funded through NASA Langley. Author

N92-14042# Centre d'Essais Aeronautique Toulouse (France). Lab. des Materiaux Metalliques.
MECHANICAL QUALIFICATION TESTS FOR MATERIALS USED IN THE FABRICATION OF AIRCRAFT PARTS [ESSAIS MECANIQUES ENTRANT DANS LE CADRE DE LA QUALIFICATION DE MATERIAUX POUR LA REALISATION DE PIECES (AVION). PROCES-VERBAL DE L'ESSAI M5-5443/01]
J. C. FAURE 12 Jun. 1991 64 p In FRENCH
(CEAT-M5-5443/01; ETN-92-99978) Avail: NTIS HC/MF A04

The mechanical tests performed to qualify several materials applied in aircraft components are described. The aim of the study is to define the rules concerning the principles of the tests and how to structure the results to be presented. The preparation of the sample, the test parameters and the analysis of the results are also defined. The tests were performed on light alloys, steels, titanium alloys and refractory alloys. The mechanical properties of the materials were evaluated by tests involving: resilience, strain, toughness, crack propagation and fatigue. The results of the mechanical tests are not included. ESA

N92-14043# Centre d'Essais Aeronautique Toulouse (France). Lab. des Essais Statiques.
OPTIMIZATION OF THE CALCULATION MARGINS OF LANDING GEARS UNDER EXTREME LOADS. RUPTURE STATIC TESTS. PART 1: PROGRAM AND TEST IMPLANTATION [OPTIMISATION DES MARGES DE CALCUL A CHARGE EXTREME POUR ATTERRISSEURS. ESSAIS STATIQUES A RUPTURE D'EPROUVETTES D'ETUDE. PROGRAMME ET INSTALLATION D'ESSAI. PROCES-VERBAL DE L'ESSAI S 8 6551 PARTIEL 1]
M. LAVIRON 5 Jul. 1991 30 p In FRENCH
(CEAT-S8-6551-PARTIEL-1-PT-1; ETN-92-99979) Avail: NTIS HC/MF A03

The aim of the study is to evaluate the failure resistance of sample landing gear of different dimensions and of different materials. Simple or combined load tests are used. The purpose of the evaluation is to improve the laws and criteria in determining

the most accurate failure parameters. Machined samples of steel and aluminum alloys are described. The samples were submitted to tensile, bending, and shear tests, which could be applied alone or combined. The cross sections of the samples were either tube, I, or H shaped. For each test performed, the extensometric equipment, the displacement sensors, and the measurement curves are given. ESA

N92-14044# Technische Univ., Delft (Netherlands). Faculty of Aerospace Engineering.
THE TWO-BAY CRACK PROBLEM IN FUSELAGES BUILT IN GLARE AND ARALL
K. J. J. M. ZAAL May 1991 17 p
(LR-653; ETN-92-90418) Avail: NTIS HC/MF A03

The two bay crack problem as a possibly important subject for certification of pressurized fuselages is addressed. For fuselages with a GLARE or ARALL skin, the residual strength and remaining fatigue life after a large scale accidental damage seem to be realistic certification subjects. The evaluation of the two bay crack problem in a fuselage built in GLARE or Aramid Reinforced Aluminum Laminate (ARALL) introduces some new problems, compared to fuselages built in aluminum. The description of the anisotropy, the fast fracture behavior in GLARE and ARALL, require an extension of the design tools presently being used to evaluate the two bay crack problem in fuselages with aluminum skin. To model the residual strength of GLARE and ARALL, both the application of the K(sub I,C) factor and the R curve are being studied. Both methods can be used in design tools such as finite element methods and the displacement compatibility method. To study the remaining fatigue life of a fuselage with a damaged GLARE or ARALL skin, Marissen's fatigue crack growth model may be used. Slight simplifications, which are thought to lead to conservative results, may be required in Marissen's model for an efficient application in design tools intended to evaluate the two bay crack problem. ESA

N92-14045# Technische Univ., Delft (Netherlands). Faculty of Aerospace Engineering.
BULGING OF FATIGUE CRACKS IN A PRESSURIZED AIRCRAFT FUSELAGE
D. CHEN and J. SCHIJVE May 1991 41 p Presented at the 16th ICAF Symposium, Tokyo, Japan, 22-24 May 1991
(LR-655; ETN-92-90420) Avail: NTIS HC/MF A03

Fatigue crack growth and residual strength must be considered as part of the damage problem of a pressurized aircraft fuselage. Longitudinal cracks offer problems because they occur in a curved thin sheet structure under biaxial loading conditions and internal pressure. The fatigue crack edges bulge outwards (out of plane deformation) which considerably complicates the fracture mechanics analysis. The problem is analyzed empirically and theoretically. Three test set ups were developed respectively for sheet specimens with a large radius of curvature loaded by internal air pressure and hoop stress. Fatigue crack growth and residual strength tests were carried out on aluminum alloy sheet specimens and some panels of new metal sheet/fiber laminates (Aramid Reinforced Aluminum Laminate (ARALL) and GLARE). Analytical relations were developed to obtain K values, which account for the nonlinear behavior associated with sheet curvature and bulging out of the crack edges. The predictions agree with the present test results, and with results from the literature obtained by finite element method calculations for fuselages and in full scale fatigue tests. ESA

N92-15065# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
MONITORING LOAD EXPERIENCE OF INDIVIDUAL AIRCRAFT
J. B. DEJONGE 3 Sep. 1990 12 p Presented at 17th ICAS Congress, Stockholm, Sweden, Sep. 1990
(NLR-TP-90084-U; ETN-92-90432) Avail: NTIS HC/MF A03

The actual service load experience of aircraft may differ appreciably from design assumptions. The necessity to monitor service loads is generally recognized now for military aircraft. A general review of the overall life management procedure commonly used today is given. Specific elements in this procedure are discussed in some detail. Specific attention is paid to the amount of scatter in severity between different flights and the required sample sizes of flight load measurements for obtaining reliable average load spectrum data. Possible causes for variation in load experience between different aircraft flying the same duty are analyzed. It is concluded that Individual Aircraft Tracking (IAT), if necessary at all, can usually be adequately accomplished by administrative means, indicated as Usage Monitoring. ESA

N92-15066# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
DEVELOPMENT AND EVALUATION OF A FINITE ELEMENT MODEL FOR A FIBER COMPOSITE HELICOPTER FUSELAGE [ENTWICKLUNG UND AUSWERTUNG EINES FINITE-ELEMENTE-MODELLS EINER HUBSCHRAUBERZELLE IN FASERVERBUNDBAUWEISE]
HANS BARNERSSOI 10 Oct. 1990 11 p In GERMAN; ENGLISH summary Presented at the I-DEAS/CAEDS User's Conference, Schluchsee, Fed. Republic of Germany, 10-12 Oct. 1990
(MBB-UD-0584-90-PUB; ETN-92-90612) Avail: NTIS HC/MF A03

Taking the German-French helicopter TIGER as an example, the use of the laminate module at pre- and post-processing is emphasized. The advantages of such modules are shown. The three dimensional surface program CARTA is described. The model is composed of points, splines, and curves. The process of laminate construction is explained. The computational process is described. It is shown that in the present version, girder elements in fiber composites cannot be idealized. A criterion of failure is introduced for fiber plates and girder elements and for local instability of sandwich elements. ESA

N92-15067# Naval Postgraduate School, Monterey, CA.
FLIGHT OPERATIONS FOR HIGHER HARMONIC CONTROL RESEARCH M.S. Thesis
JAMES J. MCGOVERN Mar. 1991 63 p
(AD-A242478) Avail: NTIS HC/MF A04 CSCL 20/11

The Department of Aeronautics and Astronautics at the Naval Postgraduate School (NPS) is interested in extending the useful life of Naval helicopters. Recognizing the need to reduce vibrations caused by aerodynamic loads on the rotor system, a Higher Harmonic Control (HHC) research effort has begun. The test vehicle of the HHC system is a Remotely Piloted Helicopter (RPH). This thesis contains an overview of the NPS HHC research effort including basic helicopter dynamics, HHC theory, and establishes research milestones. An RPH flight operations program was developed that included the first flights of two out of three RPH's being used in the research effort, identification of data and data acquisition requirements, and initial hover vibration tests. The vibration tests produced data of limited value. The two bladed RPH tested appears to produce peak accelerations at roughly twice the main rotor speed. This indicates that like a full scale helicopter, the largest vibrations do enter the airframe through the rotor system and are not a result of engine vibrations. Hence, RPH's are suitable for HHC research. This effort completed one portion of the long term HHC research and can lead to the practical and safe testing of a fully functioning HHC system. GRA

N92-15068# Naval Postgraduate School, Monterey, CA.
STRUCTURAL CONSIDERATIONS FOR AIRCRAFT PAYLOAD MODIFICATION: P-3C ZERO FUEL WEIGHT INCREASE M.S. Thesis
STEVEN D. CULPEPPER Mar. 1991 76 p
(AD-A242690) Avail: NTIS HC/MF A05 CSCL 01/3

The Navy is considering the feasibility of increasing the patrol aircraft P-3C zero fuel weight enabling avionics and payload growth. This analysis examines the consequences to the structural requirements of the center section wing box. Two solutions to the structures field equations are investigated: a simplified hand solution for preliminary feasibility calculations and a more precise solution for design analysis. Together, the solutions provide a necessary

check for the results. The simplified solution employs the Euler-Bernoulli assumption which generates a set of integrals expressed in terms of the assumed displacements. These integrals, when combined with simplified geometric shapes and symmetry, ultimately produce a decoupled matrix solution. The precise solution uses a PC based finite element method which simultaneously solves the field equations for basic elements to be linked together with the appropriate boundary conditions. For the current 135,000 pound gross weight 1 g load condition, the internal stresses calculated by finite element are in accord with those by simplified hand calculation. Extensions from this modeling will generate design criterion for the target 95,000 pound zero fuel weight aircraft as well as alternate flight or taxi conditions. GRA

N92-15069# Wright Lab., Wright-Patterson AFB, OH.
EVOLUTION AND DEVELOPMENT OF HYPERSONIC CONFIGURATIONS 1958-1990 Final Report, Jul. 1990 - Mar. 1991
ALFRED C. DRAPER and THOMAS R. SIERON Sep. 1991 128 p
(Contract AF PROJ. 2404)
(AD-A242768; WL-TR-91-3067) Avail: NTIS HC/MF A07 CSCL 01/3

This report traces the activities of the Flight Dynamics Laboratory in hypersonic configuration research. Early efforts concentrated on simple configurations and progressed to more sophisticated lifting body point designs as analysis and design techniques became available. Several flight technology demonstration programs pioneered the exploitation of this new challenging flight regime and provided an extensive data base for the development of the Space Shuttle. Hypersonic air-breathing cruise vehicles are shown to be dominated by inlet and nozzles integration with the airframe. A list of lessons learned is compiled to provide a useful reference for the designer in the early formulation of configurations concepts. GRA

N92-15070*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FLUTTER SUPPRESSION VIA PIEZOELECTRIC ACTUATION
JENNIFER HEEG Sep. 1991 17 p
(NASA-TM-104120; NAS 1.15:104120) Avail: NTIS HC/MF A03 CSCL 01/3

Experimental flutter results obtained from wind tunnel tests of a two degree of freedom wind tunnel model are presented for the open and closed loop systems. The wind tunnel model is a two degree of freedom system which is actuated by piezoelectric plates configured as bimorphs. The model design was based on finite element structural analyses and flutter analyses. A control law was designed based on a discrete system model; gain feedback of strain measurements was utilized in the control task. The results show a 21 pct. increase in the flutter speed. Author

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AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A92-17596#
AN INTELLIGENT PILOT VEHICLE INTERFACE FOR A DAY/NIGHT ADVERSE WEATHER PILOTAGE SYSTEM (D/NAPS)
HOWARD R. SMITH (United Technologies Research Center, East Hartford, CT) and PATRICIA A. CASPER (Sikorsky Aircraft, Stratford, CT) IN: AIAA Computing in Aerospace Conference, 8th, Baltimore, MD, Oct. 21-24, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 159-163. refs
(AIAA PAPER 91-3729) Copyright

D/NAPS program will use artificial intelligence and integrate with advanced pilotage sensors, controls, and displays in order to demonstrate the pilot cognitive decision aids. D/NAPS will incorporate lessons learned from the Defense Advanced Research Projects Agency (DARPA) and U.S. Air Force (USAF) Pilot's Associate program for fixed-wing aircraft. The primary purpose of D/NAPS is to use artificial intelligence technology to maximize combat helicopter mission effectiveness and survivability for day/night adverse weather operations. The Pilot-Vehicle Interface (PVI) is the key component of any system that offers pilot cognitive decision aiding, since the PVI is the intelligent interface that determines how and when to aid the pilot. This paper presents an overview of the Pilot's Associate and D/NAPS programs, and elucidates the requirements of an intelligent Pilot-Vehicle Interface. Author

A92-17597*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SENSOR FUSION FOR SYNTHETIC VISION
M. PAVEL, J. LARIMER, and A. AHUMADA (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Computing in Aerospace Conference, 8th, Baltimore, MD, Oct. 21-24, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 164-173. refs
(AIAA PAPER 91-3730)

Display methodologies are explored for fusing images gathered by millimeter wave sensors with images rendered from an on-board terrain data base to facilitate visually guided flight and ground operations in low visibility conditions. An approach to fusion based on multiresolution image representation and processing is described which facilitates fusion of images differing in resolution within and between images. To investigate possible fusion methods, a workstation-based simulation environment is being developed. Author

A92-17628#
PUTTING TEN POUNDS OF AVIONICS IN A ONE POUND PACKAGE (CAN WE DO IT AGAIN?)
J. D. SEALS (AT&T Bell Laboratories, Whippany, NJ) IN: AIAA Computing in Aerospace Conference, 8th, Baltimore, MD, Oct. 21-24, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 421-426.
(AIAA PAPER 91-3766)

Each new generation of avionics is driven by the same requirements - provide a ten-fold improvement in performance density, halve the cost, and double the reliability. In the past, avionics designers have been able to meet these requirements through advances in device technology and faster clocking. Further advances in performance density will require accompanying improvements in interconnection, packaging, and thermal management. Multichip modules, 3D interconnections, conformal packaging, and liquid cooling could provide these needed improvements, but their reliability and compatibility with other avionics components is largely unknown. A program has been initiated to prototype and evaluate these and other promising interconnection and packaging approaches for avionics applications. This paper describes some of the prototypes and presents some preliminary test results. Author

A92-18611 Technion - Israel Inst. of Tech., Haifa.
ADAPTIVE SUPPRESSION OF BIODYNAMIC INTERFERENCE *IN HELMET-MOUNTED DISPLAYS AND HEAD* TELEOPERATION
S. J. MERHAV (Technion - Israel Institute of Technology, Haifa) and S. LIFSHITZ Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Nov.-Dec. 1991, p. 1173-1180. refs
(Contract NAGW-1128; AF-AFOSR-88-0298)
Copyright

This paper addresses errors caused by vibration or turbulence in airborne helmet displays and teleoperation. It is shown by analysis and computer simulations that a modified version of the least-mean-squares adaptive noise suppression algorithm facilitates the separation of the large voluntary head movements from the vibration-induced small nonvoluntary head motion. Thus, the effects

of the biodynamic interference can be essentially removed. The results also indicate that errors in head-tracking teleoperated devices can essentially be suppressed. Extensive man-in-the-loop laboratory simulations that validate the method are described.
Author

A92-18937
INFRA-RED OFFERS NEW LANDING AID COMPETITION
BILL SWEETMAN Interavia Aerospace Review (ISSN 0020-6512), vol. 46, Dec. 1991, p. 62-66.
Copyright

An overview is presented of the development of civil enhanced visual systems (EVS), a forward looking FLIR/HUD combination that could be certificated for airliners within two years. EVS has evolved from FAA/USAF work in synthetic visual systems, the aim of which is to demonstrate redundant, all-weather landing guidance utilizing FLIR and millimeter-wave radar. One advantage of EVS over autoland is that it is an intuitive landing aid that makes all approaches visual, thus extending the pilot's performance rather than placing the pilot in the role of a monitor. R.E.P.

A92-19251
ON-BOARD DATA ACQUISITION SYSTEM FOR EMBRAER'S CBA123
SERGIO D. PENNA (EMBRAER-Empresa Brasileira de Aeronautica, S.A., Sao Jose dos Campos, Brazil) IN: ITC/USA/'90; Proceedings of the International Telemetering Conference, Las Vegas, NV, Oct. 29-Nov. 2, 1990. Research Triangle Park, NC, Instrument Society of America, 1990, p. 595-604.
Copyright

The requirements of the onboard data acquisition system and alternatives proposed for a new 19-seat, twin-engine turboprop commuter aircraft are described. These requirements include light weight, small size, modular design, reduced cabling, and easily installed connectors. The onboard data acquisition system should be capable of accommodating a large number of analog channels with programmable gain, offset, and excitation voltage settings.
R.E.P.

A92-19252
A NEW 1553 ALL-BUS INSTRUMENTATION MONITOR
ALBERT BERDUGO and WILLIAM G. RICKER (Aydin Corp., Vector Div., Newtown, PA) IN: ITC/USA/'90; Proceedings of the International Telemetering Conference, Las Vegas, NV, Oct. 29-Nov. 2, 1990. Research Triangle Park, NC, Instrument Society of America, 1990, p. 605-612. refs
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The present study discusses an airborne instrumentation monitor which acquires the information from up to eight dual-redundant buses, and formats the data for telemetry, recording, or real-time analysis according to the general requirements of IRIG-106-86, Chapter 8. An overview of these requirements is given, and the way in which the ALBUS-1553 handles specific Chapter 8 requirements is described. The ALBUS-1553 acquires all or selected 1553 messages which are formatted into IRIG-compatible serial data stream outputs. Data are time-tagged to microsecond resolution. The unit selectively transmits entire or partial 1553 messages under program control. This results in reduced transmission bandwidth if prior knowledge of 1553 traffic is known. The ALBUS also encodes analog voice inputs, discrete user-word inputs, and multiplexed analog (overhead) inputs. P.D.

A92-20025
RETROFIT PROVIDES NAVIGATION ENHANCEMENT FOR OLDER AIRCRAFT
GEORGE NOREN and JOSEPH E. O'RENDY (Litton Aero Products, Moorpark, CA) ICAO Journal (ISSN 0018-8778), vol. 46, Nov. 1991, p. 24, 25.
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The options available to retrofit an older aircraft's earlier gimballed INS confronts the operator with two alternatives: a current laser INS can be installed in place of an older INS, or the avionics compartment can be rewired to accommodate a flight management system. Consideration is given to a ring laser gyro strapdown INS, the LTN-92, which meets analog, digital, and Arinc 429 requirements in a standard size unit. For future growth, this INS has provision for a GPS processor card and Arinc 429 bus to provide this improvement when GPS becomes a commercially certifiable method of navigation update. R.E.P.

N92-14047# Aeronautical Systems Div., Wright-Patterson AFB, OH.
EVOLUTION OF AVIONIC SYSTEMS ARCHITECTURE, FROM THE 1950'S TO THE PRESENT
GARY L. LUDWIG *In* AGARD, The Conflicting Forces Driving Future Avionics Acquisition 7 p Sep. 1991
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The evolution of the avionic systems architectures in the U.S. Air Force fighter aircraft is described, beginning with the system design typical of the Century Series aircraft (the F-100, F-101, etc.) and progressing on through the long list of fielded aircraft to the front-line fighters of today and beyond to the system currently under development at the Aeronautical Systems Division. In parallel with this description, the forcing functions and catalysts for change of avionic systems architecture are also noted. In this regard, the rapid shift to digital avionics made possible by the transistor and the integrated circuit, wafer-scale integration, and high-density mass memory devices has rapidly driven the evolution of avionic system architecture. Attendant with such technology advancements, pilot interface associated with each new generation of avionic subsystem has also continued to mature and this also has had a major impact on system design. With the ever-increasing capabilities of weapons systems, pilot workload has increased dramatically. The need for simplification, integration, and automation of operator functions has become abundantly clear. The evolution of system design features intended to ease the operator's burden have greatly influenced system design, and these impacts are also reviewed. In conclusion, a quick glimpse at future means of supporting the pilot is provided, and the implications on future avionic system design are reviewed. Author

N92-14048# Aeronautical Systems Div., Wright-Patterson AFB, OH.
AVIONICS STANDARDIZATION IN THE USAF: 1980 TO 1990
NANCY L. CLEMENTS *In* AGARD, The Conflicting Forces Driving Future Avionics Acquisition 9 p Sep. 1991
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A review of avionics standardization from 1980-1990 is presented. Background, definitions, and anticipated benefits of avionics standardization are presented followed by the current extent of standards application and associated cost avoidance summaries. Lessons learned from the past 10 years are highlighted along with efforts underway to define a set of standardization, application, and implementation criteria designed to identify future avionics standardization initiatives and quantify anticipated benefits. Author

N92-14049# Boeing Military Airplane Development, Seattle, WA. Avionics Technology Div.
HISTORICAL PERSPECTIVE ON THE EVOLUTION OF AVIONICS STANDARDS
JOHN C. RUTH *In* AGARD, The Conflicting Forces Driving Future Avionics Acquisition 12 p Sep. 1991
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An Avionics Laboratory major program, the Digital Avionics Information System (DAIS), played a key role in the evolution of interface standards from the late 1960's to the middle 1980's. The DAIS program considered interface standards in its basic concept and the cornerstones of the DAIS concept were: (1) A digital multiplex distribution system; (2) Functional software coded in a Higher Order Language; (3) A functional interface standard

for processors in the form of a common instructional set architecture; and (4) A glass cockpit with interactive displays. The DAIS hypothesis was that significant ownership savings could be obtained on an aircraft and other weapon systems if some type of standard interfaces were established. Commonality of hardware was not the driving issue, but standards which defined the key interfaces and did not inhibit creative and innovative technology upgrades were imperative. The DAIS program endorsed many of the standards, 1553, 1589, 1750, and 1760, by which avionics designers now design highly integrated systems. Author

N92-14050# Ministry of Defence, Paris (France). Integration Div.

AVIONICS STANDARDIZATION IN EUROPE

L. GUIBERT *In* AGARD, The Conflicting Forces Driving Future Avionics Acquisition 15 p Sep. 1991

Avionics standardization in Europe has relied upon common standards, such as Stanags. That approach is not rigid enough to ensure real interoperability, as will be demonstrated with the Link 16 example. It is foreseen that one of the major challenges for future avionics standardization will be the modularity. For some reasons, there must be international commonality in order to obtain minimization of costs. One important issue is the applicability of modular avionics on board European aircraft. This has been studied in France with relation to the Rafale. The results of that study will be discussed in some details. Another issue is the standardization of Instruction Set Architectures (ISA) in the field of data processing. That concept helps to solve some problems, such as software interchangeability and reconfigurability, but it also has drawbacks. A solution to the problem which does not imply common ISAs is predicted in France: the software bus. That concept, related to the Real Time Ada Extension program is proposed. It is clearly understood in Europe that modular avionics will gain maximum advantage if its F31 specifications are common to the different nations and services within NATO. This enforces the need for cooperation at both governmental and industrial levels. Europe has launched two multinational programs in order to define and validate a common avionics architecture for application in the next century: the ASAAC and the EUCLID CEPA 4. The scope and content of the first phase of these programs will be described. Author

N92-14051# Thomson-CSF, Malakoff (France). Radar and Counter-Measures Div.

MIXED APPROACH TOWARDS MODULAR AVIONICS CONFLICTING REQUIREMENTS

J. P. LACROIX *In* AGARD, The Conflicting Forces Driving Future Avionics Acquisition 10 p Sep. 1991

New development efforts like PAVE-PILLAR and PAVE-PACE in the US, EUCLID CEPA 4 in Europe, aim at architecture selection or standards recommendations in order to satisfy at least three requirement domains: LCC (life cycle cost) requirements; performance requirements, and availability requirements. A tool is described (graphic capture and simulation) which aims to bring some methodological help for designing modular integrated avionics systems, by allowing a more accurate analysis of their dynamical behavior. The refinement of the system modelization is tightly dependent on the performance of the simulation package. Author

N92-14052# Ministry of Defence, London (England).

AVIONICS SOFTWARE EVOLUTION

JOHN A. TURTON *In* AGARD, The Conflicting Forces Driving Future Avionics Acquisition 17 p Sep. 1991

The critical software related aspects are reviewed, where thorough planning and implementation of philosophies and principles are needed, in order to be able to develop software based avionic systems to meet target timescales and budgets. Some of the critical software technologies are identified that will facilitate this process, both today and in the near future. The implications are described for software resulting from the currently emerging modular avionic architectures. A central theme is that the system and software generation process should be placed on as formal a theoretical basis as possible. This is in order to be able to deal effectively with the complexity of the software based avionic systems that are just around the corner. Author

N92-14053# Aeronautical Systems Div., Wright-Patterson AFB, OH.

COMMON AVIONICS BASELINE: THE PRODUCT OF THE JOINT INTEGRATED AVIONICS WORKING GROUP

CHRISTOPHER L. BLAKE *In* AGARD, The Conflicting Forces Driving Future Avionics Acquisition 12 p Sep. 1991

The JIAWG CAB is expected to have enormous influence on the entire next generation of avionic systems. It is imperative that good standardization decisions, based on a credible data base of design, test, and analysis, be used as the basis for CAB definition. Premature publication of specifications and standards whose content is not well founded and likely to change could cause resources to be wasted by the industry and could fatally undermine the credibility of this DOD avionics commonality thrust. The CAB development is concurrent with the development phases of the Light Helicopter and Advanced Tactical Fighter programs from which the data needed to close remaining technical issues will be derived. The JIAWG process provides a systematic way to define technical issues and alternative solutions and to draw on all valid data sources in establishing the preferred resolution of each issue. This process will be tightly coordinated with the weapon system programs to ensure specifications and standards incorporate adequate and current data from analysis and testing to complete each version of the CAB as part of planned weapon system development milestones. Author

N92-14054# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Systems Engineering Branch.

AVIONICS SYSTEMS DEVELOPMENT: TECHNOLOGICAL TRENDS, CONFLICTS, AND COST ISSUES IN A CHANGING EUROPEAN ENVIRONMENT

HELMUT RAPP *In* AGARD, The Conflicting Forces Driving Future Avionics Acquisition 15 p Sep. 1991

Presented here is an overview of German research and development projects generally known as modular avionics and their relationship to international initiatives. Growing system software complexity as well as rising software problems and cost have forced software development into rigid development methods and high order languages, and towards increasing standardization. Focussed upon are equipment standards that allow technology growth, maximize competition, and promote reusability of designs, and the avionics system software evolution and the experiences gained in the German TORNADO and F-4F upgrade programs. Author

N92-14055# Aeronautical Systems Div., Wright-Patterson AFB, OH.

AVIONICS MODERNIZATION/UPGRADES IN THE LATE 1990S

RONALD S. VOKITS *In* AGARD, The Conflicting Forces Driving Future Avionics Acquisition 5 p Sep. 1991

A number of issues relative to avionics upgrading are briefly discussed. Capability and supportability improvements; maintenance philosophy; availability, diagnostics, software, and packaging improvements; mixing of old and new technologies; standards; life cycles; and predictions are among the topics covered. Author

N92-14056# Aeronautical Systems Div., Wright-Patterson AFB, OH. Integrated Engineering and Technical Management Div.
AVIONICS RELIABILITY, DURABILITY, AND INTEGRITY: CAN THEY BE INDEPENDENT OF APPLICATION?
HAROLD W. UNDERWOOD *In* AGARD, The Conflicting Forces Driving Future Avionics Acquisition 22 p Sep. 1991
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The development of avionics through the application of traditional MIL-STD-785, Reliability Program for Systems and Equipment Development and Production development processes for avionic reliability has been proven to have several advantages, disadvantages, and limitations. This process is contrasted to the Avionics Integrity process which is based upon the knowledge of how the equipment is to be used, the actual environments of the operating equipment, and the application of fatigue theory and life laws to design. The process is based upon a detailed understanding of the characteristics of the parts, materials, and associated processes used in its manufacture, and the tailoring of the process controls, inspection, and test requirements. The outcome of the process will be avionics with a minimum life that is dependent upon the operational stresses applied. Additionally, a number of conflicts associated with the use of standard environments, standard parts, the use of redundancy, who is responsible for reliability, MIL-SPEC design criteria, mean time between failure as a metric, and warranties are also addressed. Author

N92-14058# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH. Systems Integration Div.
AVIONICS TECHNOLOGY BEYOND 2000
LESTER MCFAWN and D. R. MORGAN *In* AGARD, The Conflicting Forces Driving Future Avionics Acquisition 27 p Sep. 1991
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If current trends continue, military avionics will face a very difficult situation at the turn of the century. This situation is predicted despite the impressive strides made in avionics performance, reduced weight per function, reduced cost per function, and a steady improvement in hardware reliability over the past 20 years. If we are unable to achieve a reasonably balanced affordability/availability/performance capability triad, there will be no other option than to substantially reduce either the number of weapon systems or their war-fighting capability. The basic architectural framework and modular avionics strategy needed to achieve this triad will soon be in place. Most of the needed enabling technologies are under development. The next step will be to carefully exploit, integrate, and validate these technologies in bold, innovative ways. Dramatic change will be needed in the way we integrate and share sensor functions; in the way we develop and support software; and in the design environments we use. Projected factors that will fundamentally impact future avionics systems and the implications of these factors are discussed along with avionics architecture, 21st century avionics software, and the future avionic system design environment. Author

07

AIRCRAFT PROPULSION AND POWER

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

A92-17503
NUMERICAL SIMULATION FOR VARIOUS FLOWFIELDS OF AERO-ENGINE COMPONENTS
KOJI MATSUNAGA, YASUNORI ANDO, ATSUSHIGE TANAKA, and HIDEMI TOH Ishikawajima-Harima Engineering Review (ISSN 0578-7904), vol. 31, July 1991, p. 230-237. In Japanese. refs

Advances in aero-engine performance and economy are achieved by a fusion of many individual efforts in technology. Significant advances in the evolution and rationalization of aerodynamic technology appear in the development and utilization of CFD. CFD demonstrates valuable applications and is an essential complement to testing and experimentation. A brief review is presented of the current status and the future of CFD on the aero-engine development including: (1) 3D compressible Navier-Stokes computation for turbine-vane configurations; (2) incompressible Navier-Stokes computation for gas turbine combustor; and (3) Euler and Navier-Stokes computations for some ducts, stator/downstream strut interaction and swan-neck duct. Author

A92-17828#
HYPERSONIC AIRBREATHING PROPULSION ACTIVITIES FOR SAENGER
R. LEDERER, R. R. SCHWAB (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, Federal Republic of Germany), and N. VOSS (MBB GmbH, Ottobrunn, Federal Republic of Germany) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 10 p. Research supported by BMFT. refs
(AIAA PAPER 91-5040) Copyright

The airbreathing propulsion technology concept for the German Saenger Space Transportation System lower stage is presented. Attention is given to the two principal components of the propulsion system, the ram combustor and the exhaust nozzle. Examples of decisive design considerations such as internal performance, overall performance, weight, cooling, and airframe integration are provided. R.E.P.

A92-17848#
HYDROGEN EXHAUST GAS DISPOSITION BY AFTERBURNING
G. D. GARRARD and C. S. BARTLETT (Sverdrup Technology, Inc., Arnold AFB, TN) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 10 p. refs
(AIAA PAPER 91-5075)

A review of an ongoing program to provide an exhaust gas afterburning aerothermodynamic design database is presented. To provide a useful propulsion system operation time over the facility operating envelope of Mach number and altitude for efficient NASP propulsion system testing, a hydrogen disposition system (HDS) will be employed. Without the HDS, propulsion system operation times could be restricted to prevent dangerous levels of air and hydrogen from forming in the exhaust system. A successful HDS system will lower the hydrogen level in the exhaust system to under the flammability level. The HDS concept selection process resulting in the recommendation to burn the flammable hydrogen and air mixture with piloted flameholders is discussed. R.E.P.

A92-17849#
SCRAMJET RESEARCH AT THE NATIONAL AEROSPACE LABORATORY
HIROSHI MIYAJIMA (National Aerospace Laboratory, Kakuda Research Center, Japan) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 10 p. refs
(AIAA PAPER 91-5076) Copyright

A review of research conducted on scramjet engines at the National Aerospace Laboratory of Japan is presented. An initial configuration was adopted similar to that of the NASA Langley fixed-geometry, airframe-integrated modular scramjet. Results of component tests and numerical simulations, subscale engine design and fabrication, and special features of the ramjet test facility currently under construction are discussed. R.E.P.

A92-18198
AERODYNAMIC DAMPING OF BLADE VIBRATIONS IN TURBOMACHINES [AERODINAMICHESKOE DEMPFIROVANIE KOLEBANII LOPATOK TURBOMASHIN]
GEORGII S. PISARENKO and ARKADII A. KAMINER Kiev, Izdatel'stvo Naukova Dumka, 1991, 304 p. In Russian. refs
Copyright

Results of a study of the aerodynamic damping of blade vibrations in turbomachines are reported, with allowance made for factors determining the interaction of vibrating blades with the flow. In particular, attention is given to methods for determining the characteristics of aerodynamic damping of blade vibrations, principles governing the design of models used in experimental studies of aerodynamic damping, modeling of nonstationary aerodynamic processes, and equipment used in aerodynamic damping studies. V.L.

A92-18292
A PROBABILISTIC METHOD FOR MONITORING THE REMAINING LIFE OF AIRCRAFT GAS TURBINE ENGINE COMPONENTS USING THE TEMPERATURE LIMIT CRITERION [VEROIATNOSTNYI METOD KONTROLIA RASKHODOVANIIA RESURSA DETALEI AGTD PO KRITERIIU PREDEL'NOI TEMPERATURY]
A. N. VETROV, A. G. KUCHER, and N. A. SNEGIREV (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukraine) Problemy Prochnosti (ISSN 0556-171X), Oct. 1991, p. 54-58. In Russian. refs
Copyright

A method is proposed for predicting the remaining life of aircraft engine components is proposed which is based on the probabilistic comparison of the the maximum in-flight temperatures of the components with the temperature limits of their materials. The maximum temperature and temperature limit distributions are described by extreme-value laws whose parameters can be best estimated by the least squares method. A series of integral relations for the gamma-percent remaining life are obtained which require the use of numerical methods. V.L.

A92-19275
AN INTEGRATED REAL-TIME TURBINE ENGINE FLIGHT TEST SYSTEM
MIKE MORO (Allied-Signal Aerospace Corp., Garrett Engine Div., Phoenix, AZ) and PAUL J. FRIEDMAN (Loral Instrumentation, San Diego, CA) IN: ITC/USA/'90; Proceedings of the International Telemetering Conference, Las Vegas, NV, Oct. 29-Nov. 2, 1990. Research Triangle Park, NC, Instrument Society of America, 1990, p. 791-805. refs
Copyright

Commercial off-the-shelf telemetry systems for 'quick-look' to ensure data integrity on board the Boeing 720 test platform are addressed. Particular attention is given to a ground station based on a distributed architecture which designed to serve multiple engineering disciplines through acquisition subsystem serving data to independent color graphics workstations via an Ethernet local network. O.G.

A92-19696
MULTIAXIAL LOAD SPECTRA IN A COOLED GAS TURBINE BLADE UNDER IN-SERVICE CONDITIONS
A. FISCHERSWORRING-BUNK (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, Federal Republic of Germany) IN: Fatigue 90; Proceedings of the 4th International Conference on Fatigue and Fatigue Thresholds, Honolulu, HI, July 15-20, 1990. Vol. 1. Birmingham, England, Materials and Component Engineering Publications, Ltd., 1990, p. 423-428. refs
Copyright

The computed cyclic inelastic stress-strain response of a cooled turbine blade of a jet engine under in-service loading conditions is described covering the aspects of multiaxiality, associated nonproportionality, superimposed hydrostatic pressure and thermomechanical phase relationship. Stress coefficients are presented to describe multiaxiality. A normalized stress function is used to synthesize part of the resulting stress characteristics. All the histories are discussed in the context of related crack initiation life predictive techniques based on parametric relationships, giving emphasis to the aspect of multiaxiality. Author

A92-20734
EVALUATION OF A BOUNDED HIGH-RESOLUTION SCHEME FOR COMBUSTOR FLOW COMPUTATIONS
BERTHOLD NOLL (Karlsruhe, Universitaet, Federal Republic of Germany) AIAA Journal (ISSN 0001-1452), vol. 30, Jan. 1992, p. 64-69. Research supported by DFG. refs
Copyright

The present paper is concerned with the application of a high-resolution scheme for a finite volume discretization method. The capability of the chosen scheme is evaluated for the numerical simulation of three-dimensional flowfields. Special emphasis lies in the calculation of the processes in the mixing zone of gas turbine combustors. Thus, numerical results are compared with detailed measurements of velocity and temperature in a model mixing zone. The velocity field as well as the temperature field strongly depend on the scheme used for the discretization of the momentum and energy equations. The proposed high-resolution scheme and the well-known QUICK scheme yield similar results, which are superior to those obtained with the simple UPWIND scheme. For the simulation of turbulent transport, the standard k, epsilon model is employed. The effect of numerical diffusion caused by the usual UPWIND discretization of the convective transport of k and epsilon is assessed by the application of the high-resolution scheme of the discretization of the k and epsilon equations. As a result, it is found that the velocity and temperature fields are insensitive to the scheme that is applied for the discretization of the k and epsilon equations. Author

N92-13938*# Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Cincinnati, OH.
RECENT PROGRESS IN INVERSE METHODS IN FRANCE
PIERRE-FRANCOIS BRY, OLIVIER-PIERRE JACQUOTTE, and MARIE-CLAIRE LEPAPE (Office National d'Etudes et de Recherches Aeronautiques, Paris, France) *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 123-144 1991
Avail: NTIS HC/MF A99 CSCL 21E

Given the current level of jet engine performance, improvement of the various turbomachinery components requires the use of advanced methods in aerodynamics, heat transfer, and aeromechanics. In particular, successful blade design can only be achieved via numerical design methods which make it possible to reach optimized solutions in a much shorter time than ever before. Two design methods which are currently being used throughout the French turbomachinery industry to obtain optimized blade geometries are presented. Examples are presented for compressor and turbine applications. The status of these methods as far as improvement and extension to new fields of applications is also reported. Author

N92-13939*# Shanghai Inst. of Mechanical Engineering (China). Lab. of Turbomachinery Aerodynamics.
RESEARCH ON INVERSE, HYBRID AND OPTIMIZATION PROBLEMS IN ENGINEERING SCIENCES WITH EMPHASIS ON TURBOMACHINE AERODYNAMICS: REVIEW OF CHINESE ADVANCES
GAO-LIAN LIU *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 145-163 1991
Avail: NTIS HC/MF A99 CSCL 21E

Advances in inverse design and optimization theory in engineering fields in China are presented. Two original approaches, the image-space approach and the variational approach, are discussed in terms of turbomachine aerodynamic inverse design. Other areas of research in turbomachine aerodynamic inverse design include the improved mean-streamline (stream surface) method and optimization theory based on optimal control. Among the additional engineering fields discussed are the following: the inverse problem of heat conduction, free-surface flow, variational cogeneration of optimal grid and flow field, and optimal meshing theory of gears. Author

N92-13956*# Fiat Aviazione S.p.A., Turin (Italy).
RESEARCH ON INVERSE METHODS AND OPTIMIZATION IN ITALY
FRANCESCO LAROCCA *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 371-390 1991
Avail: NTIS HC/MF A99 CSCL 21E

The research activities in Italy on inverse design and optimization are reviewed. The review is focused on aerodynamic aspects in turbomachinery and wing section design. Inverse design of blade rows and ducts of turbomachinery in subsonic and transonic regime are illustrated by the Politecnico di Torino and turbomachinery industry (FIAT AVIO). Author

N92-13973*# Tsinghua Univ., Bejing (China). Dept. of Thermal Engineering.
DESIGN OF TRANSONIC COMPRESSOR CASCADES USING HODOGRAPH METHOD
ZUOYI CHEN and JINGRONG GUO *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 593-598 1991
Avail: NTIS HC/MF A99 CSCL 21E

The use of the Hodograph Method in the design of a transonic compressor cascade is discussed. The design of the flow mode in the transonic compressor cascade must be as follows: the flow in the nozzle part should be uniform and smooth; the location of the sonic line should be reasonable; and the aerodynamic character of the flow canal in the subsonic region should be met. The rate through cascade may be determined by the velocity distribution in the subsonic region (i.e., by the numerical solution of the Chapiygin equation). The supersonic sections A'C' and AD are determined by the analytical solution of the Mixed-Type Hodograph equation. Author

N92-13977# Toronto Univ., Downsview (Ontario). Inst. for Aerospace Studies.
AERODYNAMICS
J. D. DELAURIER, G. W. JOHNSTON, D. W. ZINGG, W. D. MCKINNEY, C. HAYBALL, G. SAARENVIRTA, J. D. LOWE, B. WOODCOCK, S. HULSHOFF, H. MURTY et al. *In its* Activities of the University of Toronto Institute for Aerospace Studies p 54-58 1989
Avail: NTIS HC/MF A06

A brief review of aerodynamic investigations currently underway at the Institute for Aerospace Studies is provided. An extensive investigation of airship dynamics and turbulence response has resulted in the development of a numerical analysis of airship dynamic stability and stochastic response. Research on the performance and detailed design of a remotely piloted microwave powered aircraft is underway. A 12-m span airframe is currently being constructed to assist in the development of an automatic flight control system. The aerodynamics of flapping wing flight are being studied to provide understanding of the energetics and efficiency of animal flight. A two phase program has been initiated to study finite amplitude response and flutter of two dimensional airfoils involving the computation of steady and unsteady transonic flows using nonlinear full potential equations. A number of studies of propeller aerodynamics are underway including: development of a generalized incompressible 3-D propeller analysis code; an experimental unsteady propeller loading study; application of modern computational methods to the work of Theodorsen on propeller efficiency; development of a 3-D undsteady Euler code to study propeller wing interaction at transonic speed; and investigation of the modified viscous boundary flow found on rotating propeller blades. Airfoil flow on trailing edges and on leading edge slat airfoil combinations are currently being studied. A research duct facility has been built to study the destruction of toxic hydrocarbon gases by irradiated ozone. Finally, an evaluation of various turbulence models for the computation of 3-D internal flows is in progress. CISTI

N92-14059# Innovative Textile Applications Co., Grand Junction, CO.
UNIVERSAL WEAVING FOR TURBINE ENGINE COMPOSITE PREFORMS Final Report, Jul. 1990 - Mar. 1991
KONRAD L. KRAULAND May 1991 47 p
(Contract F33615-90-C-2066)
(AD-A237667; WL-TR-91-2051) Avail: NTIS HC/MF A03 CSCL 11/5

The 3-D weaving/braiding technology being pursued at ITAC has the potential to result in techniques for manufacturing low cost, high volume, near net shape, multiaxially reinforced (through the thickness) fibrous preforms, utilizing a cartesian weaving/braiding plane, for high temperature composite applications. These techniques lend themselves to the manufacture of hybrid preforms; fiber assemblies that contain more than one shape or fiber architecture. With this tool, designers may optimize the fiber structure and shape of a preform along the length of composite parts to maximize performance. A low cost hand loom has been designed and built to demonstrate concepts empirical to this technology, laying the ground work for a fully automated 3-D cartesian weaving machine. GRA

N92-14060# National Research Council of Canada, Ottawa (Ontario). Engine Lab.
RUB INDUCED ROTOR/STATOR VIBRATION ANALYSIS ON CF700 ENGINE
BULENT TUDES (Turkish Air Force Academy, Istanbul.) Jan. 1991 101 p Sponsored by Dept. of National Defence
(NRC-TR-ENG-007; CTN-91-60273) Copyright Avail: NTIS HC/MF A06

This report presents studies carried out on rub-induced rotor/stator vibrations on a CF700 gas turbine engine. The objectives of these studies were to develop signature analysis methodologies and condition monitoring techniques for the early detection of rub-induced instabilities. Spectral analysis was carried out to identify the changes in the levels at blade passing frequencies and other dominant peaks. Both amplitude and phase modulation techniques were employed to identify the rub-induced vibrations and derive parameters that could extract the characteristic features of the signals describing the changes due to several types of rubs. Signals acquired from displacement transducers were too low for any further analysis, as the casing of the engine was much too stiff to yield an enhanced signal. Author (CISTI)

N92-14063*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE AERODYNAMIC EFFECT OF FILLET RADIUS IN A LOW SPEED COMPRESSOR CASCADE Thesis - Von Karman Inst. for Fluid Dynamics
BRIAN P. CURLETT Nov. 1991 49 p
(NASA-TM-105347; E-6717; NAS 1.15:105347) Avail: NTIS HC/MF A03 CSCL 21/5

The aerodynamic effects of fillet size in a low speed compressor cascade were experimentally studied. Two blade profiles were used during the experiment, namely a controlled diffusion blade and a double circular arc blade. Cascades were tested with three fillet radii and two boundary layer thicknesses over a large range of incidence angles. The cascade performance was determined by extensive downstream flow measurements using a two head, 5 hole pressure probe. Results differ significantly between the two types of blades tested. As fillet radius increases secondary flows and total pressure losses were found to increase for the controlled diffusion blades; whereas, for the double circular arc blades the losses decrease, particularly at high incidence angles. Author

N92-14064# Systems Control Technology, Inc., Palo Alto, CA.
TURBINE ENGINE DIAGNOSTICS SYSTEM STUDY Final Report
BARBARA K. MCQUISTON and RONALD L. DEHOFF Oct. 1991 91 p
(Contract DTFA01-87-C-00014)
(DOT/FAA/CT-91/16) Avail: NTIS HC/MF A05

The results of a system study for the Turbine Engine Diagnostics (TED) program are presented. This research project was initiated to develop a method of approach and prototype design for a system capable of predicting the failure of rotating parts in turbine engines. Systems Control Technology (SCT) Inc. was contracted by the Federal Aviation Administration (FAA) and used an innovative approach that assimilated data from multiple sources for determining trends in engine performance and health. SCT initially performed an extensive technical literature search and industry survey to augment the present understanding of current technology in the industry for computerized diagnostics systems and measurement sensor technology. The result of this study is a proposed system with a method of approach that minimizes the technical and financial risk of turbine engines, while at the same time it optimizes the safety factors needed to accurately predict component failures. This proposed system is detailed. The abstracts from the literature search are included. Author

08

AIRCRAFT STABILITY AND CONTROL

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

A92-17837*# Princeton Univ., NJ.
A GEOMETRIC APPROACH TO REGULATOR AND TRACKER DESIGN FOR AN AEROSPACE PLANE
MARK A. VAN BUREN and KENNETH D. MEASE (Princeton University, NJ) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 17 p. refs
(Contract NAG1-907)
(AIAA PAPER 91-5054) Copyright

The paper presents a nonlinear design approach drawing from singular perturbations, feedback linearization, and variable structure control, that leads to regulators with automatic gain scheduling which exhibit similar dynamic behavior over the entire flight envelope of the aerospace plane. Additionally, design approach provides for a systematic way to counter disturbance effects as well as modeling uncertainties. The unifying feature of the three nonlinear feedback control methodologies is that they all have a geometric interpretation. First, the translational dynamics are decomposed into reduced-order slow and fast dynamics by way of a formal singular perturbation analysis. After feedback linearization the fast dynamics are robustly stabilized via a variable structure control approach. The slow dynamics are stabilized using conventional proportional-integral compensation based on the nominal slow dynamics. A number of sample command and disturbance responses at opposite ends of the flight envelope are presented for a nonlinear aerospace plane model. Author

A92-17838*# *National Aeronautics and Space Administration.* Langley Research Center, Hampton, VA.
CONTROL CONCEPT FOR MANEUVERING IN HYPERSONIC FLIGHT
DAVID L. RANEY and FREDERICK J. LALLMAN (NASA, Langley Research Center, Hampton, VA) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 12 p. refs
(AIAA PAPER 91-5055) Copyright

This research investigates an approach to provide precise, coordinated maneuver control during excursions from a hypersonic cruise flight path while observing the necessary flight condition constraints. The approach achieves specified guidance commands by resolving altitude and cross-range errors into a load factor and bank angle command through a coordinate transformation which acts as an interface between outer loop guidance controls and inner loop flight controls. This interface, referred to as a 'resolver', applies constraints on angle-of-attack and dynamic pressure perturbations while prioritizing altitude regulation over crossrange. An unpiloted test simulation, in which the resolver was used to drive inner-loop flight controls, produced time histories of responses to guidance commands at Mach numbers of 6, 10, 15, and 20. It is shown that angle-of-attack and throttle perturbation constraints, combined with high-speed flight effects and the desire to maintain constant dynamic pressure, significantly impact the maneuver envelope for a hypersonic vehicle. Turn rate, climb rate, and descent rate limits are expressed in terms of these constraints. Author

A92-17839*# McDonnell Aircraft Co., Saint Louis, MO.
AEROSERVOELASTIC STABILIZATION TECHNIQUES FOR HYPERSONIC FLIGHT VEHICLES
PETER Y. CHENG, SAMUEL Y. CHAN (McDonnell Aircraft Co., Saint Louis, MO), THOMAS T. MYERS, DAVID H. KLYDE, and DUANE T. MCRUE (Systems Technology, Inc., Hawthorne, CA) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 10 p. Previously announced in STAR as N91-30156. refs
(Contract NAS1-18763)
(AIAA PAPER 91-5056) Copyright

The potential of Hybrid Phase Stabilization (HPS), particularly for highly unstable aircraft, using a hypersonic flight vehicle (HSV) as a relevant example, is discussed. The development of HPS is presented and the result is compared with that generated using a conventional gain stabilization technique. Since HPS was not addressed in the MIL-spec requirements, a preliminary residual response metric was developed to provide guidance in assessing HPS. Author

A92-17840*# Arizona State Univ., Tempe.
DYNAMICS AND CONTROL OF HYPERSONIC VEHICLES - THE INTEGRATION CHALLENGE FOR THE 1990'S
DAVID K. SCHMIDT, HARVEY MAMICH, and FRANK CHAVEZ (Arizona State University, Tempe) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 11 p. refs
(Contract NAG1-1341)
(AIAA PAPER 91-5057) Copyright

The dynamic characteristics of hypersonic vehicles are reviewed, with special attention to the interactions between the airframe, engine, and structural dynamics. Based on a preliminary investigation of the dynamics of a generic vehicle configuration similar to the X-30 with Scramjet propulsion, an assessment of these interactions is presented. The control effectors include aerodynamic pitch-control surfaces, as well as engine fuel flow and diffuser area ratio. The study configuration is statically instable in pitch, and exhibits strong airframe/engine/elastic coupling in the attitude dynamics and engine responses. This strong coupling will require a highly integrated airframe-engine control system, and the performance of the attitude control system will be contingent upon the ability to adequately deal with the structural aeroelastic response and engine dynamics. Author

A92-18463
REGULATION OF RELAXED STATIC STABILITY AIRCRAFT
HARRY G. KWATNY, JORDAN BERG (Drexel University, Philadelphia, PA), and WILLIAM H. BENNETT (Techno-Sciences, Inc., Greenbelt, MD) IEEE Transactions on Automatic Control (ISSN 0018-9286), vol. 36, Nov. 1991, p. 1315-1323. refs
(Contract F33615-88-C-3606)
Copyright

The authors formulate and solve a regulator problem for nonlinear parameter-dependent dynamics. It is shown that the problem is solvable except at parameter values associated with bifurcation of the equilibrium equations and that such bifurcations are inherently linked to the system zero dynamics. These results are applied to the study of the regulation of the longitudinal dynamics of aircraft. It is shown how bifurcation points arise in these problems and why they affect solvability of the regulator problem. The relationships between bifurcation, system zeros, and dynamic and static stability are illustrated. I.E.

A92-18601
RETROSPECTIVE ESSAY ON NONLINEARITIES IN AIRCRAFT FLIGHT CONTROL
DUNSTAN GRAHAM (Graham-Metsys, Inc., Pocono Pines, PA) and DUANE MCRUER (Systems Technology, Inc., Hawthorne, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Nov.-Dec. 1991, p. 1089-1099. refs
Copyright

A development history is presented of treatments of the peculiar and potentially destructive behavior manifested in aircraft nonlinear mechanics. With the exception of limiters and such mechanical features as preloading, the effort to define and employ beneficial nonlinearities has been largely unsuccessful. No general theory of nonlinear systems is possible, and analytical methods for the treatment of specific nonlinear effects have undergone very meager development. Discrete nonlinearities are noted to be essential between system architectures, in envelope restrictors, and in redundancy management. O.C.

A92-18608
DYNAMICS OF HANG-GLIDERS
GUIDO DE MATTEIS (Roma I, Universita, Rome, Italy) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Nov.-Dec. 1991, p. 1145-1152. Previously cited in issue 21, p. 3274, Accession no. A89-49069. refs
Copyright

A92-18610
AUTONOMOUSLY AIDED STRAPDOWN ATTITUDE REFERENCE SYSTEM
S. J. MERHAV (Technion - Israel Institute of Technology, Haifa) and M. KOIFMAN (*Israel Annual Conference on Aviation and* Astronautics, 31st, Tel Aviv, Israel, Feb. 21, 22, 1990, Collection of Papers, p. 141-152) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Nov.-Dec. 1991, p. 1164-1172. Research supported by Ministry of Defence of Israel and Precision Instrument Industries. Previously cited in issue 18, p. 3069, Accession no. A91-43095. refs
Copyright

A92-18615* Clemson Univ., SC.
PARAMETER INSENSITIVE CONTROL UTILIZING EIGENSPACE METHODS
ROBERT E. FENNELL (Clemson University, SC), WILLIAM M. ADAMS, JR. (NASA, Langley Research Center, Hampton, VA), and DAVID M. CHRISTHILF (Lockheed Engineering and Sciences Co., Hampton, VA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Nov.-Dec. 1991, p. 1208-1214. Previously cited in issue 21, p. 3493, Accession no. A88-50204. refs
(Contract N00014-86-K-0693; NAS1-18107)
Copyright

A92-18620 Princeton Univ., NJ.
APPLICATION OF STOCHASTIC ROBUSTNESS TO AIRCRAFT CONTROL SYSTEMS
ROBERT F. STENGEL (Princeton University, NJ) and LAURA R. RAY Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Nov.-Dec. 1991, p. 1251-1259. Research sponsored by FAA. Previously cited in issue 23, p. 3619, Accession no. A89-52598. refs
(Contract NGL-31-001-252)
Copyright

A92-18621
STRUCTURE/CONTROL DESIGN SYNTHESIS OF ACTIVE FLUTTER SUPPRESSION SYSTEM BY GOAL PROGRAMMING
SHINJI SUZUKI (Tokyo, University, Japan) and SEIJI MATSUDA (Nissan Motors Co., Ltd., Tokyo, Japan) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Nov.-Dec. 1991, p. 1260-1266. Previously cited in issue 21, p. 3330, Accession no. A90-47587. refs
Copyright

A92-18622* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
APPLICATION OF AEROSERVOELASTIC MODELING USING MINIMUM-STATE UNSTEADY AERODYNAMIC APPROXIMATIONS
SHERWOOD T. HOADLEY (NASA, Langley Research Center, Hampton, VA) and MORDECHAY KARPEL (Technion - Israel Institute of Technology, Haifa) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Nov.-Dec. 1991, p. 1267-1276. Previously cited in issue 12, p. 1786, Accession no. A89-30678. refs
Copyright

A92-18623
ROLL-PERFORMANCE CRITERIA FOR HIGH AUGMENTED AIRCRAFT
MARIO INNOCENTI (Auburn University, AL) and AJAY THUKRAL Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Nov.-Dec. 1991, p. 1277-1286. Previously cited in issue 21, p. 3275, Accession no. A89-49092. refs
Copyright

A92-18624
NONLINEAR CONTROL OF A TWIN-LIFT HELICOPTER CONFIGURATION
P. K. A. MENON, J. V. R. PRASAD, and D. P. SCHRAGE (Georgia Institute of Technology, Atlanta) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Nov.-Dec. 1991, p. 1287-1293. Research supported by U.S. Army. Previously cited in issue 21, p. 3491, Accession no. A88-50162. refs
Copyright

A92-18625* Army Aviation Systems Command, Moffett Field, CA.
HELICOPTER AIR RESONANCE MODELING AND SUPPRESSION USING ACTIVE CONTROL
M. D. TAKAHASHI (U.S. Army, Aviation Research and Technology Activity, Moffett Field, CA) and P. P. FRIEDMANN (California, University, Los Angeles) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Nov.-Dec. 1991, p. 1294-1300. refs
(Contract NAG2-209; NAG2-477)
Copyright

A coupled rotor/fuselage helicopter analysis with the important effects of blade torsional flexibility, unsteady aerodynamics, and forward flight is presented. Using this mathematical model, a nominal configuration is selected with an air resonance instability throughout most of its flight envelope. A multivariable compensator is then designed using two swashplate inputs and a single-body roll rate measurement. The controller design is based on the linear quadratic Gaussian technique and the loop transfer recovery method. The controller is shown to suppress the air resonance instability throughout a wide range of helicopter loading conditions and forward flight speeds. Author

A92-18626
TIME-PERIODIC CONTROL OF A MULTI-BLADE HELICOPTER
STEVEN G. WEBB (U.S. Air Force Academy, Colorado Springs, CO), ROBERT A. CALICO, and WILLIAM E. WIESEL (USAF, Institute of Technology, Wright-Patterson AFB, OH) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Nov.-Dec. 1991, p. 1301-1308. Previously cited in issue 23, p. 3617, Accession no. A89-52548. refs

A92-19103
ENHANCED AUTOPILOT DESIGN THROUGH HARDWARE-IN-THE-LOOP SIMULATION
JEFFERY C. LUCAS (Nichols Research Corp., Huntsville, AL) IN: 1990 Annual Summer Computer Simulation Conference, 22nd, Calgary, Canada, July 16-18, 1990, Proceedings. San Diego, CA, Society for Computer Simulation, 1990, p. 1019-1023.
(Contract DAAH01-88-D-0002)
Copyright

The recent U.S. Army Precision Deep Attack Missile System (PDAMS) program is discussed. The objective of the program was to demonstrate the feasibility of using electronic inertial image stabilization from a daylight ATV camera in terminal guidance. The program included the design fabrication, and testing of a missile in a near-tactical environment. This paper examines the necessity of a hardware-in-the loop simulation to enhance the autopilot design and to provide a comparison with digital simulation. C.D.

A92-19107
A MULTIDIMENSIONAL TERRAIN MODEL FOR LOW ALTITUDE TRACKING SCENARIOS
J. A. SAFFOLD and M. T. TULEY (Georgia Institute of Technology, Atlanta) IN: 1990 Annual Summer Computer Simulation Conference, 22nd, Calgary, Canada, July 16-18, 1990, Proceedings. San Diego, CA, Society for Computer Simulation, 1990, p. 1113-1118. refs
Copyright

A model that circumvents many of the shortfalls of current approaches for computation of multipath interference is developed. Current approaches utilize equiphase and flat-earth assumptions within the first Fresnel zone to compute coherent multipath (specular) field contributions. This paper describes a two-dimensional terrain representation used to determine the multipath field reflection coefficients for a low altitude scenario. The computed indirect multipath field is combined with the direct field to form a complex interference pattern. The terrain model uses a facet representation with distributed height and slope to describe the contribution of coherent (specular) and noncoherent (diffuse) multipath fields. The multidimensional terrain representation provides a more realistic model of the low altitude electromagnetic environment. Author

A92-19273
THE APPLICATION OF NEURAL NETWORKS TO DRONE CONTROL
DAN GREENWOOD (Netrologic, Inc., San Diego, CA) IN: ITC/USA/'90; Proceedings of the International Telemetering Conference, Las Vegas, NV, Oct. 29-Nov. 2, 1990. Research Triangle Park, NC, Instrument Society of America, 1990, p. 775-781. refs
Copyright

The FAA Sponsored a six months research program to investigate the application of neural networks to controlling aircraft. It was found that properly configured neural networks offer powerful new computationally robust methods to generate command vectors corresponding to collision free routes. Methods using neural networks which capture the expertise employed by controllers in resolving conflicts were formed. This paper shows that many of the neural network techniques applied to ATC can also be applied to drone control. Two different networks are presented: a multi-layer feed-forward network using back-propagation and a method using a potential field where a gradient measure is employed to maintain the aircraft separation in real time. Author

A92-20204* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
PERFORMANCE IMPROVEMENTS OF AN F-15 AIRPLANE WITH AN INTEGRATED ENGINE-FLIGHT CONTROL SYSTEM
LAWRENCE P. MYERS and KEVIN R. WALSH (NASA, Flight Research Center, Edwards, CA) Journal of Aircraft (ISSN 0021-8669), vol. 28, Dec. 1991, p. 812-817. Previously cited in issue 15, p. 2408, Accession no. A88-38747. refs
Copyright

A92-20207 Embraer S.A., Sao Jose dos Campos (Brazil).
ANALYSIS OF AIRCRAFT PERFORMANCE DURING LATERAL MANEUVERING FOR MICROBURST AVOIDANCE
DENISE A. DE MELO (Embraer - Empresa Brasileira de Aeronautica, S.A., Sao Jose dos Campos, Brazil) and R. J. HANSMAN, JR. (MIT, Cambridge, MA) Journal of Aircraft (ISSN 0021-8669), vol. 28, Dec. 1991, p. 837-842. Research supported by Embraer - Empresa Brasileira de Aeronautica, S.A. and MIT. Previously cited in issue 06, p. 767, Accession no. A90-19920. refs
(Contract NGL-22-009-640; NAG1-690)
Copyright

A92-20483
A LOW-ALTITUDE BREAKTHROUGH SYSTEM USING OPTIMAL PATH TERRAIN FOLLOWING
JINWEN AN and SHUNDA XIAO (Northwestern Polytechnical University, Xian, People's Republic of China) Northwestern Polytechnical University, Journal (ISSN 1000-2758), vol. 9, Dec. 1991, p. 1-9. In Chinese. refs

A new scheme for an automatic terrain-following system is designed using a linear programming algorithm and an output predictive control algorithm of the modern control theory. As a result, the algorithm of the automatic optimal terrain-following scheme is simplified, and the accuracy of the aircraft following optical flight path is improved. A parallel data processing multiprocessor system is designed. Simulation results show that the accuracy of path tracking of this system is quite high, with the altitude error being not greater than 3 m. I.S.

N92-14065# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Guidance and Control Panel
KNOWLEDGE BASED SYSTEM APPLICATIONS FOR GUIDANCE AND CONTROL
FRANCO CANEPA (Alenia, Torino, Italy) Jul. 1991 18 p Presented at the 51st Symposium, Madrid, Spain, 18-21 Sep. 1990
(AGARD-AR-284; ISBN-92-835-0624-3; CP-474; AD-A241357)
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An evaluation of the technical papers contributed as part of the Guidance and Control Panel's symposium on knowledge based system applications is presented. The objectives of the symposium are outlined and each of the five sessions comprising the symposium is briefly summarized. These sessions addressed representative guidance and control applications, design concepts and synthesis techniques, related methods and techniques, information processing and system architecture, and mechanization and integration issues. General conclusions related to integration between artificial intelligence (AI) technologies and between AI and conventional technologies are given. All papers presented at the symposium were compiled as conference proceedings AGARD-CP-474. M.G.

N92-14066*# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
RAPID NEAR-OPTIMAL AEROSPACE PLANE TRAJECTORY GENERATION AND GUIDANCE Final Report, 1 Dec. 1988 - 31 Aug. 1991
A. J. CALISE, J. E. CORBAN, and N. MARKOPOULOS Nov. 1991 38 p
(Contract NAG1-922)
(NASA-CR-189469; NAS 1.26:189469) Avail: NTIS HC/MF A03 CSCL 01/3

Effort was directed toward the problems of the real time trajectory optimization and guidance law development for the National Aerospace Plane (NASP) applications. In particular, singular perturbation methods were used to develop guidance algorithms suitable for onboard, real time implementation. The progress made in this research effort is reported. Author

N92-15072# Technische Univ., Brunswick (Germany, F.R.). Fakultaet fuer Maschinenbau und Elektrotechnik.
PROJECT OF AN ADAPTIVE MULTIAXIAL AUTOPILOT WITH LEARNING PILOT CONTROL Ph.D. Thesis [ENTWURF EINES SELBSTEINSTELLENDEN MEHRACHSIGEN FLUGREGLERS MIT LERNENDER VORSTEUERUNG]

ULRICH LINDEMANN 1991 116 p In GERMAN
(ETN-92-90592) Avail: NTIS HC/MF A06

The autopilot was implemented in the form of several computing programs in the digital computer of research aircraft. It was successfully tested in flight trial. The coefficients of a discrete model transfer function were identified from the dynamic behavior of the aircraft. The identification assessed the relation between the autocorrelation of the test signal and the cross correlation of test signal and aircraft behavior. This process proved efficient. A universal applicable software package was developed during the flight trial of the autopilot, which allowed for the testing of control algorithms in real time conditions in the aircraft. ESA

N92-15073# Aeronautical Research Labs., Melbourne (Australia).
F/A-18 STABILATOR: EQUIVALENT SET OF POINT FORCES REQUIRED FOR PNEUMATIC BAG LOAD CASE SIMULATION
SIMON C. DARCY Oct. 1990 44 p
(AD-A242637; ARL-STRUC-TM-571; DODA-AR-006-123) Avail: NTIS HC/MF A03 CSCL 01/3

In preparation for a fatigue test on the F/A-18 rear empennage, a method has been developed to determine actuator loads for the horizontal stabilators. A computer program called STABAG has been written which implements the method to enable automated computation of actuator loads corresponding to input spectrum points. This report describes the program and serves as an operating manual for it. GRA

N92-15074# Naval Air Development Center, Warminster, PA. Air Vehicle and Crew Systems Technology Dept.
NEURAL NETWORK AND FUZZY LOGIC TECHNOLOGY FOR NAVAL FLIGHT CONTROL Interim Report, Sep. 1990 - Jul. 1991
MARC L. STEINBERG and ROBERT D. DIGIROLAMO 6 Aug. 1991 44 p Sponsored by Office of Naval Technology
(AD-A242650; NADC-91080-60) Avail: NTIS HC/MF A03 CSCL 01/4

Neural networks and fuzzy logic have the potential to overcome some of the most difficult problems that occur in the design and implementation of modern flight control systems (FCS). Ultimately, this may yield significant gains in performance, robustness, cost survivability, and reliability. However, it is still uncertain what neural network and fuzzy logic functions are both technologically feasible and suitable for flight control system implementation. In this report, an ongoing comprehensive program to develop and assess this technology for Naval FCS applications is described. Currently, this program is focused on the development of a neural network FCS design tool, a neural network flight control law emulator, a fuzzy logic automatic carrier landing system, and a neural network flight control configuration management system. For each project, some initial results are given. Also, several new and planned projects are discussed. These include learning augmented adaptive control, neural network augmented nonlinear control, optical neurons, and neural augmentation of conventional control systems. GRA

N92-15075*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FORMULATION OF A STRATEGY FOR MONITORING CONTROL INTEGRITY IN CRITICAL DIGITAL CONTROL SYSTEMS
CELESTE M. BELCASTRO, ROBERT FISCHL, and MOSHE KAM (Drexel Univ., Philadelphia, PA.) Nov. 1991 16 p
(NASA-TM-104158; NAS 1.15:104158) Avail: NTIS HC/MF A03 CSCL 01/3

Advanced aircraft will require flight critical computer systems for stability augmentation as well as guidance and control that must perform reliably in adverse, as well as nominal, operating environments. Digital system upset is a functional error mode that can occur in electromagnetically harsh environments, involves no component damage, can occur simultaneously in all channels of a redundant control computer, and is software dependent. A strategy is presented for dynamic upset detection to be used in the evaluation of critical digital controllers during the design and/or validation phases of development. Critical controllers must be able to be used in adverse environments that result from disturbances caused by an electromagnetic source such as lightning, high intensity radiated field (HIRF), and nuclear electromagnetic pulses (NEMP). The upset detection strategy presented provides dynamic monitoring of a given control computer for degraded functional integrity that can result from redundancy management errors and control command calculation error that could occur in an electromagnetically harsh operating environment. The use is discussed of Kalman filtering, data fusion, and decision theory in monitoring a given digital controller for control calculation errors, redundancy management errors, and control effectiveness.
Author

N92-15076*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TRIM DRAG REDUCTION CONCEPTS FOR HORIZONTAL TAKEOFF SINGLE-STAGE-TO-ORBIT VEHICLES
JOHN D. SHAUGHNESSY and IRENE M. GREGORY Dec. 1991 32 p
(NASA-TM-102687; NAS 1.15:102687) Avail: NTIS HC/MF A03 CSCL 01/3

The results of a study to investigate concepts for minimizing trim drag of horizontal takeoff single-stage-to-orbit (SSTO) vehicles are presented. A generic hypersonic airbreathing conical configuration was used as the subject aircraft. The investigation indicates that extreme forward migration of the aerodynamic center as the vehicle accelerates to orbital velocities causes severe aerodynamic instability and trim moments that must be counteracted. Adequate stability can be provided by active control of elevons and rudder, but use of elevons to produce trim moments results in excessive trim drag and fuel consumption. To alleviate this problem, two solution concepts are examined. Active control of the center of gravity (COG) location to track the aerodynamic center decreases trim moment requirements, reduces elevon deflections, and leads to significant fuel savings. Active control of the direction of the thrust vector produces required trim moments, reduces elevon deflections, and also results in significant fuel savings. It is concluded that the combination of active flight control to provide stabilization, (COG) position control to minimize trim moment requirements, and thrust vectoring to generate required trim moments has the potential to significantly reduce fuel consumption during ascent to orbit of horizontal takeoff SSTO vehicles. Author

09

RESEARCH AND SUPPORT FACILITIES (AIR)

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

A92-17818#
THRUST NOZZLE TEST FACILITY AT DLR COLOGNE
H. G. HUNGENBERG, K. H. STURSBERG, and H. B. WEYER (DLR, Institut fuer Antriebstechnik, Cologne, Federal Republic of Germany) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 11 p. Research sponsored by BMFT. refs
(AIAA PAPER 91-5024) Copyright

DLR Cologne has built a thrust nozzle test facility for high temperature model tests on nozzles of hypersonic vehicles like Saenger. The facility has been designed to simulate the aerothermodynamic flow field conditions within a ramjet at flight Mach numbers of about 3.5 to 7. The high-temperature-ramcombustor intake conditions will be generated by precombustors and the low pressure exhaust conditions will be provided by a diffuser working against atmospheric pressure. The total temperature up to 3000 K will be achieved by hydrogen

combustion. When fully operational, the facility will have the capability to measure flow parameters with laser diagnostics and thrust coefficients with a strain-gage balance. Author

A92-17819*# Purdue Univ., West Lafayette, IN.
A QUIET-FLOW LUDWIEG TUBE FOR EXPERIMENTAL STUDY OF HIGH SPEED BOUNDARY LAYER TRANSITION
STEVEN P. SCHNEIDER (Purdue University, West Lafayette, IN) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 12 p. Previously announced in STAR as N91-25107. refs
(Contract NAG1-1133; NAG1-1201)
(AIAA PAPER 91-5026) Copyright

Laminar-turbulent transition in high speed boundary layers is a complicated problem which is still poorly understood, partly because of experimental ambiguities caused by operating in noisy wind tunnels. The NASA Langley experience with quiet tunnel design has been used to design a quiet flow tunnel which can be constructed less expensively. Fabrication techniques have been investigated, and inviscid, boundary layer, and stability computer codes have been adapted for use in the nozzle design. Construction of such a facility seems feasible, at a reasonable cost. Two facilities have been proposed: a large one, with a quiet flow region large enough to study the end of transition, and a smaller and less expensive one, capable of studying low Reynolds number issues such as receptivity. Funding for either facility remains to be obtained, although key facility elements have been obtained and are being integrated into the existing Purdue supersonic facilities. Author

A92-18100
HEAVY METAL
DOUGLAS BARRIE Flight International (ISSN 0015-3710), vol. 140, Dec. 18, 1991, p. 18, 20, 22, 23.
Copyright

The philosophy and application behind the extensive use of ground rigs for development of the European Fighter Aircraft is explained as providing an incremental development loop. The ground rig permits the exploration and testing of components and their parameters as they become available, within both an integrated and an isolated test environment. Utilizing a complicated ground rig, with the potential to test the flight-control software and control surfaces, allows the software developers to examine the systems' performance in a near-real, safe environment. R.E.P.

A92-18375
DRAG BALANCE FOR HYPERVELOCITY IMPULSE FACILITIES
J. M. SIMMONS (Queensland, University, St. Lucia, Australia) and S. R. SANDERSON AIAA Journal (ISSN 0001-1452), vol. 29, Dec. 1991, p. 2185-2191. Research supported by Australian Research Council. refs
Copyright

A new technique is described for measuring drag with 100-microsec rise time on a nonlifting model in a free piston shock tunnel. The technique involves interpretation of the stress waves propagating within the model and its support. A finite element representation and spectral methods are used to obtain a mean square optimal estimate of the time history of the aerodynamic loading. Thus, drag is measured instantaneously and the previous restriction caused by the mechanical time constant of balances is overcome. The effectiveness of the balance is demonstrated by measuring the drag on a cone with 15-deg semivertex angle in nominally Mach 5.6 flow with stagnation enthalpies from 2.6 to 33 MJ/kg. Measurement repeatability of about 10 percent is achieved. Author

A92-20650
CONTROL SYSTEM DESIGN FOR THE FREE DROP TEST OF EXTERNAL STORES IN A WIND TUNNEL
C. T. CHI, C. F. HSU, C. Y. HSIAO (Feng Chia University, Taichung, Republic of China), and R. C. CHANG (Chung-Shan Institute of Science and Technology, Taichung, Republic of China) IAF, International Astronautical Congress, 42nd, Montreal, Canada, Oct. 5-11, 1991. 8 p. refs
(IAF PAPER ST-91-002) Copyright

The trajectory of a store which is released from a flying vehicle can be determined by dynamic free drop wind tunnel test. This paper describes a simple, effective, and reliable control system design for the test project conducted at the Low Speed Wind Tunnel of AIDC. The system was designed based on the following guidelines: Self-contained, safety-guaranteed, user-friendly, and using PLC and pneumatic power. The system is separated into the pneumatic and the electric subsystems. Experiment results show that its performance is well accepted. Author

N92-13982# Toronto Univ., Downsview (Ontario). Inst. for Aerospace Studies.
FLIGHT SIMULATION
L. D. REID, S. ADVANI, W. O. GRAF, R. J. SOOSAAR, P. R. GRANT, P. A. ROBINSON, D. M. CHISHOLM, A. HOPPE, J. KIRDEIKIS, R. A. ROMANO et al. *In its* Activities of the University of Toronto Institute for Aerospace Studies p 78-79 1989
Avail: NTIS HC/MF A06

A brief description is provided of several University of Toronto Institute for Aerospace Studies (UTIAS) programs designed to investigate human factors and system optimization involved in flight simulation. A program of study has been undertaken to determine the critical amplitudes required to provide sensations of motion in the flight simulator sickness that are congruent with the expected motion of an aircraft. An electrogastrogram system designed to measure stomach activity associated with simulator sickness has been developed and tested. A program to evaluate nonlinear motion drive algorithms for flight simulators has been completed. The modelling of atmospheric disturbances, especially atmospheric turbulence and wind gradients associated with thunderstorms, is under study. Implementation of software for Instrument Flight Rule (IFR) flight test evaluations of a Bell 205 Helicopter simulator developed earlier, is currently underway. A generic spin simulator for simulation of light aircraft flight when airframe spin data is unavailable has been implemented on the flight simulator. An expert system for the purpose of tuning motion drive algorithms is to be developed. CISTI

N92-14027# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.).
A TAXI AND RAMP MANAGEMENT AND CONTROL SYSTEM (TARMAC)
U. VOELCKERS *In* Communications Gillies, Inc., Electronic Systems in Transportation p 94-98 Sep. 1989
Avail: Transportation Development Centre, 200 Rene Levesque Blvd. West, West Tower, Ste 601, Montreal, PQ H2Z 1X4 Canada

The development of safe and efficient low visibility ground operations has become very important with the increasing use of sophisticated systems such as Cat IIIa/b which allow all-weather approaches and landings. The high traffic rate at major airports has made improved ground operations important even for good weather. This paper outlines a general concept for a new airport ground movement control system (GMCS) currently under development at the German Aerospace Research Establishment (DLR). The GMCS system should provide complete information on the position, identity, and progress of aircraft and other vehicles operating in the movement area as well as supplying information on the positions of stationary hazards. Digital data should be used in approach, departure, and flow control. Communications with aircraft should be mainly via digital data and voice communications should be minimized. The system should provide the pilot with detailed guidance information. It should include automatic conflict avoidance and resolution. The system should be of modular design so that it can adapt to any airport structure and any traffic volume. It should have all-weather functionality, comply with International Civil Aviation Organization (ICAO) regulatory documents, and function as an integral part of air traffic control systems. CISTI

N92-14999# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands). Aerothermodynamics Section.
SIMOUN AND SCIROCCO WIND TUNNEL NOZZLE VISCOUS FLOW STUDY
D. GIORDANO, L. MARRAFFA, and G. RUSSO (Centro Italiano Ricerche Aerospaziali, Naples.) *In its* Aerothermodynamics for Space Vehicles p 197-207 Jul. 1991

The results obtained during a first study phase about the flow fields in the SIMOUN and Scirocco wind tunnel nozzles are presented. The geometrical configurations analyzed here are conical with circular section of Scirocco and contoured with semicircular section for SIMOUN. Air is the working fluid and it was assumed to behave as an ideal gas in chemical and thermal equilibrium. Two dimensional and three dimensional results were produced by SPEAR/3D, a computer program which solves the parabolized Navier-Stokes equations. Isoline contours and transversal profiles of flow field parameters are shown to give an understanding of the flow patterns which settle on the nozzles under different operating conditions. The flow field characteristics and the limitations deriving from the assumptions on which the calculations were based are discussed; accordingly, future developments of the study are envisaged. ESA

N92-15001# Deutsche Airbus G.m.b.H., Bremen (Germany, F.R.).
SHORT TIME FORCE MEASUREMENT SYSTEM
JOSEF MERTENS and KLAUS KOENIG *In* ESA, Aerothermodynamics for Space Vehicles p 223-227 Jul. 1991

The development of the SFS (Short time Force and moment measurement System) is considered. It enables measurement of aerodynamic forces and moments at testing times of less than 10 ms. This is required for measurements in high enthalpy shock tunnels to simulate reentry flight. Measurement is done using distributed accelerometers. The one year development program will comprise: development of software for modal analysis, correction and evaluation, development of a suited suspension system, development of calibration methods, test loading of a generic model with a precise load on a shock tube's endwall. ESA

N92-15002# Naples Univ. (Italy).
INFRARED MEASUREMENTS OF AERODYNAMIC HEATING IN HYPERSONIC WIND TUNNEL
L. DELUCA, G. CARDONE, G. M. CARLOMAGNO, T. ALZIARYDEROQUEFORT, and D. AYMERDELACHEVALERIE (Centre d'Essais Aeronautique Toulouse, Poitiers, France) *In* ESA, Aerothermodynamics for Space Vehicles p 229-234 Jul. 1991 Sponsored by Centro Italiano Ricerche Aerospaziali and Avions Marcel Dassault-Breguet Aviation

Significant results referring to flow visualizations and heat transfer measurements performed by means of an infrared scanning radiometer in a blowdown hypersonic wind tunnel on delta wing and ellipsoids models are discussed. Tests are carried out within the European Community space program Hermes to develop the first European space shuttle. Comparisons of infrared data with oil film flow visualizations, thermocouple measurements and numerical results are presented. ESA

N92-15003# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Div. de Thermophysique.
HEAT TRANSFER MEASUREMENTS IN ONERA SUPERSONIC AND HYPERSONIC WIND TUNNELS USING PASSIVE AND ACTIVE INFRARED THERMOGRAPHY
D. L. BALAGEAS, D. BOSCHER, A. A. DEOM, and G. GARDETTE *In* ESA, Aerothermodynamics for Space Vehicles p 235-240 Jul. 1991 Previously announced in IAA as A91-45632 Sponsored in part by Direction des Recherches, Etudes et Techniques; CEA; and Cryospace Co.

Over the past few years, a major intellectual and technical investment has been made at ONERA to use data acquisition systems and data reduction procedures using an infrared camera as a detector under routine wind tunnel conditions. This allows a really quantitative mapping of heat tranfer rate distributions in models in supersonic and hypersonic flows. Sufficient experience has been required, and an overview of the following is given: the systems and data reduction procedures developed for both passive and active methods; typical results obtained various configurations such as supersonic axisymmetrical flow around an ogival body (passive and active thermography), heat flux modulation in the reattachment zone of a flap in hypersonic regime, transitional heating in very slightly blunted spheroconical bodies in hypersonic flows, and materials testing in high enthalpy hypersonic flow (passive thermography). ESA

N92-15009# Stuttgart Univ. (Germany, F.R.). Inst. fuer Raumfahrtsysteme.
THE IRS PLASMA WIND TUNNELS FOR THE INVESTIGATION OF THERMAL PROTECTION MATERIALS FOR REENTRY VEHICLES
M. AUWETER-KURTZ, H. HABIGER, S. LAURE, E. W. MESSERSCHMID, W. ROECK, and N. TUBANOS *In* ESA, Aerothermodynamics for Space Vehicles p 283-293 Jul. 1991

The plasma wind tunnels PWK1 and PWK2 were designed to test thermal protection materials for space vehicles. They are suitable for the qualification of ablative materials as well as for heat resistant ceramics such as C-C or C-SiC. In either case, a steady state heating environment including transient conditions at the surface of space transportation systems during the early reentry phase are simulated as close to reality as possible. Such plasma wind tunnels represent the only possible way to investigate candidate materials with respect to their surface chemistry associated with erosion or ablation behavior. In these facilities, the emphasis is on reproducing the specific enthalpy of the flow, the wall temperature and heat flux respectively as well as the chemical composition with respect to the main and most reactive components on the surface of the tested specimens rather than aerodynamic similarities. The plasma wind tunnels are characterized in terms of specific enthalpy, pressure, heat flux, and mass flow. The simulation requirements are discussed with respect to the erosion mechanisms of modern heat shield materials. It is shown that the environment of the nose cap and at the leading edge of Hermes during the first phase of reentry, including the points of maximum temperature, can be simulated as well as the conditions during the reentry of the space probe Rosetta. ESA

N92-15021# Technische Hochschule, Aachen (Germany, F.R.). Shock Wave Lab.
HIGH ENTHALPY TESTING IN THE AACHEN (FED. REPUBLIC OF GERMANY) SHOCK TUNNEL TH 2
H. OLIVIER, M. VETTER, and H. GROENIG *In* ESA, Aerothermodynamics for Space Vehicles p 377-384 Jul. 1991

A simple experimental method is described to determine the free stream conditions and the stagnation enthalpy in a high enthalpy shock tunnel. The main advantage of this method is that it only uses values which are measured within the test section. If measured or computed values of the nozzle reservoir are used to determine the free stream conditions by a nozzle calculation, a lot of uncertainties enter the problem. The performed experiments and the comparisons with numerical results show that the achieved accuracy of the experimental values for high enthalpy conditions is very good. Tests at the same flow conditions have shown that the repeatability margins, typically of the pressure coefficient, are

within 5 percent, and for the Stanton number within 10 percent. The error margins are in the same range. ESA

N92-15043# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
REVIEW OF THE EUROPEAN HYPERSONIC WIND TUNNEL PERFORMANCE AND SIMULATION REQUIREMENTS
J. MUYLAERT, T. VOIRON, P. SAGNIER, D. LOURME, O. PAPIRNYK, K. HANNEMANN, K. BUETEFISCH, and GEORG KOPPENWALLNER (Hyperschall-Technologie-Goettingen, Germany, F.R.) *In its* Aerothermodynamics for Space Vehicles p 559-574 Jul. 1991
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

Hypersonic wind tunnel testing is required in many stages during the development of an aerospace vehicle. In order to reproduce the physical phenomena in a scale experiment similarity parameters must be considered. The simultaneous duplication of all simulation parameters is not possible in ground based facilities. The facilities can be grouped as follows: the classical hypersonic wind tunnels; the high enthalpy facilities; and the low density wind tunnels. A review of all the facilities within the Hermes project is given. Their simulation capabilities, flow quality, and measurement techniques are outlined. In addition, two major new high enthalpy facilities in Europe, the F4 and the High Enthalpy wind tunnel Gottingen (HEG) are presented. In order to improve the level of understanding in hypersonic testing, a standard model is recommended. ESA

N92-15077*# Vigyan Research Associates, Inc., Hampton, VA.
THE NASA LANGLEY RESEARCH CENTER 0.3-METER TRANSONIC CRYOGENIC TUNNEL MICROCOMPUTER CONTROLLER SOURCE CODE
W. ALLEN KILGORE and S. BALAKRISHNA Dec. 1991 66 p (Contract NAS1-18585)
(NASA-CR-189556; NAS 1.26:189556) Avail: NTIS HC/MF A04 CSCL 14/2

The 0.3 m Transonic Cryogenic Tunnel (TCT) microcomputer based controller has been operating for several thousand hours in a safe and efficient manner. A complete listing is provided of the source codes for the tunnel controller and tunnel simulator. Included also is a listing of all the variables used in these programs. Several changes made to the controller are described. These changes are to improve the controller ease of use and safety.
Author

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ASTRONAUTICS

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

A92-17349
SOLVING THE STRUCTURES PROBLEM FOR HYPERSONIC VEHICLES
Aerospace Engineering (ISSN 0736-2536), vol. 11, Dec. 1991, p. 15-18.
Copyright

An overview is presented of the requirements and development work conducted on lightweight, high-strength, temperature resistant structures for a fully reusable, SSTO vehicle such as the NASP. Attention is given to the enhancement of advanced heat-resistant monolithic and composite materials, and the reduction of shock wave effects in localized areas where aerothermal loadings are greatly magnified. Some concepts are studied for possible application to cooling areas of extreme temperature such as the cowl leading edge on a hypersonic vehicle's airbreathing propulsion system. R.E.P.

A92-17802#
'SPACEPLANES' R&D STATUS OF JAPAN
TATSUO YAMANAKA (National Aerospace Laboratory, Chofu, Japan) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 12 p. refs
(AIAA PAPER 91-5002) Copyright

Activities related to the development of aerospace planes are discussed with attention given to basic problems and requirements facing the fledgling industry. Among the programs in progress discussed are the Highly Maneuverable Experimental Space (Himes) vehicle, the Orbital Reentry Experiment (OREX), the Japanese Experimental Module (JEM), and the Advanced Technology for Aerospace Study (ATAS) program. The H-2 Orbiting Plane (HOPE) is also described in terms of conceptual and aerodynamic studies as well as structural and avionic considerations for a 20-ton HOPE vehicle. Test facilities and programs for SSTO and TSTO engine concepts are discussed in the light of studying aerospace-planes' systems. Specifications are given for five engines - two are rocket-mode engines - that correspond to specific mission requirements. C.C.S.

A92-17820*# NASP Joint Program Office, Wright-Patterson AFB, OH.
CONDUCTING THE NASP GROUND TEST PROGRAM
WILLIAM SULLIVAN (National Aero-Space Plane Joint Program Office, Wright-Patterson AFB, OH) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 7 p.
(AIAA PAPER 91-5029)

The National Aero-Space Plane program has recently entered a new phase of the program known as Phase 2D. During this period, five aerospace companies and the Government have formed a National Team. This team has focused on developing a single experimental (X-30) vehicle design and are pursuing a technology validation and demonstration program to prove out the design concepts and design tools. This paper presents an overview of the Phase 2D ground testing being conducted to validate the X-30 design and to demonstrate the critical technologies needed to build and fly a research vehicle during Phase 3 of the program. The Phase 2D exit criteria are discussed to identify how they provide top-level guidance for developing the ground test program. An overview of major test facility modifications being performed in support of the test program is also presented. Emphasis is placed on propulsion and structures testing since these are felt to be the primary areas requiring technologies beyond the current state-of-the-art. Also discussed is the use of uncertainty analysis as a method to account for uncertainties in test data.
Author

A92-17824#
APPLICATION OF THE STAPAT II CODE TO HYPERSONIC VEHICLE AEROTHERMODYNAMICS
BRET L. BOMAN (McDonnell Aircraft Co., Saint Louis, MO) and CHARLES A. BABISH, III (USAF, Wright Laboratory, Wright-Patterson AFB, OH) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 12 p. refs
(AIAA PAPER 91-5035)

Attention is given to the STAPAT II computer code and its application to computing the laminar, transitional, and turbulent real-gas aerothermodynamics of hypersonic aerospace vehicles. Two of the more unique and significant computational techniques formulated for incorporation into STAPAT II during its development are presented: one for coupling aerodynamic heating with wall heat transfer, the other for modeling embedded shock waves. Simulations were run to demonstrate STAPAT II's application to hypersonic vehicle aerothermodynamics. Wind tunnel models and full-scale configurations of a NASP blended wing body and the space shuttle were simulated. STAPAT II predictions compared well with data from both wind tunnel and flight tests, and with results from CFD calculations. A flight simulation involving a

full-scale multipane crew window system was also run to demonstrate the thermal analysis features of STAPAT II. Transparency system temperature solutions exhibited correct trends and values. P.D.

A92-17825*# Lockheed Engineering and Sciences Co., Hampton, VA.
A COMPARISON OF COOLING METHODS FOR THE AIRFRAME NOZZLE OF A SINGLE-STAGE-TO-ORBIT AIRCRAFT
STUART C. JONES (Lockheed Engineering and Sciences Co., Hampton, VA) and DENNIS H. PETLEY (NASA, Langley Research Center, Hampton, VA) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 12 p. refs
(AIAA PAPER 91-5036) Copyright

A comparison is made between two different cooling schemes, including a complete system thermal analysis and weight accounting for each. A hydrogen-direct system operates at a higher pressure (34.5 Mpa) and greater temperature rise in the coolant. There is no temperature limit on the coolant itself and high injector temperatures may be achieved, but the pressure lines must be routed over great distances (10 m). The system is simple, and the coolant is almost weightless. In contrast, an indirect system operates at a lower pressure (3.8n MPa) and the liquid coolant has a much greater thermal capacity. The greater thermal capacity causes much less of a temperature rise in the coolant. The chosen coolant is Syltherm 800. This nontoxic fluid is compatible with any metal, including titanium. The loop requires a separate fuel/coolant heat exchanger and coolant pump. The indirect system offers some distinct safety advantages but is heavier than the direct hydrogen coolant system. Author

A92-17830*# *NASP Joint Program Office, Wright-Patterson AFB, OH.*
A CONFIGURATION DEVELOPMENT STRATEGY FOR THE NASP
CURTIS D. SNYDER (National Aero-Space Plane Joint Program Office, Wright-Patterson AFB, OH) and S. Z. PINCKNEY (Lockheed Engineering and Sciences Co., Wright-Patterson AFB, OH) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 9 p. Previously cited in issue 24, p. 4216, Accession no. A91-56156. refs
(AIAA PAPER 91-5044)

A92-17834#
THE VALUE OF SUB-SCALE FLIGHT TESTS IN THE DEVELOPMENT OF NASP VEHICLES
PETER K. SHIH (General Dynamics Corp., Convair Div., San Diego, CA) and RICHARD D. NEUMANN (Science Applications International Corp., Dayton, OH) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 12 p. refs
(AIAA PAPER 91-5048) Copyright

A low-cost approach for hypersonic sub-scale flight test programs is presented. Simple-shaped vehicles are proposed for obtaining the qualitative technical data. This data will be used for CFD code validation and to enhance design analyses for NASP-type vehicles. Author

A92-17851*# Aerospace Corp., El Segundo, CA.
OPERATIONAL DESIGN FACTORS FOR NASP DERIVED VEHICLES
R. A. HICKMAN and J. D. ADAMS (Aerospace Corp., El Segundo, CA) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 11 p. Research sponsored by National Aero-Space Plane Joint Program Office. refs
(AIAA PAPER 91-5081) Copyright

The factors that significantly affect the operability of aerospace planes are identified and considered in terms of the development of the National Aerospace Plane (NASP). The aircraftlike vehicle can be affected by variables related to the structure, propulsion, and mechanical elements of the design. The requirements to control the factors are listed including robustness, fuels and propellants, maintainability, autonomy, and development testing. The details of the requirements indicate critical factors such as the strength-to-weight ratios of the materials, propellant-system components that can withstand 5000 consecutive cycles, and low vehicle-failure probabilities. The NASP program is concluded to require: (1) models for quantitative operational assessments; (2) a modular design for the NASP structure; (3) computer-technology integration; and (4) technologies to support and normalize cryogenic operations. C.C.S.

A92-19061
AUTOMATED TRAJECTORY SYNTHESIS FOR HYPERSONIC VEHICLES USING ENERGY MANAGEMENT AND VARIATIONAL CALCULUS TECHNIQUES
N. VENUGOPAL, R. V. GRANDHI, W. L. HANKEY, and P. J. BELCHER (Wright State University, Dayton, OH) Acta Astronautica (ISSN 0094-5765), vol. 25, Nov. 1991, p. 669-678. refs
(Contract F33615-87-C-1550)
Copyright

A generalized algorithm based on energy management techniques and calculus of variations is discussed for determining optimal trajectories of hypersonic vehicles. This method employs both techniques simultaneously such that they augment each other in obtaining the optimum path. A simulation algorithm consisting of guidance and control and numerical integration aspects is briefly described. A generic vehicle for maximizing the payload into orbit is used for testing the algorithm and the resulting optimal trajectories are presented. Author

A92-19257
IMPLEMENTATION AND USAGE OF THE RJ PROGRAM DATA ACQUISITION SYSTEM GROUND STATION
BARRY QUART (Bombardier, Inc., Canadair Aerospace Group, Montreal, Canada) and RICK MITCHELL (Loral Data Systems, Sarasota, FL) IN: ITC/USA/'90; Proceedings of the International Telemetering Conference, Las Vegas, NV, Oct. 29-Nov. 2, 1990. Research Triangle Park, NC, Instrument Society of America, 1990, p. 635-642.
Copyright

The Data Acquisition System Ground Station (DASGS), is a system developed by Loral Data Systems (Loral) for CANADAIR Aerospace Group. The system implements the latest technologies in telemetry front-end equipment, host computers, networking, and graphic workstations. The goal of the DASGS is to supply Canadair with a telemetry acquisition and processing system that can satisfy the Regional Jet (RJ) program requirements and provide future expandability to service their needs throughout the 1990's. Author

N92-14087*# Rockwell Space Operations Co., Houston, TX. Guidance and Navigation Analyst.
TESTING OF THE HIGH ACCURACY INERTIAL NAVIGATION SYSTEM IN THE SHUTTLE AVIONICS INTEGRATION LAB
RUSSELL L. STRACHAN and JAMES M. EVANS *In* NASA. Goddard Space Flight Center, Flight Mechanics/Estimation Theory Symposium, 1991 p 301-320 Oct. 1991
Avail: NTIS HC/MF A21 CSCL 22/2

The description, results, and interpretation is presented of comparison testing between the High Accuracy Inertial Navigation System (HAINS) and KT-70 Inertial Measurement Unit (IMU). The objective was to show the HAINS can replace the KT-70 IMU in the space shuttle Orbiter, both singularly and totally. This testing was performed in the Guidance, Navigation, and Control Test Station (GTS) of the Shuttle Avionics Integration Lab (SAIL). A variety of differences between the two instruments are explained. Four, 5 day test sessions were conducted varying the number and slot position of the HAINS and KT-70 IMUs. The various steps in the calibration and alignment procedure are explained. Results and their interpretation are presented. The HAINS displayed a high level of performance accuracy previously unseen with the KT-70 IMU. The most significant improvement of the performance came in the Tuned Inertial/Extended Launch Hold tests. The HAINS exceeded the 4 hr specification requirement. The results obtained

from the SAIL tests were generally well beyond the requirements of the procurement specification. Author

N92-14101# Joint Publications Research Service, Arlington, VA.
JPRS REPORT: SCIENCE AND TECHNOLOGY. USSR: SPACE
22 Nov. 1991 100 p Transl. into ENGLISH from various Russian articles
(JPRS-USP-91-007) Avail: NTIS HC/MF A05

This is a compilation of translated articles from Soviet publications. The general areas of discussion are as follows: manned mission highlights; space sciences; interplanetary sciences; space engineering; space applications; and space policy. Two articles of special interest are Small Solar Sail Spacecraft for Regatta Project, and History of EPOS Air Launched Spaceplane Project.

N92-14103# Joint Publications Research Service, Arlington, VA.
HISTORY OF EPOS AIR-LAUNCHED SPACEPLANE PROJECT
VYACHESLAV KAZMIN *In its* JPRS Report: Science and Technology. USSR: Space p 27-36 22 Nov. 1991 Transl. into ENGLISH from Krylya Rodiny (Moscow, USSR), no. 11, Nov. 1990 p 25-26, no. 12, Dec. 1990 p 16-17, and no. 1, Jan. 1991 p 4-5
Avail: NTIS HC/MF A05

Both stages of an aerospace system, with a calculated mass of 115 tons, were simply attached, winged, wide-fuselage craft for horizontal takeoff and landing and multiple use. The system was designed according to a tailless lifting body design. The carrier was a 52 ton powerful aircraft booster which would accelerate to Mach 6 and separate, launching from its back at an altitude of 28 to 30 km, a 10 ton manned orbital aircraft 8 m long with a 7.4 m wing span. Only 3.4 m of this was the outer wing, and the remaining large part of the bearing surface was the width of the fuselage. This little bird was named EPOS (Experimental Manned Orbital Aircraft). It was attached to a tank of rocket fuel for insertion into orbit at hypersonic speed. The development of EPOS attracted great attention for aviation designers. Author

N92-14108*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
LIMIT CYCLE VIBRATIONS IN TURBOMACHINERY
S. G. RYAN Dec. 1991 84 p
(NASA-TP-3181; M-676; NAS 1.60:3181) Avail: NTIS HC/MF A05 CSCL 13/9

The focus is on an examination of rotordynamic systems which are simultaneously susceptible to limit cycle instability and subharmonic response. Characteristics of each phenomenon are determined as well as their interrelationship. A normalized, single mass rotor model is examined as well as a complex model of the high pressure fuel turbopump and the Space Shuttle Main Engine. Entrainment of limit cycle instability by subharmonic response is demonstrated for both models. The nonuniqueness of the solution is also demonstrated. Author

N92-14975# Tsentralni Aerogidrodinamicheskii Inst., Moscow (USSR).
AEROTHERMODYNAMIC CONFIGURATION OF FIRST GENERATION AEROSPACE PLANES (OF BURAN-TYPE) AND FIRST FLIGHT RESULTS
V. YA. NEILAND *In* ESA, Aerothermodynamics for Space Vehicles p 13-22 Jul. 1991
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

Some main factors influencing the Aerothermodynamics Configurations (ATC) of first generation aerospace planes, the problems to be solved during its selection, the phases of the ATC development, estimation methods for aerodynamic characteristics and heat fluxes, including laboratory experiments, numerical investigations and flight tests, are discussed. The circle of problems being considered is confined to the first generation aerospace planes of the type 'Buran'. Some data of fundamental importance concerning the convergence of aerothermodynamic characteristics preflight predictions with real flight test results are presented. ESA

N92-14977# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
ANALYSIS TOOLS OF ONERA AND DLR FOR THE AEROTHERMODYNAMICS OF REENTRY VEHICLES
P. BARILLOT, J. M. BOUSQUET, G. BRENNER, J. L. DACOSTA, D. DEVEZEAUX, P. NIEDERDRENK, R. RADESPIEL, P. SAGNIER, and J. SCHOENE (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany, F.R.) *In* ESA, Aerothermodynamics for Space Vehicles p 39-46 Jul. 1991
Previously announced in IAA as A91-53246
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

Design analysis of space planes must include all flow phenomena occurring during the reentry phase of the flight. Aerodymanic and aerothermic tools must be able to treat hypersonic, supersonic and subsonic flow fields. In the frame of Hermes Technical Assistance (TA) for the National Center for Space Studies (CCNES), DLR and ONERA have improved their numerical tools in order to increase their capabilties. Euler codes are necessary to compute aerodynamic coefficients during the hyper/supersonic part of the flight. The Panel Method is used for subsonic flow. For aerothermal load calculations, engineering methods allow short term response. More sophisticated methods, such as coupled Euler/boundary layer solvers, are used to study critical design points, including nonequilibrium and wall catalycity phenomena. Navier-Stokes solvers are used to study separation phenomena. Examples of application are presented. They show the present capability of TA teams to perform aerothermodynamic evaluations for Hermes design. ESA

N92-14980# Alenia Spazio S.p.A., Naples (Italy).
AEROTHERMODYNAMIC DEVELOPMENT OF THE CARINA RE-ENTRY VEHICLE: CFD ANALYSES AND EXPERIMENTAL TESTS
A. MARZANO, M. SOLAZZO, A. SANSONE, A. CAPUANO, and G. BORRIELLO *In* ESA, Aerothermodynamics for Space Vehicles p 67-72 Jul. 1991
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

The CARINA (Italian acronym for unmanned reentry capsule) system is a microgravity payload carrier with reentry capability. In the frame of the design activities for the CARINA system, the aerothermodynamic characterization of the reentry vehicle is one of the most considerable efforts. Furthermore, the design aspects of such a vehicle are largely unexplored in Europe, requiring a technological program to support the development of the knowledge in this research area. After a tradeoff analysis and preliminary studies, a more in depth approach to the problem was planned. Two different driving lines are pointed out: the utilization of Computational Fluid Dynamics (CFD) tools and the contemporary development of an adequate experimental campaign. Test results, compared with the numerical predictions, are illustrated. ESA

N92-14984# Societe Europeenne de Propulsion, Vernon (France).
SUPERSONIC COMBUSTION STUDIES [ETUDES EN COMBUSTION SUPERSONIQUE]
H. ZELLER, D. SAUCEREAU, and M. DESAULTY (Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Moissy-Cramayel, France) *In* ESA, Aerothermodynamics for Space Vehicles p 93-100 Jul. 1991 In FRENCH
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

The potential advantage of the scramjet for space launch and research is discussed. Firsts results of theoretical and experimental studies on mixing, combustion, and supersonic boundary layer flow behavior are presented. ESA

N92-15037# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
THE INFLUENCE OF A RETARDING ROCKET ON PARAMETER LIMITS FOR REENTRY TRAJECTORIES
N. OREN *In* ESA, Aerothermodynamics for Space Vehicles p

505-507 Jul. 1991
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

This simulation enables one to compute the influence of the spinning atmosphere on the recovery devices used in a returning spacecraft: retarding rocket, lifting panels and retarding parachute. The computer simulation determines location, velocity vector, and landing spot. Two articles on the subject were published by the author. The first dealt with the influence of lifting panels on a spacecraft trajectory and the second dealt with the influence of retarding rocket burn time on energy dissipation rate in a spacecraft trajectory. The influence of the retarding rocket burn time on the maximum values along the trajectory of five output parameters is shown. The following items are the five output parameters: maximum rate of heat dissipation; maximum skin temperature; maximum deceleration; and overall trajectory time. ESA

N92-15877*# Tennessee Univ., Chattanooga. Mechanical Engineering-Mechanics.
REDESIGN OF FLIGHT SPACE SHUTTLE MAIN ENGINE NOZZLE G-15 SEAL AREA BASED ON THE THERMAL ANALYSIS AND FLOW MODELS
GARY H. MCDONALD *In* Alabama Univ., Research Reports: 1991 NASA/ASEE Summer Faculty Fellowship Program 5 p Oct. 1991
(Contract NGT-01-008-021)
Avail: NTIS HC/MF A12 CSCL 21/8

The main objective is to understand the present sealing area response to environmental conditions of the supersonic turbulent combustion gases which has led to both stress rupture cracks and hot gas leakage. A review of the existing thermal analysis and flow modeling has been performed of the present design and seal alternatives have been suggested to possibly reduce or eliminate the hot gas flow recirculation problem and the associated seal cracking. Author

11

CHEMISTRY AND MATERIALS

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

A92-17861#
AN EXPERIMENTAL INVESTIGATION OF THE COMBUSTION OF A HYDROGEN JET INJECTED PARALLEL IN A SUPERSONIC AIR STREAM
ROSEMARIE GUERRA, WINFRIED WAIDMANN, and CHRISTOPH LAIBLE (DLR, Institut fuer Chemische Antriebe und Verfahrenstechnik, Hardthausen am Kocher, Federal Republic of Germany) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 12 p. refs
(AIAA PAPER 91-5102) Copyright

The paper describes a reliable method for the ignition of a hydrogen jet in a supersonic air stream. Ignition is achieved through radicals produced by precombustion of a fuel-rich mixture of hydrogen and oxygen. To avoid interference from the boundary layer, the hydrogen jet is injected parallel to the free stream through the base of a wedge centered in the test chamber. Results from measurements of OH spectra intensity and schlieren photography show that a 2D stable flame was established just downstream of the wedge base. After ignition was achieved, precombustion was no longer necessary for flameholding, except for cases of unvitiated cold air. Results of computations showed that water, which occurs at mass fractions less than 15 percent in the freestream, not only lowers the final temperature, but also shortens the reaction time. I.S.

A92-18002
HYPERSONIC MATERIALS
FRANK COLUCCI Aerospace Composites and Materials (ISSN 0954-5832), vol. 3, Nov.-Dec. 1991, p. 4-8.
Copyright

An overview is presented of the development work being conducted on titanium matrix composites and other materials for the air-breathing hypersonic NASP. Consideration is given to various composites including, aluminum-lithium alloy, a thermoplastic PEEK matrix, organic composites, refractory composites, and titanium metal matrices. R.E.P.

A92-18898
INERTIA-FRICTION WELDING OF AN ADVANCED RAPIDLY SOLIDIFIED TITANIUM ALLOY
W. A. BAESLACK, III (Ohio State University, Columbus), D. PHILLIPS, C. ENGLISH, and A. P. WOODFIELD (GE Aircraft Engines, Cincinnati, OH) Journal of Materials Science Letters (ISSN 0261-8028), vol. 10, Dec. 1, 1991, p. 1401-1408. refs
Copyright

Inertia-friction welding is shown to be capable of effectively yielding a fine weld-zone dispersoid structure in an erbium-containing rapidly-solidified Ti alloy. The dispersoid structure observed within the inner heat-and-diffusion zone (HDZ) originated in the solid-state dissolution of the original base-metal dispersoids; it is suggested that the dissolution of the base metal dispersoid structure was kinematically enhanced by the extremely high temperatures experienced in the inner HDZ, as well as the severe local deformation experienced at the weld interface. The weld's room-temperature strength and hardness were primarily dependent on the fine transformed-beta microstructure within the weld zone. O.C.

A92-19754* Lockheed Engineering and Sciences Co., Hampton, VA.
FATIGUE CRACK INITIATION AND SMALL CRACK GROWTH IN SEVERAL AIRFRAME ALLOYS
M. H. SWAIN (Lockheed Engineering and Sciences Co., Hampton, VA), J. C. NEWMAN, JR., E. P. PHILLIPS (NASA, Langley Research Center, Hampton, VA), and R. A. EVERETT (NASA, Langley Research Center; U.S. Army, Aerostructures Directorate, Hampton, VA) IN: Fatigue 90; Proceedings of the 4th International Conference on Fatigue and Fatigue Thresholds, Honolulu, HI, July 15-20, 1990. Vol. 2. Birmingham, England, Materials and Component Engineering Publications, Ltd., 1990, p. 1079-1084. Previously announced in STAR as N90-18746. refs
Copyright

The growth of naturally-initiated small cracks under a variety of constant amplitude and variable amplitude load sequences is examined for several airframe materials: the conventional aluminum alloys, 2024-T3 and 7075-T6, the aluminum-lithium alloy, 2090-T8E41 and 4340 steel. Loading conditions investigated include constant amplitude loading at R = 0.5, 0, -1 and -2 and the variable amplitude sequences FALSTAFF, Mini-TWIST, and FELIX/28. Crack growth was measured at the root of semicircular edge notches using acetate replicas. Crack growth rates are compared on a stress intensity factor basis, to those for large cracks to evaluate the extent of the small crack effect in each alloy. In addition, the various alloys are compared on a crack initiation and crack growth morphology basis. Author

A92-19760
SHORT FATIGUE CRACK GROWTH FROM BLUNT NOTCHES IN AN AERO-ENGINE ALLOY
I. W. HUSSEY (Rolls-Royce, PLC, Derby, England) and J. BYRNE (Portsmouth Polytechnic, England) IN: Fatigue 90; Proceedings of the 4th International Conference on Fatigue and Fatigue Thresholds, Honolulu, HI, July 15-20, 1990. Vol. 2. Birmingham, England, Materials and Component Engineering Publications, Ltd., 1990, p. 1115-1120. refs
Copyright

The growth of short corner defects from the bore extremities of blunt keyhole notches in CT specimens has been studied for a

nickel-base superalloy. Variation in crack shape was determined by beach marking to establish an aspect ratio calibration with increasing crack length. Both surface and inferred bore results have been compared with an approximate analysis which determines the stress intensity factor for part-through cracks in regions of variable stress. The experimental results demonstrate that the theoretical predictions based on this analysis provide conservative estimates of the stress intensity in the absence of short crack effects and crack interactions. Author

A92-19767
CRACK INITIATION AND THE SHORT-TO-LONG CRACK GROWTH TRANSITION IN A NI-BASE SUPERALLOY
J. E. KING (Cambridge, University, England) and A. D. BOYD-LEE IN: *Fatigue 90; Proceedings of the 4th International Conference* on Fatigue and Fatigue Thresholds, Honolulu, HI, July 15-20, 1990. Vol. 2. Birmingham, England, Materials and Component Engineering Publications, Ltd., 1990, p. 1205-1210. Research supported by Rolls-Royce, PLC and British Gas, PLC. refs
Copyright

A study has been made of the initiation and early fatigue crack growth of 58 cracks in AP1 (Astroloy) with a necklace microstructure at 20 C under loading with a maximum stress equal to 0.8 of the yield stress and R = 0.1. Clear statistical trends observed in the microstructural conditions favoring initiation and the path taken by these cracks through the surface grains of the specimen are presented. Author

A92-19796
HIGH TEMPERATURE LOW CYCLE FATIGUE OF SINGLE CRYSTAL NICKEL BASE SUPERALLOYS
M. MARCHIONNI, E. PICCO, D. RANUCCI (CNR, Istituto per la Tecnologia dei Materiali Metallici non Tradizionali, Cinisello Balsamo, Italy), and V. CATENA (Fiat Aviazione S.p.A., Turin, Italy) IN: Fatigue 90; Proceedings of the 4th International *Conference on Fatigue and Fatigue Thresholds, Honolulu, HI, July* 15-20, 1990. Vol. 3. Birmingham, England, Materials and Component Engineering Publications, Ltd., 1990, p. 1735-1740. refs
Copyright

The low-cycle fatigue behavior of three different single crystal nickel base superalloys (one with high density and two with low density) is analyzed in the temperature range 600-1000 C. The fatigue life of single crystal alloys is sensibly higher than that of other cast of directionally solidified nickel base alloys due to the presence of a low plastic strain component in the hysteresis loop. The fatigue results are discussed, taking into account the anisotropy of the alloys and their density. Author

A92-19799
THERMO-MECHANICAL FATIGUE CRACK GROWTH IN AIRCRAFT ENGINE MATERIALS
T. NICHOLAS (USAF, Materials Laboratory, Wright-Patterson AFB, OH) and S. MALL (USAF, Institute of Technology, Wright-Patterson AFB, OH) IN: Fatigue 90; Proceedings of the 4th International Conference on Fatigue and Fatigue Thresholds, Honolulu, HI, July 15-20, 1990. Vol. 3. Birmingham, England, Materials and Component Engineering Publications, Ltd., 1990, p. 1905-1910. refs
Copyright

Crack growth under combined thermal and mechanical fatigue (TMF) is compared in Inconel 718 and a titanium aluminide intermetallic, Ti-24-11. Crack growth in Inconel 718 is dominated by a combination of fatigue and environmentally assisted crack growth processes. In the titanium aluminide, crack tip blunting due to creep is also present. Linear summation modeling is seen to work well for the Inconel 718, but retardation due to blunting has to be considered in the aluminide. Author

A92-19817
PREDICTION OF FATIGUE CRACK GROWTH IN A TI-6AL-4V FAN DISK FORGING UNDER SPECTRUM LOADING
R. GALATOLO (Pisa, Universita, Italy) IN: Fatigue 90; Proceedings of the 4th International Conference on Fatigue and Fatigue Thresholds, Honolulu, HI, July 15-20, 1990. Vol. 4. Birmingham, England, Materials and Component Engineering Publications, Ltd., 1990, p. 2215-2220. Research supported by CNR. refs
Copyright

Constant amplitude and spectrum loading fatigue crack growth data for the titanium alloy Ti-6Al-4V STA engine disks were used to evaluate the predictive accuracies of an advanced crack closure model (CORPUS). Predictions were very good except for the initial period of crack growth. The behavior at low crack growth rates is of course very important, because a large amount of the total life may be spent in that phase. This is therefore a serious problem and possible reasons for it are discussed. Author

A92-19820
METHODOLOGY FOR THE ASSESSMENT OF MATERIAL QUALITY EFFECTS ON AIRFRAME FATIGUE DURABILITY
P. E. MAGNUSEN, A. J. HINKLE, R. J. BUCCI, R. L. ROLF, and D. A. LUKSAK (Alcoa Laboratories, Alcoa Center, PA) IN: Fatigue 90; Proceedings of the 4th International Conference on Fatigue and Fatigue Thresholds, Honolulu, HI, July 15-20, 1990. Vol. 4. Birmingham, England, Materials and Component Engineering Publications, Ltd., 1990, p. 2239-2244. refs
Copyright

A methodology is developed for quantifying the effects of reduced microporosity and constituent particles in aerospace aluminum alloys on the fatigue performance of these alloys. For microporosity studies, four lots of a commercially produced 144-mm-thick 7050-T7451 plate were used, with two of the lots produced using an old standard process and two others by using new processing methods described by Owen et al. (1989). For variations in constituents, two high-strength Al-Zn-Cu-Mg, 7XXX series alloys with different levels of Fe and Si were used. Smooth axial fatigue tests were performed using 7.6-mm-diam round specimens. Results show that, by reducing both the number and the severity of metallurgical inhomogeneities can result in dramatic fatigue improvement. For example, the fatigue strength at 100,000 cycles determined from the data is 112 Mpa for the old quality material and 131 for the material produced using new processing methods. More dramatic increases in fatigue strength are seen at the fatigue limit of the material when designing for infinite life. I.S.

A92-19828* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PROOF TEST AND FATIGUE CRACK GROWTH MODELING ON 2024-T3 ALUMINUM ALLOY
J. C. NEWMAN, JR., C. C. POE, JR. (NASA, Langley Research Center, Hampton, VA), and D. S. DAWICKE (Analytical Services and Materials, Inc., Hampton, VA) IN: Fatigue 90; Proceedings of the 4th International Conference on Fatigue and Fatigue Thresholds, Honolulu, HI, July 15-20, 1990. Vol. 4. Birmingham, England, Materials and Component Engineering Publications, Ltd., 1990, p. 2407-2416. refs
Copyright

Pressure proof testing of aircraft fuselage structures has been suggested as a means of screening critical crack sizes and of extending their useful life. The objective of this paper is to study the proof-test concept and to model the crack-growth process on a ductile material. Simulated proof and operational fatigue life tests have been conducted on cracked panels made of 2024-T3 aluminum alloy sheet material. A fatigue crack-closure model was modified to simulate the proof test and operational fatigue cycling. Using crack-growth rate and resistance-curve data, the model was able to predict crack growth during and after the proof load. These tests and analyses indicate that the proof test increases fatigue life; but the beneficial life, after a 1.33 or 1.5 proof, was less than a few hundred cycles. Author

A92-20130
CURRENT STABILIZING OF FASTENED COMPOSITE JOINTS TO IMPROVE NON-SPARKING LIGHTNING CURRENT PERFORMANCE

D. L. HEIDLEBAUGH and J. M. CARTER (Boeing Co., Seattle, WA) International Conference on Lightning and Static Electricity, University of Bath, England, Sept. 26-28, 1989. 9 p. refs

CFRP panels and slabs joined by fasteners, as found in 'wet-wing' integral fuel tanks, have been found to possess sparking properties sufficiently stable and predictable to allow reliable lightning-current protection design. The passing of simulated lightning current across the fastener-joint interface has been found to modify or 'stabilize' the interface so that subsequent application of simulated lightning-current waveforms will require significantly higher peak currents than identical joints which have not been stabilized. Test results show that effective stabilizing currents of the order of tens of amps are independent of waveform. O.C.

A92-20349
PROTECTIVE COATINGS OF THERMAL BARRIER TYPE [REVETEMENTS PROTECTEURS DE TYPE BARRIERE THERMIQUE]
S. ALPERINE (ONERA, Direction Scientifique des Materiaux, Chatillon, France) Revue Scientifique et Technique de la Defense (ISSN 0994-1541), 2nd Quarter, 1991, p. 111-114. In French. refs
Copyright

Thermal barrier coatings (TBCs) are a new generation of protective coatings for the high-temperature components of turbine or diesel engines. Several ONERA studies on such coatings are summarized here, with particular emphasis placed on the enhancement of the resistance of TBCs to thermomechanical fatigue in an oxidizing environment. Three complementary themes are considered: (1) the effect of the composition and microstructure of the coatings on their intrinsic thermomechanical resistance; (2) investigation of the physical structure of the coatings (pores, cracks) in relation to their toughness; and (3) the role played by the ceramic-bondcoat interface and its evolution at high temperature. L.M.

N92-14411# Fraunhofer-Inst. fuer Betriebsfestigkeit, Darmstadt (Germany, F.R.).
FATIGUE OF REPAIRED COMPOSITE STRUCTURES
J. J. GERHARZ, G. DANZER, and A. MAIER (Messerschmitt-Boelkow-Blohm G.m.b.H., Munich, Germany, F.R.) *In its* Review of Investigations on Aeronautical Fatigue in the Federal Republic of Germany 1 p 1991
Avail: NTIS HC/MF A04

Investigations into the strength of repaired stringer stiffened panels of Rigidite 5245C/T800 composite laminate are summarized. The panels were fatigue loaded with modified Falstaff for wing upper surface up to three lives (18,000 flights). Surviving panels were loaded in compression up to failure (residual compressive strength test). Workshop and field repair methods were applied. The workshop repair methods consisted of flush laminate patch repairs applied to punctured skin and stringer and the field repair methods consisted of blind rivet installation in the delaminated area of nonvisible damage. The workshop repair methods used an adhesive in order to bond the patches to the reworked area of damage. The patches consisted of wet laid-up carbon fiber fabric laminate or of a laminate of fabric prepreg. The results of static and fatigue tests were dominated by the quality of the repair and the hot/wet sensitivity of the adhesive. Delamination, caused by 30 Joule low velocity impact on the skin opposite the stringer foot run out, propagated during the fatigue loading (modified Falstaff for upper wing surface). A field repair method of installing blind rivets in the delaminated area successfully delayed the delamination growth. ESA

N92-14413# Fraunhofer-Inst. fuer Betriebsfestigkeit, Darmstadt (Germany, F.R.).
ENVIRONMENTAL FATIGUE TESTS WITH COMPOSITE MATERIALS
M. BERG, D. ROTT, and H. HUTH *In its* Review of Investigations on Aeronautical Fatigue in the Federal Republic of Germany 1 p 1991
Avail: NTIS HC/MF A04

Since the certification of composite airframe structures requires consideration of the effects of in service environmental conditions on fatigue and residual strength, two environmental test rigs for eight specimens were developed. Different graphite/epoxy materials and specimens were investigated in a variety of environmental fatigue tests using for example Falstaff and Airbus component loading sequences with superimposed thermal cycles. Some published results can be found in the references. ESA

N92-15191*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
TRIBOLOGY NEEDS FOR FUTURE SPACE AND AERONAUTICAL SYSTEMS
ROBERT L. FUSARO Dec. 1991 40 p
(NASA-TM-104525; E-6399; NAS 1.15:104525) Avail: NTIS HC/MF A03 CSCL 11/3

Future aeronautical and space missions will push tribology technology beyond its current capability. The objective is to discuss the current state of the art of tribology as it is applied to advanced aircraft and spacecraft. Areas of discussion include materials lubrication mechanisms, factors affecting lubrication, current and future tribological problem areas, potential new lubrication techniques, and perceived technology requirements that need to be met in order to solve these tribology problems. Author

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ENGINEERING

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

A92-17288
NONDESTRUCTIVE TESTING DEVELOPMENTS IN THE AIRCRAFT INDUSTRY
DONALD J. HAGEMAIER (Douglas Aircraft Co., Long Beach, CA) Materials Evaluation (ISSN 0025-5327), vol. 49, Dec. 1991, p. 1470-1472, 1474-1476, 1478. refs
Copyright

Recent developements in NDT methods designed for uses in the fabrication and maintenance inspections of aircraft materials and structures are reviewed. Among the fabrication inspection methods, special attention is given to the magnetic particle testing (MT) systems using 3D magnetization, the quantitative quality indicators for MT, the electronic shearography methods, and the eddy current liftoff dynamics for the composite cure monitoring. The maintenance inspection methods considered include low-frequency eddy current testing methods, testing with a mobile automated ultrasonic scanner, and the diffracto-sight method. I.S.

A92-17289
REAL-TIME MICROFOCUS RADIOGRAPHY FOR ELECTRONIC FAILURE ANALYSIS
MICHAEL MARCHESE (USAF, Wright Laboratory, Wright-Patterson AFB, OH) and KAREN A. GLODOWSKI (DOD, Defense Electronics Supply Center, Dayton, OH) Materials Evaluation (ISSN 0025-5327), vol. 49, Dec. 1991, p. 1481-1485.

This paper is formatted as a case history of several failure-analysis projects where real-time microfocus radiography was employed as an inspection tool. These projects investigated various devices such as printed wiring boards, switches, connectors, and filters. Author

A92-17290
ENHANCED VISUAL TECHNIQUE FOR RAPID INSPECTION OF AIRCRAFT STRUCTURES

JERZY P. KOMOROWSKI, DAVID L. SIMPSON, and RONALD W. GOULD (National Research Council of Canada, Institute for Aerospace Research, Ottawa) Materials Evaluation (ISSN 0025-5327), vol. 49, Dec. 1991, p. 1486-1490. refs

A new surface inspection technique termed diffracto-sight (D Sight) is described together with the details of an inspection procedure for the detection of large aircraft surface defects. Results obtained by applying the D Sight to the detection of small surface defects are presented. It is shown that D Sight is capable of detecting cold-worked holes, corrosion areas, and fatigue cracks associated with high stress-intensity factors, as long as the surface anomaly is greater than about 10 microns. To date, it has been demonstrated that D Sight is capable of detecting surface waviness in metallic and composite materials, impact damage and edge delamination in composites, and cold-worked holes, cracks, and corrosion in metallics. I.S.

A92-17292
RAPID ULTRASONIC SCANNING OF AIRCRAFT STRUCTURES
M. K. REIGHARD, T. W. VAN OORDT, and N. L. WOOD (McDonnell Aircraft Co., Saint Louis, MO) Materials Evaluation (ISSN 0025-5327), vol. 49, Dec. 1991, p. 1506, 1508, 1510 (3 ff.). refs
Copyright

An automated ultrasonic inspection system, called the Mobile Automated Ultrasonic System (MAUS), developed for the detection of defects in advanced aircraft composites, is described. The MAUS consists of a scanner, for positioning probes on the inspection surface, and an electronic package, for acquiring and imaging data on a video screen. The MAUS, originally developed for the 'time-of-flight' inspection, is suited for rapid assessment of a wide variety of aircraft structures and materials, including composite laminates, complex co-cured composites, and bonded structures. I.S.

A92-17293
ASNT AND AEROSPACE - WHAT ABOUT THE NEXT 50 YEARS?
THOMAS D. COOPER (USAF, Wright Laboratory, Wright-Patterson AFB, OH) Materials Evaluation (ISSN 0025-5327), vol. 49, Dec. 1991, p. 1526-1529, 1531-1535. refs
Copyright

The 50-year history (since its inception in 1941) of the development of NDT inspection methods and of devices and systems for inspecting aircraft surfaces is described with special attention given to the technologies involved in these methods and devices and to the role of NDE in the damage-tolerance approach to designing new structures. Consideration is also given to recent improvements in the NDT methods developed for use in aerospace and to the projections of NDT developments for the next 50 years. I.S.

A92-17348
HYDRAULIC PUMPS - THE KEY TO POWER GENERATION
JAMES H. BRAHNEY Aerospace Engineering (ISSN 0736-2536), vol. 11, Dec. 1991, p. 9-13.
Copyright

A review is presented of the development of aircraft hydraulic pumps and their continuing growth due to the increasing demands dictated by the power requirements for higher aerodynamic loading and the integration of propulsion system devices (thrust vectoring) into the flight control system. Consideration is given to the various types of hydraulic pumps and the recent work directed at developing microprocessor-controlled pumps for use in variable-pressure hydraulic systems. R.E.P.

A92-17414
ULTRASONIC MOTOR UTILIZING ELASTIC FIN ROTOR
TATSUYA UCHIKI, KENTARO NAKAMURA, MINORU KUROSAWA, SADAYUKI UEHA (Tokyo Institute of Technology, Yokohama, Japan), and TORU NAKAZAWA (ALPS Electric Co., Ltd., Nagaoka, Japan) (Ferroelectric materials and their applications; Proceedings of the 8th Meeting, Kyoto, Japan, May 29-31, 1991. A92-17401 05-76) Japanese Journal of Applied Physics, Part 1 (ISSN 0021-4922), vol. 30, Sept. 1991, p. 2289-2291. refs
Copyright

The design principles of a 5-mm-diam ultrasonic micromotor utilizing an elastic fin rotor are discussed, and the characteristics of the experimental rotor model of the motor are described. The experimental rotation speed of the rotor model was found to be nearly equal to that of the theoretical. I.S.

A92-17562
ENHANCEMENT OF MODAL SWEPT SINE DATA BY CONTROL OF EXCITING FORCES
G. C. FOSS (Boeing Defense and Space Group, Seattle, WA) Experimental Techniques (ISSN 0732-8818), vol. 15, Nov.-Dec. 1991, p. 22-26.
Copyright

A shaker control system is described which improves the quality of frequency response data obtained from nonlinear test articles during sine sweep excitation. The system showed good results on a prototype space truss and a missile fin. Currently it is used only with averaged sine FFT-type analysis. O.G.

A92-17627#
A REVIEW OF DIGITAL FLIGHT CONTROL SYSTEM UPSETS CAUSED BY ELECTROMAGNETIC INTERFERENCE
BRUCE T. CLOUGH (USAF, Flight Dynamics Directorate, Wright-Patterson AFB, OH) IN: AIAA Computing in Aerospace Conference, 8th, Baltimore, MD, Oct. 21-24, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 414-420.
(AIAA PAPER 91-3765)

Examinations of the MIL-STD-461C data base, operational experience, and specific tests show that upsets of digital flight-control systems are caused by low-frequency amplitude modulated signals corrupting the sensor inputs. Studies show that the current digital (and analog) flight-control systems are susceptible to electromagnetic radiation, that is, continuous wave, AM signal of 0 to 3 Hz modulation content, and has carrier frequencies of between 1 and 250 MHz. When the systems are placed in an airframe the frequency region constricts to 3 to 30 MHz, reflecting the influence of airframe/wire coupling. Field levels vary according to the electromagnetic interference susceptibility specifications the system was built to. Most current systems respond to average field levels of 200 V/m over some part of the carrier-frequency range. Steps to reduce the upset potential of analog portions are required if average field levels greater than 200 V/m are experienced during operation. Then, harder analog sensors and sensor/flight computer interfaces are required. Author

A92-17823#
CONJUGATE CONDUCTION/CONVECTION/NUCLEATE-BOILING HEAT TRANSFER WITH A HIGH-SPEED BOUNDARY LAYER
FREDERICK L. SHOPE (Calspan Corp., Arnold AFB, TN) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 12 p. refs
(AIAA PAPER 91-5033)

A space-marching boundary-layer program has been extensively modified to model conjugate conduction/convection heat transfer for the case of coflowing high-speed gas and liquid coolant. Solid body conduction is modeled as one-dimensional, constant property heat transfer. The coolant is modeled empirically as a bulk fluid with combined forced convection and nucleate boiling. The flow solver was modified to solve the group of conjugate boundary equations simultaneously and implicitly with the existing momentum and energy equations for the gas. The code has been applied to analysis of a backside water-cooled nozzle for a high-enthalpy, supersonic wind tunnel. Author

A92-17843*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ANALYSIS OF COOLING SYSTEMS FOR HYPERSONIC AIRCRAFT
DENNIS H. PETLEY (NASA, Langley Research Center, Hampton, VA), STUART C. JONES, and WILLIAM M. DZIEDZIC (Lockheed Engineering and Sciences Co., Hampton, VA) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 13 p. refs
(AIAA PAPER 91-5063) Copyright

A computer program has been written to analyze cooling systems of hypersonic aircraft. This computer program called NASP/SINDA is written into the SINDA'85 command structure and uses the SINDA'85 finite difference subroutines. Both internal fluid flow and heat transfer must be analyzed, because increased heating causes a decrease in the flow of the coolant. Also local hot spots will cause a redistribution of the coolant in the system. Both steady state and transient analyses have been performed. Details of empirical correlations are presented. Results for two cooling system applications are given. Author

A92-17950
PVD COATINGS FOR AIRCRAFT TURBINE BLADES
HELMUT LAEMMERMANN (Leybold AG, Hanau, Federal Republic of Germany) and GERHARD KIENEL (Karlsruhe, Technische Universitaet, Federal Republic of Germany) Advanced Materials and Processes (ISSN 0882-7958), vol. 140, Dec. 1991, p. 18-23.
Copyright

In commercial operations, turbine blade-coating may be conducted via electron-beam vacuum evaporation, which is a PVD technique, and low-pressure plasma-spraying, which is a thermal-spray method possessing an equipment-cost advantage over PVD. Attention is presently given to the processing stages involved in vacuum evaporation, typical coating compositions, and vacuum-evaporation method variations. Low pressure plasma spraying is the only thermal-spray method capable of yielding the high coating purity and strong coating-substrate bond needed for turbine blade applications. O.C.

A92-18005
ROLLING IN THE TOLERANCE
Aerospace Composites and Materials (ISSN 0954-5832), vol. 3, Nov.-Dec. 1991, p. 30-33.
Copyright

Precision cold-rolling is recognized as a cost-effective method of producing net and near-net shapes with exotic and expensive alloys, such as those utilized in aerospace applications. This technique enables metal surfaces to be finished as finely as 10 to 16 rms, often eliminating the requirement for more final finishing operations. R.E.P.

A92-18362* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ALGEBRAIC TURBULENCE MODELING FOR UNSTRUCTURED AND ADAPTIVE MESHES
DIMITRI J. MAVRIPLIS (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 29, Dec. 1991, p. 2086-2093. Previously cited in issue 16, p. 2558, Accession no. A90-38781. refs
Copyright

A92-18369
COMPRESSIBILITY EFFECTS IN THIN CHANNELS WITH INJECTION
A. LINAN, F. A. WILLIAMS (California, University, La Jolla), and G. BALAKRISHNAN AIAA Journal (ISSN 0001-1452), vol. 29, Dec. 1991, p. 2149-2154. Research supported by CICYT. refs
(Contract AF-AFOSR-89-0310)
Copyright

A theoretical analysis of the inviscid flow between a porous plate and a parallel impermeable plate is performed for small values of the ratio of the plate separation distance to the lateral extent of the plates, for both planar and axisymmetric geometries. The problem of computing the flowfield is reduced to the solution of a single integral equation, which is accomplished numerically. The ratio of specific heats gamma is a parameter of the solution, and parametric results are presented from gamma = 1.0 to 1.67. The flow exhibits choking at a critical value of the lateral extent of the plate, in the vicinity of which the Mach number approaches unity. The results are needed in providing external boundary-layer conditions for studying the flame structure in the viscous region between two counterflowing streams when compressibility is important. Author

A92-18373* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NUMERICAL STUDY ON USING SULFUR HEXAFLUORIDE AS A WIND TUNNEL TEST GAS
W. K. ANDERSON (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 29, Dec. 1991, p. 2179, 2180. Abridged. Previously cited in issue 16, p. 2544, Accession no. A90-37958. refs
Copyright

A92-18377
EXPERIMENTAL AND THEORETICAL ANALYSIS OF COMPOSITE I-BEAMS WITH ELASTIC COUPLINGS
RAMESH CHANDRA and INDERJIT CHOPRA (Maryland, University, College Park) AIAA Journal (ISSN 0001-1452), vol. 29, Dec. 1991, p. 2197-2206. refs
(Contract DAAL03-88-C-022)
Copyright

A92-18830
SOME RESULTS ON METAL AND COMPOSITE PATCH REINFORCEMENT OF ALUMINUM HONEYCOMB PANEL
C. L. ONG and S. B. SHEN (Chung-Shan Institute of Science and Technology, Taichung, Republic of China) Theoretical and Applied Fracture Mechanics (ISSN 0167-8442), vol. 16, Nov. 1991, p. 145-153. refs
Copyright

Composite patches used to reinforce aircraft structures is on the increase as their advantages over that of rivet fastened metal patches are identified in application. This work further illustrates the superiority of bonding the cracked portion of an aluminum honeycomb panel with carbon or boron fiber-reinforced composite patches. Three different aluminum thicknesses were investigated: 2.5 mm, 4.1 mm, and 6.4 mm. The fatigue life increased three times over that of riveting metal patches to the same honeycomb. Moreover, repair can be administered to thicker structural components. Satisfactory results are obtained by honeycomb panels of 4.1 mm and 6.4 mm thick when patched, respectively, by adhesive bonding at room and higher temperature. Influence of the curing temperature on bonded strength is also discussed. Author

A92-19091
SIMULATION OF RADAR CLUTTER AND JET ENGINE MODULATION USING DIGITAL QUADRATURE MODULATOR
KENNETH R. HARRISON and RICHARD F. OLSON (Simulation Technologies, Inc., Huntsville, AL) IN: 1990 Annual Summer Computer Simulation Conference, 22nd, Calgary, Canada, July 16-18, 1990, Proceedings. San Diego, CA, Society for Computer Simulation, 1990, p. 907-911. refs
Copyright

The use of a new Digital Quadrature Modulator (DQM) in radar signal synthesis is described. DQM performance measurements are compared with those from Linear Quadrature Modulators (LQMs) and found to be superior for a variety of signal synthesis trials. It is concluded that the introduction of the DQM-based signal generation into the RFSS will result in a marked reduction in setup and calibration time for the facility. Several changes are proposed to improve the DQM performance and allow it to operate on a wider range of input signals. C.D.

A92-19202
AN ALTERNATIVE METHOD FOR ACQUIRING AVIONIC BUS DATA IN A CLASS I PCM TELEMETRY SYSTEM
THOMAS SALLEY and STEVEN E. THORSSELL (Metraplex Corp., Frederick, MD) IN: ITC/USA/'90; Proceedings of the International Telemetering Conference, Las Vegas, NV, Oct. 29-Nov. 2, 1990. Research Triangle Park, NC, Instrument Society of America, 1990, p. 1-5. refs

IRIG 106-86 Chapter 8 describes the standard for acquisition of MIL-STD-1553 traffic flow. All incoming words (command, status, or data) are transmitted and fill words are used to maintain continuous data output. If all incoming words are not needed, or if other data such as sampled analog data from transducers are also to be transmitted, then a different approach is warranted. Selected data from the avionics bus can be placed into predefined PCM words, eliminating the transmission of useless data, and optimizing the bandwidth available to a Class I telemetry system. The engineering considerations and constraints for avionics bus data acquisition and analysis will be explored in this paper.
Author

A92-19231
A STATE-OF-THE-ART DATA ACQUISITION SYSTEM
RICHARD D. TALMADGE (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) and MANSOUR RADMAND (Aydin Corp., Vector Div., Newtown, PA) IN: ITC/USA/'90; Proceedings of the International Telemetering Conference, Las Vegas, NV, Oct. 29-Nov. 2, 1990. Research Triangle Park, NC, Instrument Society of America, 1990, p. 351-360. refs

Recent developments in manufacturing technology have afforded a new capability in miniaturized instrumentation systems. The advent of ASIC (Application Specific Integrated Circuit) technology has provided the tools to implement very sophisticated signal conditioning circuits in micro-miniature instrumentation. This paper discusses the development of the Automatic Gain Ranging Amplifier (AGRA) and its implementation in the Aydin Vector MMSC-800 instrumentation package. Also discussed is the miniaturization of a 1553 Bus monitor, IRIG-B Time Code reader/accumulator and the development of a helical scan miniature tape recording system capable of recording 2+ hours of 3.4 Mbps data. The paper concludes by giving applications for and benefits of using this new state-of-the-art instrumentation.
Author

A92-19463
REPRESENTATION OF GEOMETRIC STIFFENING IN MULTIBODY SYSTEM SIMULATION
OSKAR WALLRAPP and RICHARD SCHWERTASSEK (DLR, Institut fuer Dynamik der Flugsysteme, Oberpfaffenhofen, Federal Republic of Germany) International Journal for Numerical Methods in Engineering (ISSN 0029-5981), vol. 32, Dec. 1991, p. 1833-1850. refs

Geometric, rotational or dynamic stiffening is a well and long known phenomenon in the analysis of flexible bodies. In multibody dynamics the effect has attracted attention only recently. The objective of this paper is to contribute to the understanding of the modeling of geometric stiffening in multibody system simulation. Today's methods for modeling the effect assume that the (applied) stresses in a flexible system body are zero in its reference configuration, in which it performs large overall motions. The corresponding inertial loads are shown to be balanced by constraint stresses. This can be seen easily when formulating the system equations of motion for non-zero reference stresses. As a result one obtains an efficient alternative to compute the geometric stiffening terms. The method increases the generality of flexible body models for multibody system simulation. Author

A92-19618
LDV MEASUREMENTS AND INVESTIGATION OF FLOW FIELD THROUGH RADIAL TURBINE GUIDE VANES
HASAN EROGLU and WIDEN TABAKOFF (Cincinnati, University, OH) ASME, Transactions, Journal of Fluids Engineering (ISSN 0098-2202), vol. 113, Dec. 1991, p. 660-667. refs
(Contract DAAL03-87-G-0017; DAAL03-90-G-0129)

The results of LDV measurements and investigation of the detailed flow field in a radial inflow turbine nozzle are presented. The flow velocities were measured at upstream, inside and downstream of the nozzle blades for two different mass flow rates, using a three-component LDV system. Results are presented as contour plots of mean velocities, flow angles, and turbulence intensities. The flow field inside the nozzle blade passages was found to be influenced by the upstream scroll geometry. The flow turbulence increased in the downstream flow direction. The LDV mean flow results on the blade-to-blade midspan plane which is parallel to the end walls were also compared with an inviscid, 'panel method' solution. Author

A92-19677
FATIGUE AND DAMAGE TOLERANCE VERIFICATION OF AIRCRAFT STRUCTURES
ANDERS F. BLOM (Aeronautical Research Institute of Sweden, Bromma) IN: Fatigue 90; Proceedings of the 4th International Conference on Fatigue and Fatigue Thresholds, Honolulu, HI, July 15-20, 1990. Vol. 1. Birmingham, England, Materials and Component Engineering Publications, Ltd., 1990, p. 13-22. refs

The position is argued that to provide and maintain aircraft structural integrity comprehensive treatment be given to such interrelated issues as maintenance, testing, stress analysis, and load budgets. An overview is given of procedures related to damage-tolerance verification and fatigue analysis including initial flaw-size assumptions. The analytical concepts set forth emphasize the identification of fatigue-critical areas, the calculation of stress-intensity factors, and experimental truncation tests. Load spectra, interactions, and monitoring techniques are mentioned, and a protocol for structural testing is outlined. Durability of aircraft structures is found to be related to proper inspection and repair, whereas structural integrity relies primarily on data regarding flight profiles, the resulting load spectra, stress distributions, and material properties. C.C.S.

A92-19812
FRACTURE ANALYSIS AND CRACK PROPAGATION IN PRESSURIZED FUSELAGE STRUCTURES - EXPERIMENTAL AND NUMERICAL INVESTIGATIONS
E. BRUGNOLI, A. LA BARBERA, and M. MARCHETTI (Roma I, Universita, Rome, Italy) IN: Fatigue 90; Proceedings of the 4th International Conference on Fatigue and Fatigue Thresholds, Honolulu, HI, July 15-20, 1990. Vol. 4. Birmingham, England, Materials and Component Engineering Publications, Ltd., 1990, p. 2091-2096. Research supported by MPI. refs
(Contract CNR-88,00370,11)

The paper deals with fatigue-crack propagation and fracture analysis of pressurized fuselage structures. Cracks are initiated in the longitudinal direction, and during the propagation crack lengths are measured at both the crack tips. Finite-element analysis is developed in order to evaluate the elastic fields (stress, strain, and energy distributions), and both the overall and local responses are investigated. The effects of panel thickness and type of stiffening frame on crack propagation are singled out. Author

A92-19818
FATIGUE TESTING OF A GAS TURBINE FAN DISC
TARUN GOSWAMI (Wollongong, University, Australia) IN: Fatigue 90; Proceedings of the 4th International Conference on Fatigue and Fatigue Thresholds, Honolulu, HI, July 15-20, 1990. Vol. 4. Birmingham, England, Materials and Component Engineering Publications, Ltd., 1990, p. 2221-2226.

Results are presented on a mission analysis of a gas turbine fan disc made of Ti6AL4V, assuming the predominance of

mechanical stresses. Results of disk tests on a cyclic spinning rig show that, for a fan disc of Ti6LA4V operating at room temperature, the number of equivalent cycles for a mission in the case of an engine in service is 75. The amplitude of rig rpm is 11,000, at the design limit. I.S.

A92-19977
DARPA HIGH RESOLUTION DISPLAY TECHNOLOGIES
MARKO SLUSARCZUK (DARPA, Arlington, VA) IN: Airborne reconnaissance XIV; Proceedings of the Meeting, San Diego, CA, July 10-12, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 19-29.
Copyright

Much of the information of interest to pilots in flight is display-limited, and is undergoing substantial expansion due to improved sensor output and signal processing; attention is accordingly given to digitally-based instrument display imaging in the present evaluation of high-resolution cockpit display technologies. Also noted are the advantages of digitally transmitted sensor data in cases where the airborne reconnaissance user may be able to analyze telemetered airborne data in real time and respond with requests to the pilot for more detailed information of specific battlefield sites. O.C.

A92-19986
RECONFIGURABLE MOBILE SYSTEM - GROUND, SEA AND AIR APPLICATIONS
GARY L. LAMONICA and JAMES W. STURGES (Loral Defense Systems, Litchfield Park, AZ) IN: Airborne reconnaissance XIV; Proceedings of the Meeting, San Diego, CA, July 10-12, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 128-137.
Copyright

The Reconfigurable Mobile System (RMS) is a highly mobile data-processing unit for military users requiring real-time access to data gathered by airborne (and other) reconnaissance data. RMS combines high-performance computation and image processing workstations with resources for command/control/communications in a single, lightweight shelter. RMS is composed of off-the-shelf components, and is easily reconfigurable to land-vehicle or shipboard versions. Mission planning, which involves an airborne sensor platform's sensor coverage, considered aircraft/sensor capabilities in conjunction with weather, terrain, and threat scenarios. RMS's man-machine interface concept facilitates user familiarization and features iron-based function selection and windowing. O.C.

A92-19988
AEROBUREAU - STRATEGIC TELEVISION AIRMOBILE REPORTS VIA SATELLITE
CHUCK DE CARO IN: Airborne reconnaissance XIV; Proceedings of the Meeting, San Diego, CA, July 10-12, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 173-198.
Copyright

'Aerobureau' is an airborne newsroom capable of furnishing news-gathering, communications, logistics, remote sensing, and satellite-uplink TV transmission functions for live coverage of major events. The Aerobureau organization plans to market its services to U.S. and foreign news networks, cable services, and local TV stations. Aerobureau will be unique in its ability to operate over politically unstable and logistically remote and isolated locales. O.C.

A92-20206* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
PNEUMATIC DISTORTION COMPENSATION FOR AIRCRAFT SURFACE PRESSURE SENSING DEVICES
STEPHEN A. WHITMORE (NASA, Flight Research Center, Edwards, CA) and CORNELIUS T. LEONDES (Washington, University, Seattle) Journal of Aircraft (ISSN 0021-8669), vol. 28, Dec. 1991, p. 828-836. refs
Copyright

In this paper a technique of compensating for pneumatic distortion in aircraft surface pressure sensing devices is developed. The compensation allows conventional pressure sensing technology to obtain improved unsteady pressure measurements. Pressure distortion caused by frictional attenuation and pneumatic resonance within the sensing system makes obtaining unsteady pressure measurements by conventional sensors difficult. Typically, most of the distortion occurs within the pneumatic tubing used to transmit pressure impulses from the surface of the aircraft to the measurement transducer. This paper develops a second-order distortion model that accurately describes the behavior of the primary wave harmonic of the pneumatic tubing. The model is expressed in state-variable form and is coupled with standard results from minimum-variance estimation theory to develop an algorithm to compensate for the effects of pneumatic distortion. Both postflight and real-time algorithms are developed and evaluated using simulated and flight data. Covariance selection and filter-tuning examples are presented. Results presented verify that, given appropriate covariance magnitudes, the algorithms accurately reconstruct surface pressure values from remotely sensed pressure measurements. Author

A92-20213
EXPERIMENTAL INVESTIGATION OF PERIODICALLY EXCITED ROTATING COMPOSITE ROTOR BLADES
O. RAND (Technion - Israel Institute of Technology, Haifa) Journal of Aircraft (ISSN 0021-8669), vol. 28, Dec. 1991, p. 876-884. refs
Copyright

Experimental procedure for investigating the structural dynamics characteristics of thin-walled composite helicopter rotor blades undergoing periodical excitation during rotation is proposed and demonstrated. The testing setup, which is based on measurements in a vacuum chamber, provides the isolation of the structural dynamics behavior by eliminating the aerodynamic loads and introducing deliberate periodic concentrated loads at the blade's tip. The study presented in this paper includes the testing of thin-walled composite box beams in the nonrotating static case and in the case of periodic loading during rotation at various angular speeds along with comparisons with theoretical predictions. The investigation of the measured composite-related couplings and rotational effects showed some significant nonlinear characteristics. Author

A92-20215* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
HEAT TRANSFER MEASUREMENTS FROM A SMOOTH NACA 0012 AIRFOIL
PHILIP E. POINSATTE, G. J. VAN FOSSEN, JAMES E. NEWTON (NASA, Lewis Research Center, Cleveland, OH), and KENNETH J. DE WITT (Toledo, University, OH) Journal of Aircraft (ISSN 0021-8669), vol. 28, Dec. 1991, p. 892-898. refs
(Contract NAG3-72)
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Local convective heat transfer coefficients were measured from a smooth NACA 0012 airfoil having a chord length of 0.533 m. Flight data were taken for the smooth airfoil at Reynolds numbers based on chord in the range 1.24 to 2.50 million and at various angles of attack up to 4 deg. During these flight tests, the freestream velocity turbulence intensity was found to be very low. Wind tunnel data were acquired in the Reynolds number range 1.20 to 4.52 million and at angles of attack from -4 to +8 deg. The turbulence intensity in the IRT was 0.5-0.7 percent with the cloud-generating sprays off. A direct comparison between the results obtained in flight and in the IRT showed that the higher level of turbulence intensity in the IRT had little effect on the heat transfer for the lower Reynolds numbers but caused a moderate increase in heat transfer at the higher Reynolds numbers. Turning on the cloud-generating spray nozzle atomizing air in the IRT did not alter the heat transfer. The present data were compared with leading-edge cylinder and flat plate heat transfer correlations that are often used to estimate airfoil heat transfer in computer codes. Author

A92-20216
FLUTTER ANALYSIS OF ANISOTROPIC PANELS WITH PATCHED CRACKS
KUO-JIUN LIN, PONG-JEU LU, and JIANN-QUO TARN (National Cheng Kung University, Tainan, Republic of China) Journal of Aircraft (ISSN 0021-8669), vol. 28, Dec. 1991, p. 899-907. refs
(Contract NSCRC-77-0210-D006-14)
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A finite element approach is developed to analyze the panel flutter problems of thin plate-like composite panels with patched cracks. The panel studies is a compound structure that comprises three layers including a thin cracked panel, an adhesive, and a thin patch. A 48-degree-of-freedom (DOF) triangular crack patching element is derived for numerically analyzing the compound structure. The aerodynamic pressure acting on the panel is estimated using linearized piston theory with aerodynamic damping effect neglected. By a proper tailoring of the materials, very high flutter and/or divergence boundary could usually be obtained for the composite panels. The existence of a crack usually reduces the aeroelastic stability boundary; however, some exceptions were found for the composite panel within certain range of specific filament orientation. The deterioration in flutter/divergence performance due to a crack can, in general, be cured by means of patching, and anisotropic patching is more effective as compared to the isotropic patching provided that the tailoring of the structural parameters is done correctly. Author

A92-20217* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ROUGHNESS EFFECTS ON HEAT TRANSFER FROM A NACA 0012 AIRFOIL
PHILIP E. POINSATTE, G. J. VAN FOSSEN (NASA, Lewis Research Center, Cleveland, OH), and KENNETH J. DE WITT (Toledo, University, OH) Journal of Aircraft (ISSN 0021-8669), vol. 28, Dec. 1991, p. 908-911. Previously cited in issue 08, p. 1150, Accession no. A90-22180. refs
(Contract NAG3-72)
Copyright

A92-20324
TWO-DIMENSIONAL EFFECTS IN A TRIANGULAR CONVECTING FIN
A. AZIZ and H. NGUYEN (Gonzaga University, Spokane, WA) Journal of Thermophysics and Heat Transfer (ISSN 0887-8722), vol. 6, Jan.-Mar. 1992, p. 165-167. refs
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A FEM solution is presented for the two-dimensional triangular fin, together with heat-transfer data for a wide range of Biot number and length-to-base thickness ratio; the information may accordingly be used for purposes of performance prediction as well as design. In the case of design tasks, it must be recalled that the assumption of a constant heat-transfer coefficient constitutes a major limitation of the analysis. O.C.

A92-20356
LIMITATIONS TO THE LARGE STRAIN THEORY
Y. M. CHENG (Hong Kong Polytechnic, Hong Kong) and Y. TSUI (University of Hong Kong, Hong Kong) International Journal for Numerical Methods in Engineering (ISSN 0029-5981), vol. 33, Jan. 15, 1992, p. 101-114. refs
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In the formulation of a large strain problem, the Euler-Cauchy-Stokes decomposition and the Eulerian objective stress and strain rates used for the formulation of the problem are actually applicable only for some special cases and are not suitable for general large strain and rotation rates. In this paper, the limitations and applicabilities of the conventional large strain formulation under various deformation cases will be studied. Author

A92-20741
DETECTION OF FLOW STATE IN AN UNSTEADY SEPARATING FLOW
M. A. RAMIZ and MUKUND ACHARYA (Illinois Institute of Technology, Chicago) AIAA Journal (ISSN 0001-1452), vol. 30, Jan. 1992, p. 117-123. Previously cited in issue 11, p. 1651, Accession no. A89-30527. refs
(Contract F49620-86-C-0133)
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A92-20746
NONLINEAR STALL FLUTTER AND DIVERGENCE ANALYSIS OF CANTILEVERED GRAPHITE/EPOXY WINGS
PETER DUNN and JOHN DUGUNDJI (MIT, Cambridge, MA) AIAA Journal (ISSN 0001-1452), vol. 30, Jan. 1992, p. 153-162. Previously cited in issue 11, p. 1700, Accession no. A90-29373. refs
(Contract F49620-86-C-0066)
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A92-20756
VIBRATION CHARACTERISTICS OF PRETWISTED AEROFOIL CROSS-SECTION BLADE PACKETS UNDER ROTATING CONDITIONS
M. SABUNCU (Ninth September University, Bornova, Turkey) and J. THOMAS (Surrey, University, Guildford, England) AIAA Journal (ISSN 0001-1452), vol. 30, Jan. 1992, p. 241-250. refs
Copyright

Turbine blades are usually pretwisted and have asymmetric cross sections. Furthermore, turbine blades are formed into packets by joining them at critical locations with shrouds or lacing. Such a procedure alters the vibration characteristics of the blade. In this paper, the free vibration characteristics of rotating, shrouded, pretwisted aerofoil cross-section blade packets are investigated using a finite element model. One end of the pretwisted blade is assumed to be fixed at the periphery of a disk rotating about its center, whereas the other end of the blade is connected by a curved shroud. Expressions for kinetic and strain energies of a pretwisted blade packet subjected to centrifugal force are derived. Shear deformation and rotary inertia effects are neglected in the analysis. The effects pretwist, stagger angle, rotational speed, shroud length, shroud thickness, shroud width, and the distance of shear center from the centroid on the vibration characteristics of blade packets are investigated. Comparisons made between theoretical and experimental results show very good agreement. Author

A92-20764
SIMPLE METHOD OF SUPERSONIC FLOW VISUALIZATION USING SMOKE
L. S. MILLER and E. IRANI (Wichita State University, KS) AIAA Journal (ISSN 0001-1452), vol. 30, Jan. 1992, p. 278, 279. refs
Copyright

A modified smoke wire visualization method for application in high-speed and supersonic flows has been developed which produces a large number of fine smoke filaments that do not dissipate. This new technique is easily implemented in an open-inlet induction-type supersonic wind tunnel. Shock waves and expansion regions are clearly identified by the smoke filament behavior. O.C.

A92-20771
HOLOGRAPHIC-INTERFEROMETRY METHODS EMPLOYED FOR VIBRATION-STRENGTH TESTING OF AVIATION-ENGINE WORKPIECES
D. S. ELENEVSKII, N. I. KRAINIUKOV, IU. N. SHAPOSHNIKOV, and A. G. KHRAMOV (AN SSSR, Tsentral'noe Konstruktorskoe Biuro Unikal'nogo Priborostroeniia, Samara, USSR) Optics and Lasers in Engineering (ISSN 0143-8166), vol. 15, no. 5, 1991, p. 357-367. refs
Copyright

The vibroshifting fields generated by turbine blades and aerospace engines are calculated numerically with a mathematical system incorporating holographic-interferometry data. The vibroshift field is computed directly from the interferogram pattern, whereas the deformation and strain of the object are obtained experimentally

on the basis of the resulting data. The experimental installation is shown diagrammatically, and algorithms are presented which permit the analysis of brightness distributions of interferogram-pattern points, fringe centers, and the geometrical parameters of the image. Interferogram processing conducted on a PC with 512 x 512-pixel capacity is conducted for a compressor blade by means of the time-averaging and with the proposed local approximation by a second-order surface. The vibroshift vector field and corresponding projection demonstrate the results of detection of dark fringes and filtered skeletons facilitated by the method. C.C.S.

N92-13950*# Stuttgart Univ. (Germany, F.R.). Inst. fuer Aerodynamik und Gasdynamik.
SUPERCRITICAL BLADE DESIGN ON STREAM SURFACES OF REVOLUTION WITH AN INVERSE METHOD
E. SCHMIDT and H.-D. GREIN *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and *Optimization in Engineering Sciences (ICIDES-3)* p 293-305 1991
Avail: NTIS HC/MF A99 CSCL 20D

A method to solve the inverse problem of supercritical blade-to-blade flow on stream surfaces of revolution with variable radius and variable stream surface thickness in a relative system is described. Some aspects of shockless design and of leading edge resolution in the numerical procedure are depicted. Some supercritical compressor cascades were designed and their complete flow field results were compared with computations of two different analysis methods. Author

N92-13962*# Khmelnitsky Technological Inst. (USSR).
IDENTIFICATION OF DYNAMIC CHARACTERISTICS OF FLEXIBLE ROTORS AS DYNAMIC INVERSE PROBLEM
W. P. ROISMAN and L. D. VAJINGORTIN *In* Pennsylvania State Univ., Third International Conference on Inverse Design Concepts and Optimization in Engineering Sciences (ICIDES-3) p 457-468 1991
Avail: NTIS HC/MF A99 CSCL 20D

The problem of dynamic and balancing of flexible rotors were considered, which were set and solved as the problem of the identification of flexible rotor systems, which is the same as the inverse problem of the oscillation theory dealing with the task of the identifying the outside influences and system parameters on the basis of the known laws of motion. This approach to the problem allows the disclosure the picture of disbalances throughout the rotor-under-test (which traditional methods of flexible rotor balancing, based on natural oscillations, could not provide), and identify dynamic characteristics of the system, which correspond to a selected mathematical model. Eventually, various methods of balancing were developed depending on the special features of the machines as to their design, technology, and operation specifications. Also, theoretical and practical methods are given for the flexible rotor balancing at far from critical rotation frequencies, which does not necessarily require the knowledge forms of oscillation, dissipation, and elasticity and inertia characteristics, and to use testing masses. Author

N92-13985# Toronto Univ., Downsview (Ontario). Inst. for Aerospace Studies.
NONSTATIONARY GASDYNAMICS
J. J. GOTTLIEB, C. P. T. GROTH, R. J. HAWBOLDT, D. F. HAWKEN, G. D. LOCK, C. H. WONG, Y. S. CHAN, J. MAILLETTE, G. L. PETRINI, J. S. PICKET et al. *In its* Activities of the University of Toronto Institute for Aerospace Studies p 93-95 1989
Avail: NTIS HC/MF A06

A review is provided of nonstationary gas dynamic investigations carried out at the University of Toronto Institute for Aerospace Studies. Numerical studies aimed at predicting the operation and performance of two stage light-gas guns and selecting optimum gas operating conditions are ongoing. Preliminary internal ballistics work on modelling the motions of propellant gases and projectiles in an experimental gun with a high pressure combustion section and a low pressure launch tube has been completed. The study of propellant combustion in a closed vessel to obtain propellant burning rates and combustion gas properties for use in modelling of gas guns is now underway. The nonequilibrium structure of a shock front in a dusty gas is being studied in a dusty shock tube facility to determine particle drag and heat transfer coefficients. Studies undertaken to provide data for the design of a large air-blast and thermal simulation facility include: investigation of the reflection eliminator, the venting from the test section of combustion products from thermal radiation sources, and the prediction of unsteady flow. A high pressure reservoir with an exit nozzle containing a slot has been constructed to obtain experimental data on discharge coefficients of orifices and slots in high-low pressure guns and on blast simulators. CISTI

N92-14210*# Rome Air Development Center, Griffiss AFB, NY.
ARCHITECTURE FOR SURVIVABLE SYSTEM PROCESSING (ASSP)
RICHARD J. WOOD *In* NASA. Lewis Research Center, Space Communications Technology Conference: Onboard Processing and Switching p 69-74 Nov. 1991
Avail: NTIS HC/MF A13 CSCL 17/2

The Architecture for Survivable System Processing (ASSP) Program is a multi-phase effort to implement Department of Defense (DOD) and commercially developed high-tech hardware, software, and architectures for reliable space avionics and ground based systems. System configuration options provide processing capabilities to address Time Dependent Processing (TDP), Object Dependent Processing (ODP), and Mission Dependent Processing (MDP) requirements through Open System Architecture (OSA) alternatives that allow for the enhancement, incorporation, and capitalization of a broad range of development assets. High technology developments in hardware, software, and networking models, address technology challenges of long processor life times, fault tolerance, reliability, throughput, memories, radiation hardening, size, weight, power (SWAP) and security. Hardware and software design, development, and implementation focus on *the interconnectivity/interoperability of an open system architecture* and is being developed to apply new technology into practical OSA components. To insure for widely acceptable architecture capable of interfacing with various commercial and military components, this program provides for regular interactions with standardization working groups (e.g.) the International Standards Organization (ISO), American National Standards Institute (ANSI), Society of Automotive Engineers (SAE), and Institute of Electrical and Electronic Engineers (IEEE). Selection of a viable open architecture is based on the widely accepted standards that implement the ISO/OSI Reference Model. Author

N92-14217*# TRW Space Technology Labs., Redondo Beach, CA. Space and Technology Group.
GETTING EXPERT SYSTEMS OFF THE GROUND: LESSONS LEARNED FROM INTEGRATING MODEL-BASED DIAGNOSTICS WITH PROTOTYPE FLIGHT HARDWARE
AMY STEPHAN and CAROL A. ERIKSON *In* NASA. Lewis Research Center, Space Communications Technology Conference: Onboard Processing and Switching p 135-141 Nov. 1991
Avail: NTIS HC/MF A13 CSCL 17/2

As an initial attempt to introduce expert system technology into an onboard environment, a model based diagnostic system using the TRW MARPLE software tool was integrated with prototype flight hardware and its corresponding control software. Because this experiment was designed primarily to test the effectiveness of the model based reasoning technique used, the expert system ran on a separate hardware platform, and interactions between the control software and the model based diagnostics were limited. While this project met its objective of showing that model based reasoning can effectively isolate failures in flight hardware, it also identified the need for an integrated development path for expert system and control software for onboard applications. In developing expert systems that are ready for flight, artificial intelligence techniques must be evaluated to determine whether they offer a real advantage onboard, identify which diagnostic functions should be performed by the expert

systems and which are better left to the procedural software, and work closely with both the hardware and the software developers from the beginning of a project to produce a well designed and thoroughly integrated application. Author

N92-14262*# Ohio State Univ., Columbus. ElectroScience Lab.
SATCOM ANTENNA SITING STUDY ON P-3C AIRCRAFT, VOLUME 1 Final Report
D. A. BENSMAN and R. J. MARHEFKA Sep. 1991 198 p
(Contract NAG2-542)
(NASA-CR-189514; NAS 1.26:189514; FR-721711-4-VOL-1)
Avail: NTIS HC/MF A09 CSCL 20/14

The NEC-BSC (Basic Scattering Code) was used to study the performance of a SATCOM antenna on a P-3C aircraft. After plate cylinder fields are added to version 3.1 of the NEC-BSC, it is shown that the NEC-BSC can be used to accurately predict the performance of a SATCOM antenna system on a P-3C aircraft. The study illustrates that the NEC-BSC gives good results when compared with scale model measurements provided by Boeing and Lockheed. Author

N92-14263*# Ohio State Univ., Columbus. ElectroScience Lab.
SATCOM ANTENNA SITING STUDY ON P-3C AIRCRAFT, VOLUME 2 Final Report
D. A. BENSMAN and R. J. MARHEFKA Sep. 1991 193 p
(Contract NAG2-542)
(NASA-CR-189515; NAS 1.26:189515; FR-721711-4-VOL-2)
Avail: NTIS HC/MF A09 CSCL 20/14

This volume contains an antenna location study for the P-3C aircraft. From this location study, a determination can be made of the complete antenna system required to achieve the desired pattern and polarization coverage. The antenna used is the same Batwing airborne UHF satellite communications antenna use in volume 1. The aircraft model used in the majority of the locations studied is the simple cylindrical aircraft model defined in volume 1. Author

N92-14270# Federal Aviation Administration, Atlantic City, NJ.
DATA MULTIPLEXING NETWORK (DMN) PHASE 3 EQUIPMENT OPERATIONAL TEST AND EVALUATION (OT AND E)/INTEGRATION TEST REPORT
WAYNE E. BELL Dec. 1991 123 p
(DOT/FAA/CT-TN91/50) Avail: NTIS HC/MF A06

This test report contains the results of the Operational Test and Evaluation (OT&E)/Integration testing of the Data Multiplexing Network (DMN) Phase 3 B Commercial Off-The-Shelf (COTS) Equipment. The OT&E/Integration testing was accomplished by conducting unit level tests at the Federal Aviation Administration (FAA) Technical Center, and integration tests at the key test sites of Albuquerque, New Mexico; Minneapolis, Minnesota; and Denver, Colorado, Air Route Traffic Control Centers (ARTCC's). The FAA-E-2786 Verification Requirement Matrix (VRTM) and NAS-SS-1000, Volumes 1 and 4, were verified during OT&E/Integration. Also, the test results determined the operational effectiveness and suitability of the Motorola Codex COTS equipment in the National Airspace System (NAS) environment. Based on the test results, it is concluded that the Motorola Codex COTS equipment performed its function of providing data exchange between NAS facilities and is considered qualified for operational development. Author

N92-14309# David Taylor Research Center, Bethesda, MD.
NAVIER-STOKES ANALYSIS OF TURBULENT BOUNDARY LAYER AND WAKE FOR TWO-DIMENSIONAL LIFTING BODIES
PHUC NGUYEN and J. GORSKI *In* NAS-NRC, Eighteenth Symposium on Naval Hydrodynamics p 633-644 1991
Avail: NTIS HC/MF A99

Navier-Stokes calculations were performed on two 2-D lifting foils which have been tested in a wind tunnel. In the experiment, the angles of attack for the two foils were set up to yield approximately the same lift at a Reynolds number of 2.25x10(exp 6) (based on chord). One foil has a thicker trailing edge than the other, and has mild flow separation on the last 4 percent chord of the suction side. The flow solver, called the David Taylor Navier-Stokes (DTNS) code, is formulated with artificial compressibility and upwind differencing. The Launder-Spalding kappa-epsilon turbulence model is used. Predictions of the turbulent flow quantities of the boundary layer and wake are compared with the experimental data for both foils. These predictions, including flow separation location, agree reasonably well with the data. After these validation predictions, the Navier-Stokes analysis method and a design technique based on conformal mapping are combined to develop new 2-D foil sections. Since the turbulent kinetic energy is the dynamic pressure, and the Reynolds shear stresses are related to the turbulence production, these quantities are used to develop new 2-D sections with desirable turbulent boundary layer characteristics. The characteristics of one new section are presented as results of the new foil design process. Author

N92-14310*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A NAVIER-STOKES SOLUTION OF HULL-RING WING-THRUSTER INTERACTION
C.-I. YANG (David Taylor Research Center, Bethesda, MD.), P. HARTWICH, and P. SUNDARAM *In* NAS-NRC, Eighteenth Symposium on Naval Hydrodynamics p 687-696 1991
Avail: NTIS HC/MF A99 CSCL 20/4

Navier-Stokes simulations of high Reynolds number flow around an axisymmetric body supported in a water tunnel were made. The numerical method is based on a finite-differencing high resolution second-order accurate implicit upwind scheme. Four different configurations were investigated, these are: (1) barebody; (2) body with an operating propeller; (3) body with a ring wing; and (4) body with a ring wing and an operating propeller. Pressure and velocity components near the stern region were obtained computationally and are shown to compare favorably with the experimental data. The method correctly predicts the existence and extent of stern flow separation for the barebody and the absence of flow separation for the three other configurations with ring wing and/or propeller. Author

N92-14313*# Nevada Univ., Reno. Engineering Research and Development Center.
NUMERICAL INVESTIGATIONS IN THREE-DIMENSIONAL INTERNAL FLOWS Semiannual Status Report, 1 Jul. - 31 Dec. 1991
WILLIAM C. ROSE 1991 27 p
(Contract NCC2-507)
(NASA-CR-189467; NAS 1.26:189467) Avail: NTIS HC/MF A03 CSCL 20/4

The general objectives of NASA's Generic Hypersonics Research Program (GHP) are to develop a technology background required for aeronautical research in the hypersonic Mach number flow range. These research efforts are to complement the National Aerospace Plane (NASP) Program and are geared toward the development of experimental and computational fluid dynamics (CFD) techniques. One of the prominent goals of inlet design for high speed applications is to produce an inlet that delivers uniform flow at its exit in the shortest possible distance. In previous studies, the technologies for determining contours for both the ramp and cowl were demonstrated that allowed a nearly shock free exiting flow field to be obtained. This technology was developed further during the present reporting period and applied to a preliminary design investigation of a biconic hypersonic research vehicle with a nearly 2-D inlet attached near the aft end of the vehicle. The results of a parametric investigation of this proposed inlet for freestream Mach numbers between 10 and 15 are described. Author

N92-14344*# Texas A&M Univ., College Station. Dept. of Mechanical Engineering.
NONLINEAR ROTORDYNAMICS ANALYSIS Final Report
SHERIF T. NOAH Feb. 1991 96 p

(Contract NAS8-37465)
(NASA-CR-184263; NAS 1.26:184263) Avail: NTIS HC/MF A05 CSCL 13/9

Effective analysis tools were developed for predicting the nonlinear rotordynamic behavior of the Space Shuttle Main Engine (SSME) turbopumps under steady and transient operating conditions. Using these methods, preliminary parametric studies were conducted on both generic and actual HPOTP (high pressure oxygen turbopump) models. In particular, a novel modified harmonic balance/alternating Fourier transform (HB/AFT) method was developed and used to conduct a preliminary study of the effects of fluid, bearing and seal forces on the unbalanced response of a multi-disk rotor in the presence of bearing clearances. The method makes it possible to determine periodic, sub-, super-synchronous and chaotic responses of a rotor system. The method also yields information about the stability of the obtained response, thus allowing bifurcation analyses. This provides a more effective capability for predicting the response under transient conditions by searching in proximity of resonance peaks. Preliminary results were also obtained for the nonlinear transient response of an actual HPOTP model using an efficient, newly developed numerical method based on convolution integration. Currently, the HB/AFT is being extended for determining the aperiodic response of nonlinear systems. Initial results show the method to be promising. Author

N92-14345# Defence Research Establishment Pacific, Victoria (British Columbia). Research and Development Branch.
FILTER DEBRIS ANALYSIS: A CONCRETE APPROACH TO WEAR DIAGNOSIS
H. P. DOMINIQUE and A. J. MCKENZIE (RE TECH Ltd., Victoria, British Columbia) Nov. 1988 29 p Original contains color illustrations
(DREP-TM-88-20; CTN-91-60271) Avail: NTIS HC/MF A03

The diagnostic merits of microscopic inspection and chemical analysis of metallic debris recovered from lubricating oil filters in a variety of oil-wetted machinery are discussed. The filter cleaning method and how it affects the amount of debris recovered is considered. The significance of representative debris levels and some criteria for establishing these levels are discussed. Abnormal debris accumulations and the corresponding mechanical malfunctions are presented to illustrate how filter debris analysis can be used to diagnose increased component wear in a variety of machinery. Merits for application of this technique for the diagnosis of machinery condition are considered. The report concludes that this method of assessing wear is particularly suited for equipment fitted with fine lubricating oil filters such as diesel, turbo-prop, and gas turbine engines and is recommended as a complement to other methods currently used for machinery condition monitoring. Author (CISTI)

N92-14346*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ROTORDYNAMIC INSTABILITY PROBLEMS IN HIGH-PERFORMANCE TURBOMACHINERY, 1990
Washington Oct. 1991 458 p Workshop held in College Station, TX, 21-23 May 1990; sponsored by Texas A and M Univ. and NASA. Lewis Research Center
(NASA-CP-3122; E-5628; NAS 1.55:3122) Avail: NTIS HC/MF A20 CSCL 13/9

The present workshop continues to report field experience and experimental results, and it expands the use of computational and control techniques with the integration of damper, bearing, and eccentric seal operation results. The intent of the workshop was to provide a continuing impetus for an understanding and resolution of these problems.

N92-14348*# Kyushu Electric Power Co., Inc., Fukuoka (Japan). Thermal Power Dept.
FIELD TELEMETRY OF BLADE-ROTOR COUPLED TORSIONAL VIBRATION AT MATUURA POWER STATION NUMBER 1 UNIT
KUNIYOSHI ISII, HIDEAKI MURAKAMI, YASUHIKO OTAWARA, and AKIRA OKABE (Hitachi Ltd., Japan) *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1990 p 15-20 Oct. 1991
Avail: NTIS HC/MF A20 CSCL 13/9

The quasi-modal reduction technique and finite element model (FEM) were used to construct an analytical model for the blade-rotor coupled torsional vibration of a steam turbine generator of the Matuura Power Station. A single rotor test was executed in order to evaluate umbrella vibration characteristics. Based on the single rotor test results and the quasi-modal procedure, the total rotor system was analyzed to predict coupled torsional frequencies. Finally, field measurement of the vibration of the last stage buckets was made, which confirmed that the double synchronous resonance was 124.2 Hz, meaning that the machine can be safely operated. The measured eigen values are very close to the predicted value. The single rotor test and this analytical procedure thus proved to be a valid technique to estimate coupled torsional vibration. Author

N92-14349*# Southampton Univ. (England). Dept. of Mechanical Engineering.
THE EFFECTS OF MANUFACTURING TOLERANCES ON THE VIBRATION OF AERO-ENGINE ROTOR-DAMPER ASSEMBLIES
J. E. H. SYKES and R. HOLMES *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1990 p 21-47 Oct. 1991 Sponsored in part by The Science and Engineering Research Council, England, and Rolls Royce plc
Avail: NTIS HC/MF A20 CSCL 13/9

A range of rotor assemblies incorporating one and two squeeze film dampers with various static misalignments is investigated. Waterfall diagrams are constructed which demonstrate the effects of such misalignment and damper support flexibility on the nature and severity of subsynchronous resonance and jump phenomena. Vibration signatures of similar rotor-bearing assemblies are shown to contrast strongly due to different accumulations of tolerances during manufacture, fitting, and operation. Author

N92-14350*# Northwestern Polytechnical Univ., Xian (China). Vibration Research Council.
THE STABILITY OF THE STEADY STATE AND BISTABLE RESPONSE OF A FLEXIBLE ROTOR SUPPORTED ON SQUEEZE FILM DAMPERS
GUANG MENG *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1990 p 49-62 Oct. 1991 Original language document was announced in IAA as A91-22355 Sponsored in part by Aviation Scientific Foundation of China
Avail: NTIS HC/MF A20 CSCL 13/9

The stability of the steady state response, the bistable response, and the jumping characteristics are analyzed for the case when a system accelerates or decelerates through the bistable region of a flexible rotor-centralized squeeze film damper system. It was found that the system steady state responses have two unstable regions. The larger the unbalance parameter and the smaller the bearing parameter and the external damping ratio, the easier it is for the system to lose stability. The larger the mass ratio and the smaller the stiffness ratio, the lower the threshold rotating speed of instability. The instability of the system steady-state response determined here is due to the system nonsynchronous response in many cases. Author

N92-14351*# University of South Florida, Tampa.
STABILITY OF INTERSHAFT SQUEEZE FILM DAMPERS
A. EL-SHAFEI *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1990 p 63-77 Oct. 1991 Previously announced in IAA as A91-50240
Avail: NTIS HC/MF A20 CSCL 13/9

Intershaft squeeze film dampers were investigated for damping of dual rotor aircraft jet engines. It was thought that the intershaft damper would enhance the stability of the rotor-bearing system. Unfortunately, it was determined that the intershaft squeeze film damper was unstable above the engine's first critical speed. Here,

a stability analysis of rotors incorporating intershaft squeeze film dampers is discussed. A rotor model consisting of two Jeffcott rotors with two intershaft squeeze film dampers was investigated. Examining the system characteristic equation for the conditions at which the roots indicate an ever-growing unstable motion results in the stability conditions. The cause of the instability is identified as the rotation of the oil in the damper clearance. Several proposed configurations of intershaft squeeze film dampers are discussed, and it is shown that the intershaft dampers are stable supercritically only with a configuration in which the oil film does not rotate.
Author

N92-14354*# Stuttgart Univ. (Germany, F.R.). Inst. fuer Thermische Stroemungsmaschinen und Maschinenlaboratorium.
EXPERIMENTAL INVESTIGATIONS OF EXCITING FORCES CAUSED BY FLOW IN LABYRINTH SEALS
G. THIELEKE and H. STETTER *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1990 p 109-134 Oct. 1991 Sponsored in part by Forschungsvereinigung Verbrennungskraftmaschinen e. V., Frankfurt/Main, Fed. Republic of Germany
Avail: NTIS HC/MF A20 CSCL 13/9

The interaction of the flow through the labyrinth seals with the shaft of the rotor can have an effect on the stability of turbomachines. Thus, the excited forces, so-called cross forces or nonconservative forces, arise, which act perpendicular to the rotor eccentricity. This effect is caused by an unsymmetrical pressure distribution within the labyrinth cavities. Experimental studies were carried out for different types of labyrinth geometries: two staggered labyrinths with teeth on the stator and grooved rotor as well as a full and a convergent stepped labyrinth. These labyrinths can be found on the tip shrouding of bladings in steam or gas turbines. The following parameters were varied in the test facility: geometry of the labyrinth seals (number of cavities, inlet region), shaft rotation, pressure difference on the seal, entry swirl and eccentricity of the rotor. The results are presented for stiffness coefficients of the labyrinth seals, leakage flow and circumferential flow in each cavity which was measured with special probes. Generally, the inlet swirl has the greatest influence on the coefficients of the seals. The experimental results were compared with theoretical results and were in good agreement. Author

N92-14356*# Kaiserslautern Univ. (Germany, F.R.). Dept. of Mechanical Engineering.
EVALUATION OF ROTORDYNAMIC COEFFICIENTS OF LOOK-THROUGH LABYRINTHS BY MEANS OF A THREE VOLUME BULK FLOW MODEL
R. NORDMANN and P. WEISER *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1990 p 147-163 Oct. 1991
Avail: NTIS HC/MF A20 CSCL 13/9

To describe the compressible, turbulent flow in a labyrinth seal, a three volume bulk flow model is presented. The conservation equations for mass, momentum, and energy are established in every control volume. A perturbation analysis is performed, yielding zeroth order equations for centric rotor position and first order equations describing the flow field for small rotor motions around the seal center. The equations are integrated numerically. From perturbation pressure, the forces on the shaft and the dynamic coefficients are calculated. Author

N92-14357*# Texas A&M Univ., College Station. Turbomachinery Lab.
TEST RESULTS FOR ROTORDYNAMIC COEFFICIENTS OF THE SSME HPOTP TURBINE INTERSTAGE SEAL WITH TWO SWIRL BRAKES
DARA W. CHILDS, ERIAN BASKHARONE, and CHRISTOPHER RAMSEY *In* NASA. Lewis Research Center, Rotodynamic Instability Problems in High-Performance Turbomachinery, 1990 p 165-178 Oct. 1991 Previously announced in IAA as A91-29469
(Contract NAG3-181)
Avail: NTIS HC/MF A20 CSCL 13/9

Test results are presented for the HPOTP Turbine Interstage Seal with both the current and an alternate, aerodynamically designed, swirl brake. Tests were conducted at speeds out to 16,000 rpm, supply pressures up to 18.3 bars, and the following three inlet tangential velocity conditions: (1) no preswirl; (2) intermediate preswirl in the direction of rotation; and (3) high preswirl in the direction of rotation. The back pressure can be controlled independently and was varied to yield the following four pressure ratios: 0.4, 0.45, 0.56, and 0.67. The central and simplest conclusion to be obtained from the test series is that the alternate swirl brake consistently outperforms the current swirl brake in terms of stability performance. The alternate swirl brake's whirl frequency ratio was generally about one half or less than corresponding values for the current design. In many cases, the alternate design yielded negative whirl frequency ratio values in comparison to positive values for the current design. The alternate design can be directly substituted into the space currently occupied by the current design. There is no change in leakage performance. Author

N92-14360*# Kaiserslautern Univ. (Germany, F.R.). Dept. of Mechanical Engineering.
DETERMINATION OF ROTORDYNAMIC COEFFICIENTS FOR LABYRINTH SEALS AND APPLICATION TO ROTORDYNAMIC DESIGN CALCULATIONS
P. WEISER and R. NORDMANN *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1990 p 203-221 Oct. 1991
Avail: NTIS HC/MF A20 CSCL 13/9

In today's rotordynamic calculations, the input parameters for a finite element analysis (FEA) determine very much the reliability of eigenvalue and eigenmode predictions. While modeling of an elastic structure by means of beam elements etc. is relatively straightforward to perform and the input data for journal bearings are usually known exactly enough, the determination of stiffness and damping for labyrinth seals is still the subject of many investigations. Therefore, the rotordynamic influence of labyrinths is often not included in FEA for rotating machinery because of a lack of computer programs to calculate these parameters. This circumstance can give rise to severe vibration problems especially for high performance turbines or compressors, resulting in remarkable economic losses. The forces generated in labyrinths can be described for small motions around the seal center with a linearized force-motion relationship. Several years ago, we started with the development of computer codes for the determination of rotordynamic seal coefficients. Our different approaches to evaluate the dynamic fluid forces generated by turbulent, compressible seal flow are introduced. Author

N92-14361*# Kobe Univ. (Japan). Faculty of Engineering.
EXPERIMENT OF STATIC AND DYNAMIC CHARACTERISTICS OF SPIRAL GROOVED SEALS
T. IWATSUBO, B. C. SHENG, and M. ONO *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1990 p 223-233 Oct. 1991
Avail: NTIS HC/MF A20 CSCL 13/9

The leakages and the dynamic characteristics of six types of spiral grooved seals are experimentally investigated. The effect of the helix angle of the seal is investigated mainly under the condition of the same nominal clearances, land and groove lengths, and groove depths. The dynamic characteristics are measured for various parameters such as preswirl velocity, pressure difference between inlet and outlet of the seal, whirling amplitude, whirling speed, and rotating speed of the rotor. The results are also compared with leakage increases with the increase of the helix angle, but as the rotating speed increases, the leakages of the larger helix angle seals quickly drop. The leakage of the smooth-stator (SS)/smooth-grooved rotor (SGR) seal drops faster than that of the spiral-grooved stator (SGS)/smooth-rotor (SR) seal. It is found that a circumferential flow can be produced by the flow along the helix angle direction, and this circumferential flow acts as a negative swirl. For the present helix angle range, there is an optimum helix angle with which the seal has a

comparatively positive effect on the rotor stability. Compared with the SGS/SR seals, the SS/SGR seal has a worse effect on the rotor stability. Author

N92-14362*# Sulzer Bros. Ltd., Winterthur (Switzerland).
ANNULAR SEALS OF HIGH ENERGY CENTRIFUGAL PUMPS: PRESENTATION OF FULL SCALE MEASUREMENT
S. FLORJANCIC, R. STUERCHLER, and T. MCCLOSKEY (Electric Power Research Inst., Palo Alto, CA.) *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1990 p 235-267 Oct. 1991
(Contract RP-1884-10)
Avail: NTIS HC/MF A20 CSCL 13/9

Prediction of rotordynamic behavior for high energy concentration centrifugal pumps is a challenging task which still imposes considerable difficulties. While the mechanical modeling of the rotor is solved most satisfactorily by finite element techniques, accurate boundary conditions for arbitrary operating conditions are known for journal bearings only. Little information is available on the reactive forces of annular seals, such as neck ring and interstage seals and balance pistons, and on the impeller interaction forces. The present focus is to establish reliable boundary conditions at annular seals. For this purpose, a full scale test machine was set up and smooth and serrated seal configurations measured. Dimensionless coefficients are presented and compared with a state of the art theory. Author

N92-14363*# Technische Univ., Munich (Germany, F.R.). Inst. of Mechanics.
HYDRAULIC ACTUATOR SYSTEM FOR ROTOR CONTROL
HEINZ ULBRICH and JOSEF ALTHAUS *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1990 p 269-284 Oct. 1991
Avail: NTIS HC/MF A20 CSCL 13/9

In the last ten years, several different types of actuators were developed and fabricated for active control of rotors. A special hydraulic actuator system capable of generating high forces to rotating shafts via conventional bearings is addressed. The actively controlled hydraulic force actuator features an electrohydraulic servo valve which can produce amplitudes and forces at high frequencies necessary for influencing rotor vibrations. The mathematical description will be given in detail. The experimental results verify the theoretical model. Simulations already indicate the usefulness of this compact device for application to a real rotor system. Author

N92-14364*# General Electric Co., Cincinnati, OH. Aircraft Engines.
A SIMPLIFIED METHOD FOR PREDICTING THE STABILITY OF AERODYNAMICALLY EXCITED TURBOMACHINERY
ALBERT F. STORACE *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1990 p 285-299 Oct. 1991
Avail: NTIS HC/MF A20 CSCL 13/9

A method is presented for the quick and accurate prediction of the stability of aerodynamically excited turbomachinery using real eigenvalue/eigenvector data obtained from a rotordynamics model. An expression is presented which uses the modal data and the transmitted torque to provide a numerical value of the relative stability of the system. This approach provides a powerful design tool to quickly ascertain the effects of squeeze-film damper bearings, bearing location, and support changes on system stability. Author

N92-14366*# Virginia Univ., Charlottesville. Dept. of Mechanical and Aerospace Engineering.
DYNAMIC CHARACTERISTICS AND STABILITY ANALYSIS OF SPACE SHUTTLE MAIN ENGINE OXYGEN PUMP
EDGAR J. GUNTER and LYLE BRANAGAN *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1990 p 317-344 Oct. 1991
Avail: NTIS HC/MF A20 CSCL 13/9

The dynamic characteristics of the Space Shuttle high pressure oxygen pump are presented. Experimental data is presented to show the vibration spectrum and response under actual engine operation and also in spin pit testing for balancing. The oxygen pump appears to be operating near a second critical speed and is sensitive to self excited aerodynamic cross coupling forces in the turbine and pump. An analysis is presented to show the improvement in pump stability by the application of turbulent flow seals, preburner seals, and pump shaft cross sectional modifications. Author

N92-14367*# Bently Rotor Dynamics Research Corp., Minden, NV.
ROTOR-TO-STATOR PARTIAL RUBBING AND ITS EFFECTS ON ROTOR DYNAMIC RESPONSE
AGNES MUSZYNSKA, WESLEY D. FRANKLIN, and ROBERT D. HAYASHIDA *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1990 p 345-362 Oct. 1991
(Contract NAS8-36719)
Avail: NTIS HC/MF A20 CSCL 13/9

Results from experimental and analytical studies on rotor to stationary element partial rubbings at several locations and their effects on rotor dynamic responses are presented. The mathematical model of a rubbing rotor is given. The computer program provides numerical results which agree with experimentally obtained rotor responses. Author

N92-14370*# Bently Rotor Dynamics Research Corp., Minden, NV.
COMMENTS ON FREQUENCY SWEPT ROTATING INPUT PERTURBATION TECHNIQUES AND IDENTIFICATION OF THE FLUID FORCE MODELS IN ROTOR/BEARING/SEAL SYSTEMS AND FLUID HANDLING MACHINES
AGNES MUSZYNSKA and DONALD E. BENTLY *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1990 p 391-410 Oct. 1991
Avail: NTIS HC/MF A20 CSCL 13/9

Perturbation techniques used for identification of rotating system dynamic characteristics are described. A comparison between two periodic frequency-swept perturbation methods applied in identification of fluid forces of rotating machines is presented. The description of the fluid force model identified by inputting circular periodic frequency-swept force is given. This model is based on the existence and strength of the circumferential flow, most often generated by the shaft rotation. The application of the fluid force model in rotor dynamic analysis is presented. It is shown that the rotor stability is an entire rotating system property. Some areas for further research are discussed. Author

N92-14371*# Newcastle Polytechnic, Newcastle-upon-Tyne (England).
THE APPLICATION OF A CYLINDRICAL-SPHERICAL FLOATING RING BEARING AS A DEVICE TO CONTROL STABILITY OF TURBOGENERATORS
P. S. LEUNG, I. A. CRAIGHEAD, and T. S. WILKINSON (NEI Parsons Ltd., Newcastle-upon-Tyne, England) *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1990 p 411-426 Oct. 1991
Avail: NTIS HC/MF A20 CSCL 13/9

The development of a new device to control stability of turbogenerators is described. The device comprises a floating ring installed between the journal and bearing housing of a fluid film bearing. The journal and the inner surface of the ring are cylindrical while the outer surface of the ring and bearing surface are spherical providing axial location of the ring and self-alignment of the bearing. The employment of this device would lead to a consistent machine performance. System stability may be controlled by changing a number of bearing and floating ring parameters. This device also offers an additional advantage of having a very low frictional characteristic. A feasibility study was carried out to investigate the suitability of the new device to turbogenerator applications. Both theoretical analysis and experimental observations were carried

out. Initial results suggest that the new floating ring device is a competitive alternative to other conventional arrangements.
Author

N92-14373*# Texas A&M Univ., College Station. Dept. of Mechanical Engineering.
EFFECT OF ECCENTRICITY ON THE STATIC AND DYNAMIC PERFORMANCE OF A TURBULENT HYBRID BEARING
LUIS A. SANANDRES *In* NASA. Lewis Research Center, Rotordynamic Instability Problems in High-Performance Turbomachinery, 1990 p 443-459 Oct. 1991 Sponsored in part by Rockwell International Corp., and State of Texas Advanced Technology Program
Avail: NTIS HC/MF A20 CSCL 13/9

The effect of journal eccentricity on the static and dynamic performance of a water lubricated, 5-recess hybrid bearing is presented in detail. The hydrostatic bearing has been designed to operate at a high speed and with a large level of external pressurization. The operating conditions determine the flow in the bearing to be highly turbulent and strongly dominated by fluid inertia effects. The analysis covers the spectrum of journal center displacements directed towards the middle of a recess and towards the mid-land portion between two consecutive recesses. Predicted dynamic force coefficients are uniform for small to moderate eccentricities. For large journal center displacements, fluid cavitation and recess position determine large changes in the bearing dynamic performance. The effect of fluid inertia force coefficients on the threshold speed of instability and whirl ratio of a single mass flexible rotor is discussed. Author

N92-14374*# Aerojet-General Corp., Sacramento, CA. Propulsion Div.
CERAMIC REGENERATOR PROGRAM Final Report, Aug. 1988 - Jun. 1991
JERROLD E. FRANKLIN Nov. 1991 180 p Original contains color illustrations
(Contract NAS3-25416)
(NASA-CR-189053; NAS 1.26:189053; KFF-FR; RPT/F0094.93A)
Avail: NTIS HC/MF A09; 5 functional color pages CSCL 21/5

The feasibility of fabricating an Air Turbo Ramjet (ATR) regenerator containing intricate hydraulic passages from a ceramic material in order to allow operation with high temperature combustion gas and to reduce weight as compared with metallic materials was demonstrated. Platelet technology, ceramic tape casting, and multilayer ceramic packaging techniques were used in this fabrication of subscale silicon nitride components. Proof-of-concept demonstrations were performed to simulate a methane cooled regenerator for an ATR engine. The regenerator vane was designed to operate at realistic service conditions, i.e., 600 psi in a 3500 R (3040 F), 500 fps combustion gas environment. A total of six regenerators were fabricated and tested. The regenerators were shown to be able to withstand internal pressurization to 1575 psi. They were subjected to testing in 500 fps, 3560 R (3100 F) air/propane combustion products and were operated satisfactorily for an excess of 100 hr and 40 thermal cycles which exceeded 2460 R (2000 F). Author

N92-14382# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
APPLICATION OF MSC/DYNA TO SHOCK AND IMPACT PROBLEMS IN AIRCRAFT INDUSTRY
KLAUS WOLF, IOANNIS NITSOPOULOS, HARALD SUSKI, and DETLEF LIEBE (MacNeal-Schwendler G.m.b.H., Munich, Germany, F.R.) 19 Mar. 1991 19 p Presented at the 18th MSC European Users' Conference, Prien am Chiemsee, Fed. Republic of Germany, 19-21 Jun. 1991
(MBB-UD-0593-91-PUB; OTN-021385; ETN-91-90195) Avail: NTIS HC/MF A03

Applications to important problems in aircraft industry are presented. In the first one the so called Hammershock and the flight loads are forcing the intake of a jet engine plane. The flight loads as the static part are treated with MSC/NASTRAN for efficiency, the hammershock as the highly transient with MSC/DYNA. How to combine these totally different calculations is described. The second problem is about an impact of a steel sphere on a fabric laminated plate. Using the failure criterion of SIMO-Chang, it can be shown, that, after the sphere has bounced off, the plate is partly destroyed caused by failed plies and remaining deformations. Considering the assumptions made the results of MSC/DYNA are in good agreement with the experiment. ESA

N92-14386# Wright Lab., Wright-Patterson AFB, OH.
PROCEEDINGS OF DAMPING 1991, VOLUME 3 Final Report, Feb. 1989 - Feb. 1991
Aug. 1991 517 p Conference held in San Diego, CA, 13-15 Feb. 1991
(Contract AF PROJ. 2401)
(AD-A241313; WL-TR-91-3078-VOL-3) Avail: NTIS HC/MF A22 CSCL 20/11

Individual papers are presented, and the topics covered include the following: viscoelastic material testing and characterization, passive damping concepts, passive damping analysis and design techniques, optimization, damped control/structure interaction, viscous dampers, friction damping, other vibration suppression techniques, damping identification and dynamic testing, applications to aircraft, space structures, marine structures, commercial products, defense applications, and payoffs of vibration suppression. GRA

N92-14391*# Rockwell International Corp., Canoga Park, CA. Rocketdyne Div.
AIRFOIL VIBRATION DAMPERS PROGRAM Final Report
ROBERT M. COOK 11 Nov. 1991 242 p
(Contract NAS8-36720)
(NASA-CR-188929; NAS 1.26:188929; RI/RD-91-230; REPT-91RC13695) Avail: NTIS HC/MF A11 CSCL 20/11

The Airfoil Vibration Damper program has consisted of an analysis phase and a testing phase. During the analysis phase, a state-of-the-art computer code was developed, which can be used to guide designers in the placement and sizing of friction dampers. The use of this computer code was demonstrated by performing representative analyses on turbine blades from the High Pressure Oxidizer Turbopump (HPOTP) and High Pressure Fuel Turbopump (HPFTP) of the Space Shuttle Main Engine (SSME). The testing phase of the program consisted of performing friction damping tests on two different cantilever beams. Data from these tests provided an empirical check on the accuracy of the computer code developed in the analysis phase. Results of the analysis and testing showed that the computer code can accurately predict the performance of friction dampers. In addition, a valuable set of friction damping data was generated, which can be used to aid in the design of friction dampers, as well as provide benchmark test cases for future code developers. Author

N92-14397# Fraunhofer-Inst. fuer Betriebsfestigkeit, Darmstadt (Germany, F.R.).
REVIEW OF INVESTIGATIONS ON AERONAUTICAL FATIGUE IN THE FEDERAL REPUBLIC OF GERMANY Review Period, Jun. 1989 - May 1991
O. BUXBAUM and A. SCHOEPFEL 1991 65 p Presented at 22d International Committee on Aeronautical Fatigue, Tokyo, Japan, 1991
(ETN-92-90317) Avail: NTIS HC/MF A04

Results of investigations in the field of fatigue gained by industry and research organizations are summarized. Most of the subjects are fatigue test results from specimens and components under constant amplitude; program and random loading. Other reports concern investigations about the cyclic stress strain behavior as well as crack propagation, fracture mechanics, and residual strength. A considerable amount of reports on investigations of composite materials, especially of graphite/epoxies and their properties under environmental influence, are included.
ESA

N92-14405# Industrieanlagen-Betriebsgesellschaft m.b.H., Ottobrunn (Germany, F.R.).
LOW CYCLE FATIGUE OF CAST NICKEL BASE TURBINE ROTORS
J. W. BERGMANN and C. M. SONSINO (Fraunhofer-Inst. fuer Betriebsfestigkeit, Darmstadt, Germany, F.R.) *In* Fraunhofer Inst. fuer Betriebsfestigkeit, Review of Investigations on Aeronautical Fatigue in the Federal Republic of Germany 2 p 1991
Avail: NTIS HC/MF A04

A research program on rotor materials of turbochargers and gas turbines and on appropriate life prediction methods is considered. Crack initiation and short crack propagation behavior in smooth and notched specimens, simulating real hot spot areas, is experimentally determined under constant and variable amplitude loading. Crack propagation is investigated both on smooth specimens under strain control using the marker load technique and on compact tension specimens. Fatigue life prediction models for crack initiation (safe life approach) and short crack propagation (damage tolerance approach) will be checked on the basis of test results from notched specimens. Materials under investigation are IN 713 C and MAR-M-247 LC in a fine grain and hipped condition. Testing temperatures are 400, 600, and 760 C. ESA

N92-14414# Industrieanlagen-Betriebsgesellschaft m.b.H., Ottobrunn (Germany, F.R.).
COMPARISON BETWEEN HOT/WET TEST AND RT/DRY TEST ON THE SEASTAR HORIZONTAL STABILIZER AND FIN
C. PETERS *In* Fraunhofer Inst. fuer Betriebsfestigkeit, Review of Investigations on Aeronautical Fatigue in the Federal Republic of Germany 2 p 1991
Avail: NTIS HC/MF A04

A fatigue qualification test carried out with the horizontal stabilizer and fin of the amphibian Seastar is described. The fatigue test was carried out successfully without damage and no damage propagation was identified according to the damage types effected in the damage tolerance concept. The certification requirements were more than fulfilled because the residual strength test after three lives was also carried out successfully. By the comparison of the hot/wet test and the RT/dry test it was established that the environmental conditions led to a strength reduction of approximately 12 percent. Assuming that the temperature cycles do not reduce the strength in the fatigue test, the strength reduction occurred due to the influence of humidity. ESA

N92-14424# Industrieanlagen-Betriebsgesellschaft m.b.H., Ottobrunn (Germany, F.R.).
PROBABILISTIC LIFING APPROACH FOR AERO ENGINE DISKS MADE OF POWDER NICKEL BASE ALLOYS CONTAINING CERAMIC DEFECTS
J. W. BERGMANN, R. HEIDENREICH, H. JAECKELS, A. BRUECKNER-FOIT, U. QUADFASEL, H: FISCHMEISTER, G. KOENIG, and E. AFFELT (Motoren- und Turbinen-Union Muenchen G.m.b.H., Germany, F.R.) *In* Fraunhofer Inst. fuer Betriebsfestigkeit, Review of Investigations on Aeronautical Fatigue in the Federal Republic of Germany 1 p 1991
Avail: NTIS HC/MF A04

In a joint research program a probabilistic approach for fatigue lifing of engine disks was developed to a preliminary state. This approach is mainly based on the distribution of the size and occurrence of ceramic particles in a nickel base powder alloy disk and the scatter and type of distribution of crack propagation data. Crack propagation data was established by smooth specimen tests under constant and variable (TURBISTAN) strain controlled loading. The material under investigation was Udimet 700 as hipped in the technically pure version and in three additional versions with 20, 50 and 100 micron Al2O3 particles, which were introduced intentionally into the clean powder in a well defined fraction. The temperatures were 400C and 600C. Microstructural effects on crack propagation were recorded and will be included in the lifing approach. The probabilistic and a deterministic approach will be applied to a model disk and results will be compared. Final reports are expected in 1991. ESA

N92-14425# Deutsche Airbus G.m.b.H., Hamburg (Germany, F.R.).
AIRBUS INDUSTRIE A330/A340: FULL SCALE FATIGUE TEST OF CENTER FUSELAGE AND WING
T. NIELSEN *In* Fraunhofer Inst. fuer Betriebsfestigkeit, Review of Investigations on Aeronautical Fatigue in the Federal Republic of Germany 3 p 1991
Avail: NTIS HC/MF A04

Principles of the EF2 (French acronym for trial fatigue 2) test of a center fuselage and wing are given. The goal of the test is to verify that the A330/A340 structure reaches or exceeds its design goals. The A330/A340 structures are almost identical, but differ with respect to the number of engines and will be subjected to different mission profiles. One combined test specimen was defined. The test will be divided into two phases beginning with combined loads of the A340 short and medium range versions up to 40,000 flights, followed by A330 short range loading up to the test end, resulting in a total of 80,000 flights. The test specimen is illustrated and its control and loading described. Methods to verify the damage tolerance behavior of the A330/A340 primary structure and to investigate the fatigue and damage tolerance behavior of aluminum lithium material which makes up part of the EF2 fuselage structure are summarized. ESA

N92-14428# Deutsche Airbus G.m.b.H., Hamburg (Germany, F.R.).
METHODOLOGY FOR ASSESSMENT OF SKIN REPAIRS ON AIRBUS AIRCRAFT
B. BRANDECKER and U. SCHMAELZLE *In* Fraunhofer Inst. fuer Betriebsfestigkeit, Review of Investigations on Aeronautical Fatigue in the Federal Republic of Germany 2 p 1991
Avail: NTIS HC/MF A04

The assessment of existing repairs on in-service aircraft, i.e., the determination of necessary inspection threshold and intervals, and/or time of modification or replacement for each repair, is discussed. Static aspects as well as fatigue and damage tolerance aspects are considered. A new methodology which includes guidance material allowing operators to assess the repairs without both complex calculation and support from the manufacturer is reviewed. For example, wing repairs cannot be generalized. The methodology is limited to the fuselage and vertical tail and comprises the following subjects: skin and longitudinal lap joint repairs; circumferential joint repairs; door skin repairs; repairs of door surrounding frames; repairs around door cut outs; repairs of vertical tail skin. As an example, the basic features of the method used for assessing skin and lap joint repairs are described. ESA

N92-14431# Deutsche Airbus G.m.b.H., Bremen (Germany, F.R.).
A CONCEPT FOR THE REVISIONS OF STRUCTURAL INSPECTION SCHEDULES
H.-J. MEYER and L. SCHWARMANN *In* Fraunhofer Inst. fuer Betriebsfestigkeit, Review of Investigations on Aeronautical Fatigue in the Federal Republic of Germany 31 p 1991
Avail: NTIS HC/MF A04

Revisions of established inspection schedules should not only be released in case of an in service finding, but also institutionally updated following an Airframe Condition Monitoring Procedure (ACMP). In order to improve methods and inspection procedures, it is aimed to perform an inspection just when a crack reaches its detectable length or, more realistically, to schedule inspections closer to damage. Since aircraft utilization and loading environment differ individually, a closer to damage inspection schedule must account for these differences. The basic general inspection program has to be attuned to the actual service experience for each individual aircraft. It is anticipated that reliable tools for individual aircaft tracking will soon be available and a Flexible Response Inspection Schedule (FRIS) can be established. ACMP, a software system comprising all data processing necessary to transfer collected airline sevice data into a structural inspection adjustment program, is considered. Update sequences will ensure continuing lifelong structural reassessment. Monitoring a fleet with ACMP will for the first time provide relations between aircraft

utilization, including environment, and occurrence of damage. During the life of the aircraft, the Schedule for Structural Inspection (SSI) of the Maintenance Review Board (MRB) is expected to change completely from the originally supposed SSI to in service findings. Although the main objective of ACMP is to adjust inspection threshold and intervals, ACMP results can on the other hand be used to change aircraft operation in order to extend intervals or to postpone thresholds or even repair and replacement actions. ESA

N92-15004# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Div. de Thermophysique.
ABLATION AND TEMPERATURE SENSORS FOR FLIGHT MEASUREMENTS IN REENTRY BODY HEAT SHIELDS
J. J. CASSAING, D. L. BALAGEAS, A. A. DEOM, and J. C. LESTEL *In* ESA, Aerothermodynamics for Space Vehicles p 241-246 Jul. 1991 Sponsored in part by CEA and Aerospatiale
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

Since 1977, Onera has ground and flight tested different techniques for heat shield recession: acoustic and combined temperature/ablation optical measurements. This last technique uses a gage that views the radiation optically from a cavity embedded within the heat shield. Flight measurements, both of temperature and of passage of the ablation front are compared with data generated by a predictive numerical code. The ablation and the heat diffusion into the instrumented ablator can be simulated numerically to evaluate accurately the errors due to the presence of the gage. The ablation measurement alone of the reentry body nose is made by an acoustic gage. The temperature measurement alone of the heatshield inner wall will be soon carried out by an optical sensor. ESA

N92-15027# Dornier System G.m.b.H., Friedrichshafen (Germany, F.R.). Aerodynamics Dept.
COMPUTATIONAL AEROTHERMODYNAMIC METHODS FOR INDUSTRIAL APPLICATIONS TO RE-ENTRY AND HYPERSONIC CRUISE PROBLEMS
H. RIEGER, H. STOCK, and B. WAGNER *In* ESA, Aerothermodynamics for Space Vehicles p 421-437 Jul. 1991
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

A survey of computational fluid dynamics capabilities and related methodologies which may be useful to support the design of vehicles flying at high supersonic speeds in cruise conditions or passing the hypersonic flight regime during reentry from low Earth orbit, is given. A main objective in hypersonic design is the search for the best compromise between a feasible flight control system and an aerodynamic shape exposed to thermal loads which can be tolerated by the thermal protection system. For the prediction of aerokinetic thermal loads, depending on the flow situation, several alternatives exist which can give reliable answers. Emphasis is placed on Euler and Navier-Stokes methods as well as on more limiting prediction tools like parabolized Navier-Stokes and boundary layer methods. Application of these flow simulation methods to simple as well as to complex configurations of current interest are presented. Activities in the area of transition for hypersonic flows are discussed. ESA

N92-15029# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
NUMERICAL SIMULATION OF THERMOCHEMICAL NON-EQUILIBRIUM VISCOUS FLOWS AROUND REENTRY BODIES
F. COQUEL, V. JOLY, C. MARMIGNON, and C. FLAMENT (Ohio State Univ., Columbus.) *In* ESA, Aerothermodynamics for Space Vehicles p 447-452 Jul. 1991 Previously announced in IAA as A91-45648 Sponsored by Direction des Recherches, Etudes et Techniques
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

A fully coupled implicit finite volume method is applied to the prediction of axisymmetric and plane equilibrium viscous flows around reentry bodies. The governing equations are discretized using a second order upwind scheme of Harten type for the inviscid fluxes and a space centered scheme for the viscous fluxes. The effects of different physical assumptions and models are investigated. Chemical and thermochemical nonequilibrium calculations around a hyperboloid are compared. The numerical simulation of the chemical nonequilibrium flow around a double ellipse is presented. Comparisons are made respectively between two chemical models and between two transport phenomenon models. ESA

N92-15030# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
EQUILIBRIUM SOLUTION OF THE EULER AND NAVIER-STOKES EQUATIONS AROUND A DOUBLE ELLIPSOIDAL SHAPE WITH MONO- AND MULTI-BLOCKS INCLUDING REAL GAS EFFECTS, PART 1
H. WONG and J. HAEUSER *In its* Aerothermodynamics for Space Vehicles p 453-458 Jul. 1991
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

Chemical and thermal equilibrium solutions of the Euler and Navier-Stokes equations around a double ellipsoidal shape at Mach 25 with an angle of attack of 30 degrees are presented. Atmospheric air is assumed to be the continuum medium and is modeled as a real gas. The solutions are obtained by using a finite volume method and the algorithm employs a cell centered fully implicit upwind scheme. Three dimensional mono and multiblock structured grids are employed in order to study the influence of grid topology on the physical solution. Moreover, the grid qualities such as orthogonality, grid point clustering, smoothness, and grid size are also discussed. In particular, the effect of grid adaptation with respect to the physical solution was examined. The aerodynamic coefficients, property contours, and shock standoff distance are presented and compared in each case. ESA

N92-15033# European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands).
PARALLELIZATION OF A DIRECT SIMULATION MONTE CARLO (DSMC) CODE FOR FLUID DYNAMICS
GIULIO PRISCO *In its* Aerothermodynamics for Space Vehicles p 477-482 Jul. 1991
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

Direct Simulation Monte Carlo (DSMC) codes are an essential tool for the computation of aerothermodynamical effects on hypersonic space vehicles. They permit computer simulation of flows to be extended in the rarefied regime, where macroscopic fluid equations do not hold. Being more CPU (Central Processing Unit) intensive than other computational approaches, DSMC codes are an ideal application for parallel machines. The work done in order to modify a DSMC code for parallel/vector execution is described. Short, but, self contained introductions to rarefied gas dynamics, Monte Carlo techniques, and parallel/vector processing are also given. ESA

N92-15083*# Mechanical Technology, Inc., Latham, NY.
INDUSTRIAL CODE DEVELOPMENT
WILBUR SHAPIRO *In* NASA. Lewis Research Center, Seals Flow Code Development p 15-26 Mar. 1991
Avail: NTIS HC/MF A08 CSCL 11/1

The industrial codes will consist of modules of 2-D and simplified 2-D or 1-D codes, intended for expeditious parametric studies, analysis, and design of a wide variety of seals. Integration into a unified system is accomplished by the industrial Knowledge Based System (KBS), which will also provide user friendly interaction, contact sensitive and hypertext help, design guidance, and an expandable database. The types of analysis to be included with the industrial codes are interfacial performance (leakage, load,

stiffness, friction losses, etc.), thermoelastic distortions, and dynamic response to rotor excursions. The first three codes to be completed and which are presently being incorporated into the KBS are the incompressible cylindrical code, ICYL, and the compressible cylindrical code, GCYL. Author

N92-15084*# CFD Research Corp., Huntsville, AL.
DEVELOPMENT OF A CFD CODE FOR ANALYSIS OF FLUID DYNAMIC FORCES IN SEALS
MAHESH M. ATHAVALE, ANDRZEJ J. PRZEKWAS, and ASHOK K. SINGHAL *In* NASA. Lewis Research Center, Seals Flow Code Development p 27-39 Mar. 1991
Avail: NTIS HC/MF A08 CSCL 20/4

The aim is to develop a 3-D computational fluid dynamics (CFD) code for the analysis of fluid flow in cylindrical seals and evaluation of the dynamic forces on the seals. This code is expected to serve as a scientific tool for detailed flow analysis as well as a check for the accuracy of the 2D industrial codes. The features necessary in the CFD code are outlined. The initial focus was to develop or modify and implement new techniques and physical models. These include collocated grid formulation, rotating coordinate frames and moving grid formulation. Other advanced numerical techniques include higher order spatial and temporal differencing and an efficient linear equation solver. These techniques were implemented in a 2D flow solver for initial testing. Several benchmark test cases were computed using the 2D code, and the results of these were compared to analytical solutions or experimental data to check the accuracy. Tests presented here include planar wedge flow, flow due to an enclosed rotor, and flow in a 2D seal with a whirling rotor. Comparisons between numerical and experimental results for an annular seal and a 7-cavity labyrinth seal are also included. Author

N92-15089*# Army Propulsion Lab., Cleveland, OH.
ARMY RESEARCH CONCERNS IN ENGINE SEALING
ROBERT C. BILL *In* NASA. Lewis Research Center, Seals Flow Code Development p 75-82 Mar. 1991
Avail: NTIS HC/MF A08 CSCL 11/1

The Army Propulsion Directorate is primarily concerned with small engine technology, where sealing performance is most critical. Tip leakage and secondary flow losses have a much greater performance impact on small engine aero-components than on large engines. A brief survey and critique of presently employed sealing concepts is presented. Some recent new research thrusts that show promise for substantial improvement are discussed. An especially promising approach for small engine applications is brush seals. Brush seal concepts are being considered for outer air seal and secondary airflow system seal locations. Author

N92-15092*# Air Force Systems Command, Wright-Patterson AFB, OH. Lubrication Branch.
PROGRAMS AT WRIGHT-PATTERSON AIR FORCE BASE
RON DAYTON *In* NASA. Lewis Research Center, Seals Flow Code Development p 103-106 Mar. 1991
Avail: NTIS HC/MF A08 CSCL 11/1

The Lubrication Branch has two active programs that are developing gas turbine engine mainshaft air/oil seals. Both of these programs, one of which is with General Electric Aircraft Engines and the other with Pratt & Whitney Aircraft, are addressing counter-rotating intershaft applications which involve very high rubbing velocities. The objectives and requirements of these efforts are briefly addressed. Author

N92-15093*# Detroit Diesel Allison, MI.
SEAL DEVELOPMENT ACTIVITIES AT ALLISON TURBINE DIVISION Abstract Only
JOHN MUNSON *In* NASA. Lewis Research Center, Seals Flow Code Development p 107 Mar. 1991
Avail: NTIS HC/MF A08 CSCL 11/1

Brush seals are being evaluated for potential near and far term gas turbine engine applications. Development is in the form of rig component testing and engine testing. Allison has tested an engine with 20 individual brush seal positions. These seals were located throughout the engine. The emphasis of the current work is on obtaining long term performance data for brush seals. Very little of this data is available. Allison is presently developing film riding face seal technology to support future gas turbine engine applications. A face seal with an approximate 7 inch diameter was successfully tested to 1000 F, 100 psid, and 650 ft/sec. Seal leakage remained below 1 scfm throughout the duration of the test. A model for the compressible gas film was developed which separates the model for the compressible gas film was developed which separates the primary seal rings during operation. This model is based on the traditional Reynold's approach which is customarily applied to lubrication type problems. Because of the difficulty of experimentally verifying the program predictions, a commercial Navier-Stokes code was used in parallel. By comparing predictions for similar cases, it is expected that the limitations of the Reynold's model can be assessed as it applies to this particular seal. Author

N92-15094*# General Electric Co., Cincinnati, OH.
AREAS OF SEAL R/D AT GE
A. NELSON POPE *In* NASA. Lewis Research Center, Seals Flow Code Development p 109-112 Mar. 1991
Avail: NTIS HC/MF A08 CSCL 11/1

About four years ago, work was completed on a 36 inch diameter gas to gas carbon ring seal used to buffer low pressure turbine air at the rim of the forward outer flowpath on the GE36 unducted fan (UDF) engine. At about the same time, we were developing a long life counter-rotating intershaft air-oil seal of approximately 7.6 inch diameter for operation at 800 fps, 800 F, and 50 psid. Although we were successful in meeting most program goals with a split ring seal of the axial bushing type, the seal with the greatest payoff in life and air leakage rates, bearing many features in common with the GE36 seal, could not be successfully tested because of the structural weakness of the primary seal ring carbon material. This was a split ring seal using a hybrid combination of orifice compensated hydrostatic and shrouded hydrodynamic gas bearings. We are presently working to develop this design in conjunction with high strength materials being developed by Pure Carbon Co. In the area of engine secondary gas flow path-sealing for performance improvement, we are currently working with carbon and all metal face seals. A 15 inch diameter all metal 'aspirating' face seal, using self-acting hydrostatic bearings, was successfully tested to 700 fps, 100 psid, and 1000 F, demonstrating long life at flow reduction of 86 percent compared to a 'best' labyrinth. This seal will be developed through 1400 F, 900 fps, and 350 psid. The seal 'aspirates' closed at about idle speed pressure during engine start and reopens at engine shutdown. A hydraulic thrust balance seal, currently using orifice compensated hydrostatics, is under development. Other aspects of these projects are briefly covered. Author

N92-15095*# Edgerton, Germeshausen and Grier, Inc., Wellesley, MA. Fluid Components Technology Group.
SEAL RELATED DEVELOPMENT ACTIVITIES AT EG/G
HAROLD F. GREINER *In* NASA. Lewis Research Center, Seals Flow Code Development p 113-122 Mar. 1991
Avail: NTIS HC/MF A08 CSCL 11/1

Seal related development activities including modeling, analysis, and performance testing are described for several current seal related projects. Among the current seal related projects are the following: high pressure gas sealing systems for turbomachinery; brush seals for gas path sealing in gas turbines; and tribological material evaluation for wear surfaces in sealing systems. Author

N92-15203* National Aeronautics and Space Administration. Pasadena Office, CA.
MULTICOMPONENT GAS SORPTION JOULE-THOMSON REFRIGERATION Patent
JACK A. JONES, inventor (to NASA), S. WALTER PETRICK, inventor (to NASA), and STEVEN BARD, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 12 Nov. 1991 7 p Filed 28 Jun. 1990 Supersedes N90-26176 (28 - 20, p 2844)

(NASA-CASE-NPO-17569-1-CU; US-PATENT-5,063,747; US-PATENT-APPL-SN-545236; US-PATENT-CLASS-62-461; US-PATENT-CLASS-624-3.2; US-PATENT-CLASS-624-51.2; US-PATENT-CLASS-624-467; US-PATENT-CLASS-624-500; INT-PATENT-CLASS-F17C-11/00) Avail: US Patent and Trademark Office CSCL 13/9

The present invention relates to a cryogenic Joule-Thomson refrigeration capable of pumping multicomponent gases with a single stage sorption compressor system. Alternative methods of pumping a multicomponent gas with a single stage compressor are disclosed. In a first embodiment, the sorbent geometry is such that a void is defined near the output of the sorption compressor. When the sorbent is cooled, the sorbent primarily adsorbs the higher boiling point gas such that the lower boiling point gas passes through the sorbent to occupy the void. When the sorbent is heated, the higher boiling point gas is desorbed at high temperature and pressure and thereafter propels the lower boiling point gas out of the sorption compressor. A mixing chamber is provided to remix the constituent gases prior to expansion of the gas through a Joule-Thomson valve. Other methods of pumping a multicomponent gas are disclosed. For example, where the sorbent is porous and the low boiling point gas does not adsorb very well, the pores of the sorbent will act as a void space for the lower boiling point gas. Alternatively, a mixed sorbent may be used where a first sorbent component physically adsorbs the high boiling point gas and where the second sorbent component chemically absorbs the low boiling point gas.

Official Gazette of the U.S. Patent and Trademark Office

N92-15272# Technology Development Corp., Madrid (Spain).
ELECTRONICALLY STEERABLE ANTENNA FOR AIRCRAFT
J. BARBERO, M. L. HERNANZ, M. HERNANZ, C. MARTIN, J. VASSALLO, and B. HEDGE *In* ESA, Second European Conference on Satellite Communications ECSC-2 p 425-427 Oct. 1991
Copyright Avail: NTIS HC/MF A22; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

The design of an electronically steerable medium gain antenna for aircraft able to provide voice communication via satellite is presented. The antenna consists of 5 radiating facets and the coverages achieved, including the effect of the aircraft fuselage, are based on the experimental results obtained with the actual components of the beam forming network (switches, phase shifters, power dividers) and the radiating facets including the matching network. One hundred percent of the mandatory coverage (colatitude 0 to 85 degrees) is achieved with a gain greater than 10 dBi and 12 dBi are achieved in 60 percent of it. Concerning the goal coverage (colatitude 0 to 105 degrees) a gain greater than 7 dBi is achieved in 84 percent of it. The dimensions of the radome required for this antenna are: length 1780 mm, width 255 mm, height 197 mm. ESA

N92-15367# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.
FERRUNDI COMPANY SUPPLIES 4500 MODEL HEAD UP DISPLAY DEVICES TO INDIA'S MIG-21 AIRCRAFT
25 Jul. 1991 6 p Transl. into ENGLISH from Guoji Hangkong (China), no. 7, 1985 p 52-53
(AD-A241044; FTD-ID(RS)T-0172-91) Avail: NTIS HC/MF A02 CSCL 09/5

The 4500 Model head up display device is a type which is produced by the Ferrundi Company. It is a light weight head up display device and weapon aiming system which is capable of being supplied for retrofit use. the display device is a conventional non-holographic system which is capable of supplying a 25 degree circumference field of vision and uses direct or alternating current power sources. The system also possesses auto-supervision and control as well as automatic measurement and testing functions. GRA

N92-15385# Solar Turbines, Inc. San Diego, CA.
HIGH-TEMPERATURE COMBUSTOR AND SEAL FOR A WATER PISTON PROPULSOR Final Report, Jun. 1985 - Mar. 1991
M. A. GALICA and R. T. LECREN Mar. 1991 61 p
(Contract N00167-85-C-0042; NR PROJ. C31-50)
(AD-A242493; SR90-R-5253-76; DTRC/SD-CR-16/91) Avail: NTIS HC/MF A04 CSCL 21/2

The detailed design and testing of a high temperature combustor and seal for a water piston propulsor is reported. The system is comprised of a high pressure combustor together with a carbon graphite rotor-contacting face seal. Analyses are presented to support the design of an air cooled combustor liner. The seal is pneumatically loaded against the rotor face using a variable pressure. Superalloy materials are selected for most components with a vitreous enamel corrosion resistant coating applied to the high-temperature combustor liner. The combustor was subjected to a series of rig tests to define its performance prior to integrating it with the rotor system. A simulated rotor test was also conducted to study the seal plate bellows pressure relationship required to attain a satisfactory seal. After the solar combustion and seal system was integrated with the rotor system, three series of water channel tests were conducted to determine the overall system performance. The combustor performed satisfactorily although the imposed operating conditions, i.e., pressure and air flow, were significantly different from the original design specifications, requiring the combustor to operate at higher combustor loadings. The tested propulsion efficiency of the WPP was lower than predicted. An attempt to improve performance by matching the shape of the combustor outlet to the rotor passage inlet yielded minimal improvements. GRA

N92-15392# Sandia National Labs., Albuquerque, NM.
NUMERICAL SIMULATION OF VAWT STOCHASTIC AERODYNAMIC LOADS PRODUCED BY ATMOSPHERIC TURBULENCE: VAWT-SAL CODE
G. F. HOMICZ Sep. 1991 73 p
(Contract DE-AC04-76DP-00789)
(DE92-000597; SAND-91-1124) Avail: NTIS HC/MF A04

Blade fatigue life is an important element in determining the economic viability of the Vertical-Axis Wind Turbine (VAWT). A principal source of blade fatigue is thought to be the stochastic (i.e., random) aerodynamic loads created by atmospheric turbulence. This report describes the theoretical background of the VAWT Stochastic Aerodynamic Loads (VAWT-SAL) computer code, whose purpose is to numerically simulate these random loads, given the rotor geometry, operating conditions, and assumed turbulence properties. A Double-Multiple-Stream Tube (DMST) analysis is employed to model the rotor's aerodynamic response. The analysis includes the effects of Reynolds number variations, different airfoil sections and chord lengths along the blade span, and an empirical model for dynamic stall effects. The mean ambient wind is assumed to have a shear profile which is described by either a power law or a logarithmic variation with height above ground. Superimposed on this is a full 3-D field of turbulence: i.e., in addition to random fluctuations in time, the turbulence is allowed to vary randomly in planes perpendicular to the mean wind. The influence of flow retardation on the convection of turbulence through the turbine is also modeled. Calculations are presented for the VAWT 34-m Test Bed currently in operation at Bushland, Texas. Predicted time histories of the loads, as well as their Fourier spectra, are presented and discussed. Particular emphasis is placed on the differences between so-called 'steady-state' (mean wind only) predictions, and those produced with turbulence present. Somewhat surprisingly, turbulence is found to be capable of either increasing or decreasing the average output power, depending on the turbine's tip-speed ratio. A heuristic explanation for such behavior is postulated, and a simple formula is derived for predicting the magnitude of this effect without the need for a full stochastic simulation. DOE

N92-15402*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ANALYSIS OF AIRCRAFT ENGINE BLADE SUBJECT TO ICE IMPACT
E. S. REDDY, G. H. ABUMERI (Sverdrup Technology, Inc., Brook Park, OH.), CHRISTOS C. CHAMIS, and P. L. N. MURTHY 1991

24 p Presented at the Ninth Conference on Fibrous Composites in Structural Design, Lake Tahoe, NV, 4-7 Nov. 1991; cosponsored by DOD, NASA, and FAA
(NASA-TM-105336; E-6703; NAS 1.15:105336) Avail: NTIS HC/MF A03 CSCL 20/11

The ice impact on the engine blade made of layered composite is simulated. The ice piece is modeled as an equivalent spherical object and has the velocity opposite to that of the aircraft with direction parallel to the engine axis. Near the impact region and along the leading edge, the blade is assumed to be fully stressed and undergoes large deflection. A specified portion of the blade around the impact region is modeled. The effect of ice size and velocity on the average leading edge strain are investigated for a modified SR-2 model unswept composite propfan blade. Parametric studies are performed to study the response due to ice impact at various locations along the span. Also, the effects of engine speed on the strain and impact displacements are discussed. It is found that for a given engine speed, a critical ice speed exists that corresponds to the maximum strain and this critical speed increases with increase in the engine speed. Author

N92-15406*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
STRUCTURAL DYNAMICS BRANCH RESEARCH AND ACCOMPLISHMENTS FOR FY 1990
Nov. 1991 43 p
(NASA-TM-103747; E-5993; NAS 1.15:103747) Avail: NTIS HC/MF A03 CSCL 20/11

Presented here is a collection of FY 1990 research highlights from the Structural Dynamics Branch at the NASA Lewis Research Center. Highlights are from the branch's major work areas: aeroelasticity, vibration control, dynamic systems, and computational structural methods. A listing is given of FY 1990 branch publications. Author

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GEOSCIENCES

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

A92-18902
MESOSCALE DYNAMICS OF COLD FRONTS - STRUCTURES DESCRIBED BY DROPSOUNDINGS IN FRONTS 87
ALAN J. THORPE and SID A. CLOUGH (Reading, University, England) Royal Meteorological Society, Quarterly Journal (ISSN 0035-9009), vol. 117, pt. B, July 1991, p. 903-941. refs

Data from dropsoundings in Fronts 87 research aircraft are analyzed. Several new aspects of cold-front dynamics are identified from these data. The aircraft flew a pattern with four or five runs oriented approximately at right angles to the front, but with each run displaced in the along-front direction by about 100 km. The dropsondes gave soundings to a height of approximately 7 km with a cross frontal spacing of 20 km at best and 60 km on average. A minimal and objective analysis of the data is presented, but the high resolution of the dropsonde observations permits the evaluation of differentiated quantities, such as potential vorticity, with some confidence. Issues addressed include the degree of thermal-wind balance, the structure of conserved variables such as equivalent potential temperature and absolute momentum, the cross-frontal circulation, and the role of diabatic processes such as the evaporation of snow, and the potential vorticity structure on the mesoscale and its interpretation. C.A.B.

A92-20128* Electro Magnetic Applications, Inc., Lakewood, CO.
NONLINEAR TRIGGERED LIGHTNING MODELS FOR USE IN FINITE DIFFERENCE CALCULATIONS
TERENCE RUDOLPH, RODNEY A. PERALA, and POH H. NG (Electro Magnetic Applications, Inc., Lakewood, CO) International Conference on Lightning and Static Electricity, University of Bath, England, Sept. 26-28, 1989. 9 p. refs
(Contract NAS1-16984; NAS1-17748)

Two nonlinear triggered lightning models have been developed for use in finite difference calculations. Both are based on three species of air chemistry physics and couple nonlinearly calculated air conductivity to Maxwell's equations. The first model is suitable for use in three-dimensional modeling and has been applied to the analysis of triggered lightning on the NASA F106B Thunderstorm Research Aircraft. The model calculates number densities of positive ions, negative ions, and electrons as a function of time and space through continuity equations, including convective derivative terms. The set of equations is closed by using experimentally determined mobilities, and the mobilities are also used to determine the air conductivity. Results from the model's application to the F106B are shown. The second model is two-dimensional and incorporates an enhanced air chemistry formulation. Momentum conservation equations replace the mobility assumption of the first model. Energy conservation equations for neutrals, heavy ions, and electrons are also used. Energy transfer into molecular vibrational modes is accounted for. The purpose for the enhanced model is to include the effects of temperature into the air breakdown, a necessary step if the model is to simulate more than the very earliest stages of breakdown. Therefore, the model also incorporates a temperature-dependent electron avalanche rate. Results from the model's application to breakdown around a conducting ellipsoid placed in an electric field are shown. Author

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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.

A92-17582#
MODEL BASED REASONING IN THE AEROSPACE DOMAIN
W. E. BOND (McDonnell Douglas Research Laboratories, Saint Louis, MO), JON STICKLEN, and M. PEGAH (Michigan State University, East Lansing) IN: AIAA Computing in Aerospace Conference, 8th, Baltimore, MD, Oct. 21-24, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 40-47. Research supported by McDonnell Douglas Independent Research and Development Program. refs
(AIAA PAPER 91-3709) Copyright

Model based reasoning has been investigated for its use in both simulation and diagnostic tasks. This paper outlines how an appropriate model-based representation can also document and assist the engineering design process for small to medium-sized designs. A specific representation and reasoning methodology (Functional Modeling/Functional Reasoning) is outlined and applied to the task of modeling the fuel system of the U.S. Navy/McDonnell Douglas F/A-18 fighter aircraft. Author

A92-17585*# ORA Corp., Ithaca, NY.
FORMAL SPECIFICATION AND VERIFICATION OF ADA SOFTWARE
GEOFFREY R. HIRD (Ora Corp., Ithaca, NY) IN: AIAA Computing in Aerospace Conference, 8th, Baltimore, MD, Oct. 21-24, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 62-68. refs
(Contract NAS1-18972)
(AIAA PAPER 91-3713) Copyright

The use of formal methods in software development achieves levels of quality assurance unobtainable by other means. The Larch

approach to specification is described, and the specification of avionics software designed to implement the logic of a flight control system is given as an example. Penelope is described which is an Ada-verification environment. The Penelope user inputs mathematical definitions, Larch-style specifications and Ada code and performs machine-assisted proofs that the code obeys its specifications. As an example, the verification of a binary search function is considered. Emphasis is given to techniques assisting the reuse of a verification effort on modified code. Author

A92-17594*# Mitre Corp., Houston, TX.
CASE FOR REAL-TIME SYSTEMS DEVELOPMENT - QUO VADIS?
DONA M. ERB (Mitre Corp., Houston, TX) IN: AIAA Computing in Aerospace Conference, 8th, Baltimore, MD, Oct. 21-24, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 144-152. refs
(Contract NAS9-18057)
(AIAA PAPER 91-3726) Copyright

The paper focuses on the distinctive issues of computer-aided software engineering (CASE) products for the development of real-time systems. CASE technologies and associated standardization efforts are evolving from sets of conflicting interests. The majority of case products are intended for use in the development of management information systems. CASE products to support the development of large, complex real-time systems must provide additional capabilities. Generic concerns include the quality of the implementation of the required method for the phase of the system's development and whether the vendor is stable and committed to evolving the products in parallel with nonproprietary standards. The CASE market is undergoing considerable consolidation. The paper describes the major forces, cooperating entities, and remaining uncertainties that need to be weighed in near-term CASE procurements to limit risk of loss of investment in project time, trianing, and money. Author

A92-17605#
KNOWLEDGE MAINTENANCE IN AN EVOLVING SYSTEM USING A DEEP STRUCTURE REPRESENTATION
NORMAN D. GEDDES (Applied Systems Intelligence, Inc., Gainesville, GA) and RICHARD ARMSTRONG (ISC Corp., Marietta, GA) IN: AIAA Computing in Aerospace Conference, 8th, Baltimore, MD, Oct. 21-24, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 234-242. Research supported by DARPA, USAF, and Lockheed Corp. refs
(AIAA PAPER 91-3941) Copyright

This work develops an alternate view of the role of a deep structure knowledge representation as a knowledge archiving language that can be freely translated to or from application-specific representations that are efficient for execution. A prototype of such a system has been developed as a means for maintaining, archiving, and translating the immense nonstatic tactical air combat knowledge bases created for the DARPA/USAF/Lockheed Pilot's Associate program. Significant gains in knowledge consistency and maintainability are expected to be possible as a result of this approach. Author

A92-17608#
ADVANCED AVIONICS SYSTEM DEVELOPMENT ENVIRONMENT
MILES B. PELLAZAR (Northrop Corp., Aircraft Div., Hawthorne, CA) IN: AIAA Computing in Aerospace Conference, 8th, Baltimore, MD, Oct. 21-24, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 261-269. Research supported by Northrop Corp. refs
(AIAA PAPER 91-3944) Copyright

While avionics systems continue to increase in complexity and sophistication, tools to facilitate the development of avionics software continue to lag behind. Rapidly escalating costs associated with developing, deploying, and managing large-scale avionics software systems continue to plague avionics engineering organizations. There is a crucial need for advanced mechanisms that will improve software productivity and significantly reduce software development costs. This paper presents an overview of Northrop's Advanced Avionics System Development Environment (AASDE) project initiated to address these pressing software issues. The paper begins with a discussion on the proposed AASDE framework and its major subsystems. Next, a detailed description of new avionics software tools being developed under this project is presented. The paper concludes with the current state of the project and its future direction. Author

A92-17626#
RADAR TROUBLESHOOTING ASSISTANT EXPERT SYSTEM
DANIEL R. DORRANCE and KENNETH M. GROHMAN (McDonnell Douglas Avionics Laboratories, Saint Louis, MO) IN: AIAA Computing in Aerospace Conference, 8th, Baltimore, MD, Oct. 21-24, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 411-413. refs
(AIAA PAPER 91-3764) Copyright

The application of AI to expert systems is discussed in terms of a product for solving radar problems caused by the final stages of the F-15E manufacturing cycle. The system employs a knowledge-based approach with production rules and can use backward chaining and limited forward chaining. The assistant expert system supports manufacturing personnel by recommending replacement of specific radar LRUs or by suggesting troubleshooting techniques. C.C.S.

A92-17629*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
APPLICATIONS OF AN AUTOMATED PROGRAMMING SYSTEM
CARRIE K. WALKER (NASA, Langley Research Center, Hampton, VA), JOHN J. TURKOVICH, and THOMAS K. MASOTTO (Charles Stark Draper Laboratory, Inc., Cambridge, MA) IN: AIAA Computing in Aerospace Conference, 8th, Baltimore, MD, Oct. 21-24, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 427-439. refs
(AIAA PAPER 91-3767) Copyright

A Computer-Aided Software Engineering (CASE) system has been developed at the Charles Stark Draper Laboratory (CSDL) under the direction of the NASA Langley Research Center. The Automated Programming Subsystem is the core of the CSDL CASE system. The Automated Programming Subsystem allows an engineer to describe software specifications as hierarchical engineering block diagrams, a natural design technique for the specification of real-time software. The objective of the Automated Programming Subsystem is to capture completely and consistently both logical and schematic information as diagrams are developed, and then to automatically transform this information into source code (Ada or C) and documentation. The Automated Programming Subsystem of CSDL CASE has been used on many applications, from small to moderate size. Six of these applications are described in this paper. Author

A92-17637*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
OPTICAL COMPUTING AT NASA AMES RESEARCH CENTER
MAX B. REID, MARIA G. BUALAT, JOHN D. DOWNIE, DAVID GALANT, CHARLES K. GARY, BUTLER P. HINE, PAUL W. MA, ANNA H. PRYOR, and LILLY SPIRKOVSKA (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Computing in Aerospace Conference, 8th, Baltimore, MD, Oct. 21-24, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 503-515. refs
(AIAA PAPER 91-3779) Copyright

Optical computing research at NASA Ames Research Center seeks to utilize the capability of analog optical processing, involving free-space propagation between components, to produce natural implementations of algorithms requiring large degrees of parallel computation. Potential applications being investigated include robotic vision, planetary lander guidance, aircraft engine exhaust analysis, analysis of remote sensing satellite multispectral images,

control of space structures, and autonomous aircraft inspection. Author

A92-17645#
FAULT TREE INTERPRETER
TERRY DICKERSON (McDonnell Aircraft Co., Saint Louis, MO) IN: AIAA Computing in Aerospace Conference, 8th, Baltimore, MD, Oct. 21-24, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 580-585.
(AIAA PAPER 91-3789) Copyright

The Fault Tree Interpreter (FTI) is an expert system shell for developing rule-based expert systems to control automatic test equipment (ATE). The FTI, which is implemented in Ada, brings expert system technology to any computing system which has an Ada compiler. Using the FTI, test station programmers can easily develop a rule group (i.e., test program) to test a unit under test (UUT) and determine if it is good or bad. Optimized for use in the automatic test station environment, the FTI interfaces with test station and executive software. Conventional test methodology halts UUT testing at the first fault. However, a rule-based system can diagnose multiple independent UUT failures. Included with the FTI is a rule group development system which is independent of ATE hardware. The FTI has been ported to multiple computer platforms and can easily be ported to additional platforms. To date the FTI has been delivered on two ATE systems and is performing very well. Author

A92-17654#
FAILURE ENVIRONMENT ANALYSIS TOOL (FEAT) DEVELOPMENT STATUS
ROBERT W. STEVENSON, JAMES G. MILLER, and MICHAEL E. AUSTIN (Lockheed Engineering and Sciences Co., Houston, TX) IN: AIAA Computing in Aerospace Conference, 8th, Baltimore, MD, Oct. 21-24, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 676-682. refs
(AIAA PAPER 91-3803) Copyright

This paper describes a computer software application which operates on digraph models of systems to determine and display failure effects. The software was developed by NASA to help integrate effects across large systems, to support mission controllers in making time critical decisions in response to indications of failures in flight systems, and to provide a portion of a planned engineering workstation based upon advanced graph and network theory. Author

A92-17664#
DESIGNING THROUGH TEST
BARRY T. MCKINNEY (USAF, Rome Laboratory, Griffiss AFB, NY) and F. M. SPEED, JR. (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) IN: AIAA Computing in Aerospace Conference, 8th, Baltimore, MD, Oct. 21-24, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 763-767. refs
(AIAA PAPER 91-3822)

Engineers at the Air Force's Rome Laboratory and Aeronautical Systems Division, in an effort to extend the design process through the entire procurement cycle, have begun software development that automates the design and analysis of accelerated reliability tests. Test designs and resulting analysis will comply with standard validation requirements and economic considerations. The software will progressively develop component unique, experimentally designed, reliability quantification procedures, as well as perform a complete data reduction and final estimation of the component's inherent operational reliability. Author

A92-17813*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
MULTIDISCIPLINARY MODELING AND SIMULATION OF A GENERIC HYPERSONIC VEHICLE
K. K. GUPTA, K. L. PETERSEN (NASA, Flight Research Center, Edwards, CA), and C. L. LAWSON (Eloret Institute, Claremont, CA) AIAA, International Aerospace Planes Conference, 3rd, Orlando, FL, Dec. 3-5, 1991. 13 p. refs
(AIAA PAPER 91-5015) Copyright

The modeling and simulation of hypersonic vehicles which involve the interaction of a number of major technical disciplines including aerodynamics, structures, heat transfer, propulsion, and control engineering are described. Finite element numerical formulations of individual disciplines including their appropriate integration for multidisciplinary simulation are presented. An efficient unstructured grid generation strategy, evolved by modifying an existing code, is developed. R.E.P.

A92-18464
AN ALTERNATIVE DERIVATION OF THE MODIFIED GAIN FUNCTION OF SONG AND SPEYER
PEGGY J. GALKOWSKI and MOHAMMED A. ISLAM (IBM Corp., Federal Sector Div., Owego, NY) IEEE Transactions on Automatic Control (ISSN 0018-9286), vol. 36, Nov. 1991, p. 1323-1326.
Copyright

A simpler derivation of the modified gain function for the bearings-only measurement problem as defined by Song et al. (1985) is presented. The form which results shows the relationship between the modified gain and the standard gain. The relationship between the modified gain and the standard gain of an extended Kalman filter is shown. It is confirmed that the modified gain extended Kalman filter performs better than the standard extended Kalman filter. I.E.

A92-18616
OPTIMAL CONTROL PROBLEMS WITH MAXIMUM FUNCTIONAL
PING LU (Iowa State University of Science and Technology, Ames) and NGUYEN X. VINH (Michigan, University, Ann Arbor) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 14, Nov.-Dec. 1991, p. 1215-1223. refs
Copyright

This paper considers the optimal control problem with a performance index that includes a maximum functional. Necessary conditions are derived that are more general than those of previous work, some of which is shown to be reducible and, therefore, included in the results found here. An illustrative example demonstrates that necessary conditions are satisfied by a unique solution of the problem. The problem of threat avoidance for aircraft is formulated as the optimal control problem considered here. Numerical results for a subsonic glider are presented. Author

A92-19084
VERIFICATION OF FLIGHT SOFTWARE BY EMBEDDING SOFTWARE SIMULATION IN SIMULATION OF EXTERNAL ENVIRONMENT
NORMAN H. FISCHER and DOUGLAS PERRY (Battelle, Columbus, OH) IN: 1990 Annual Summer Computer Simulation Conference, 22nd, Calgary, Canada, July 16-18, 1990, Proceedings. San Diego, CA, Society for Computer Simulation, 1990, p. 463-468.
Copyright

Flight software can be tested by embedding it in a detailed simulation of the spacecraft, sensors, and external stimulants. This paper shows the application of this approach to three Delta SDIO missions. Sample results regarding attitude determination, navigation, and attitude control are reported. C.D.

A92-19094
A PROCESSOR-IN-THE-LOOP SIMULATION USING AN XANALOG COMPUTER
LOUISA J. CYNAMON (Raytheon Co., Bedford, MA) IN: 1990 Annual Summer Computer Simulation Conference, 22nd, Calgary, Canada, July 16-18, 1990, Proceedings. San Diego, CA, Society for Computer Simulation, 1990, p. 931-937.
Copyright

A real-time closed-loop 6-DOF processor-in-the-loop (PIL) simulation facility has been developed using a Xanalog computer. This computer provides a high speed, desk-top environment for a simulation that runs at less than 1.67 ms. This facility is used to

debug and validate digital autopilot software. The Xanalog provides an alternative to the more expensive real-time computers on the market. This paper presents a discussion of the models used in the simulation, their implementation, and provides a critique of the Xanalog as a real-time simulation processor. Author

A92-19386
CLEANROOM - AN ALTERNATIVE SOFTWARE DEVELOPMENT PROCESS
HARLAN D. MILLS (Software Engineering Technology, Inc., Vero Beach, FL) IN: Aerospace software engineering - A collection of concepts. Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1991, p. 187-200. refs
Copyright

The Cleanroom software engineering process develops software of certified reliability under statistical quality control in a pipeline of increments, with no program debugging before independent statistical usage testing of the increments. It requires rigorous methods of software specification, design, and testing, with which disciplined software engineering teams are capable of producing low- or zero-defect software of arbitrary size and complexity. Such engineering discipline is not only capable of producing highly reliable software, but also the certification of the reliability of the software as specified. The IBM COBOL Structuring Facility, a complex product of some 80 K lines of source code, was developed in the Cleanroom discipline, with no debugging before usage testing and certification of its reliability. A version of the HH60 (helicopter) flight control program of over 30 KLOC was also developed in Cleanroom. Author

A92-19405
AEROSPACE SOFTWARE ENGINEERING IN THE UNITED KINGDOM
NICHOLAS JENNINGS (British Aerospace, PLC, Sowerby Research Centre, Bristol, England) IN: Aerospace software engineering - A collection of concepts. Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1991, p. 545-559. refs
Copyright

Certain aspects of software engineering that are of importance to the UK aerospace industry are discussed in the light of the currently considered new UK draft defense standard aimed at increasing the standards for safety-critical software. Particular emphasis is placed on formal methods and their application to aerospace software engineering. The discussion covers requirements analysis, static analysis tools, low-level languages, tools for dynamic testing, code design and implementation, and integrated project support environments. V.L.

A92-19406
AEROSPACE SOFTWARE IN SWEDEN
INGEMAR CARLSSON (Defence Materiel Administration, Stockholm, Sweden) IN: Aerospace software engineering - A collection of concepts. Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1991, p. 561-580. refs
Copyright

Recent developments and current trends in aerospace software systems and processes in Sweden are reviewed. In particular, attention is given to to the use of a high-order language system, Pascal D80, in the JAS 39 multirole combat aircraft, the use of the Ada language, computers in space applications, and an industrial approach to the object-oriented development of large-scale systems. The discussion also covers Base/OPEN, a tool development and tool integration framework; the CAX framework concept; and future processing paradigms. V.L.

A92-19605* Pennsylvania State Univ., University Park.
A STOCHASTIC REGULATOR FOR INTEGRATED COMMUNICATION AND CONTROL SYSTEMS. I - FORMULATION OF CONTROL LAW. II - NUMERICAL ANALYSIS AND SIMULATION
LUEN-WOEI LIOU and ASOK RAY (Pennsylvania State University, University Park) ASME, Transactions, Journal of Dynamic Systems, Measurement, and Control (ISSN 0022-0434), vol. 113, Dec. 1991, p. 604-619. refs
(Contract N00014-90-J-1513; NAG3-323; NSF DMC-87-07648)
Copyright

A state feedback control law for integrated communication and control systems (ICCS) is formulated by using the dynamic programming and optimality principle on a finite-time horizon. The control law is derived on the basis of a stochastic model of the plant which is augmented in state space to allow for the effects of randomly varying delays in the feedback loop. A numerical procedure for synthesizing the control parameters is then presented, and the performance of the control law is evaluated by simulating the flight dynamics model of an advanced aircraft. Finally, recommendations for future work are made. V.L.

A92-19609* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SOME ASPECTS OF UNCERTAINTY IN COMPUTATIONAL FLUID DYNAMICS RESULTS
U. B. MEHTA (NASA, Ames Research Center, Moffett Field, CA) ASME, Transactions, Journal of Fluids Engineering (ISSN 0098-2202), vol. 113, Dec. 1991, p. 538-543. refs
Copyright

Uncertainties are inherent in computational fluid dynamics (CFD). These uncertainties need to be systematically addressed and managed. Sources of these uncertainty analysis are discussed. Some recommendations are made for quantification of CFD uncertainties. A practical method of uncertainty analysis is based on sensitivity analysis. When CFD is used to design fluid dynamic systems, sensitivity-uncertainty analysis is essential. Author

A92-19619* Old Dominion Univ., Norfolk, VA.
AERODYNAMIC SENSITIVITY ANALYSIS METHODS FOR THE COMPRESSIBLE EULER EQUATIONS
OKTAY BAYSAL and MOHAMED E. ELESHAKY (Old Dominion University, Norfolk, VA) ASME, Transactions, Journal of Fluids Engineering (ISSN 0098-2202), vol. 113, Dec. 1991, p. 681-688. refs
(Contract NAG1-1188)
Copyright

This study presents a mathematical formulation developed for aerodynamic sensitivity coefficients based on a discretized form of the compressible 2D Euler equations. A brief motivating introduction to the aerodynamic sensitivity analysis and the reasons behind an integrated flow/sensitivity analysis for design algorithms are presented. The finite difference approach and the quasi-analytical approach are used to determine the aerodynamic sensitivity coefficients. A new flow prediction concept, which is an outcome of the direct method in the quasi-analytical approach, is developed and illustrated with an example. Surface pressure coefficient distributions of a nozzle-afterbody configuration obtained from the predicted flowfield solution are compared successfully with their corresponding values obtained from a flowfield analysis code and the experimental data. P.D.

A92-20150
SOVIET CFD - AN INTERNATIONAL PERSPECTIVE
V. A. SOSUNOV and M. IA. IVANOV (Tsentral'nyi Nauchno-Issledovatel'skii Institut Aviatsionnogo Motorostroeniia, Moscow, USSR) Aerospace America (ISSN 0740-722X), vol. 30, Jan. 1992, p. 48-51.
Copyright

An overview is presented of Soviet CFD development and the organizations that have had experience using moderately powerful computers to solve practical problems encountered in aerospace design methods. Highly accurate monotonic difference methods that follow the local flow structure, have been developed and now form the basis for constructing effective algorithms and codes that solve practical external and internal aerodynamics problems. Consideration is given to a potential area for international CFD cooperation that would involve solving problems connected with the design of scramjets for the aerospace plane. R.E.P.

N92-14598*# Computer Sciences Corp., Hampton, VA.
ANALYSIS OF OBJECTS IN BINARY IMAGES M.S. Thesis - Old Dominion Univ.
DESIREE M. LEONARD Washington NASA Dec. 1991 76 p
(Contract NAS1-19038)
(NASA-CR-4420; NAS 1.26:4420) Avail: NTIS HC/MF A05 CSCL 12/1

Digital image processing techniques are typically used to produce improved digital images through the application of successive enhancement techniques to a given image or to generate quantitative data about the objects within that image. In support of and to assist researchers in a wide range of disciplines, e.g., interferometry, heavy rain effects on aerodynamics, and structure recognition research, it is often desirable to count objects in an image and compute their geometric properties. Therefore, an image analysis application package, focusing on a subset of image analysis techniques used for object recognition in binary images, was developed. This report describes the techniques and algorithms utilized in three main phases of the application and are categorized as: image segmentation, object recognition, and quantitative analysis. Appendices provide supplemental formulas for the algorithms employed as well as examples and results from the various image segmentation techniques and the object recognition algorithm implemented. Author

N92-14673# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Guidance and Control Panel.
ARTIFICIAL NEURAL NETWORK APPROACHES IN GUIDANCE AND CONTROL
Sep. 1991 183 p Lecture series held in Monterey, CA, 8-9 Oct. 1991, in Kjeller, Norway, 14-15 Oct. 1991, and in Neubiberg, Fed. Republic of Germany, 17-18 Oct. 1991
(AGARD-LS-179; ISBN-92-835-0635-9) Copyright Avail: NTIS HC/MF A09; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Ever increasing operational and technical requirements have led to highly integrated flight, guidance and control, and weapons delivery systems. The effective implementation of these functions makes the fusion and interpretation of sensor data and the multifunctional use of sensor information inevitable. Neural networks, consisting of parallel microcomputing elements, hold great promise for guidance, navigation, and control applications because of their ability to learn and acquire knowledge. The objective of this lecture series, sponsored by the Guidance and Control Panel of AGARD, was to present both the fundamentals of neural networks and a number of guidance, navigation, and control (GNC) applications. Some specific topics addressed include neural network architectures and design methodologies, target detection and recognition, vision systems, robots, and multisensor data fusion.

N92-14674# Bodenseewerk Geraetetechnik G.m.b.H., Ueberlingen (Germany, F.R.). Intelligent Systems Div.
INTRODUCTION TO NEURAL COMPUTING AND CATEGORIES OF NEURAL NETWORK APPLICATIONS TO GUIDANCE, NAVIGATION AND CONTROL
UWE K. KROGMANN *In* AGARD, Artificial Neural Network Approaches in Guidance and Control 24 p Sep. 1991
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The creation of artificial neural networks (ANN) is directed towards the realization of capabilities and characteristics such as self-organization, learning, and associative memory. This is achieved by the particular structure of neural networks where a large number of simple processor elements are interconnected with uni-directional signal channels to single- or multi-layer networks. All processing elements are working in parallel as compared to one central, extremely efficient computer for sequential arithmetic and/or symbolic information processing. Artificial neural networks are not programmed but trained and learn like their biological paradigm, the brain. This is done by changing the intensity of the connections between processor elements and by generating or eliminating structural connections. A brief introduction to the architecture and functional characteristics of neural networks is presented. In addition, the general structure of guidance and control problems is described and the application of ANNs to guidance and control tasks is examined. Example applications relate to the fault tolerant measurement of the proprio-specific motion of an air vehicle and neural target classification. M.G.

N92-14677# Hecht-Nielsen Neurocomputer Corp., Inc., San Diego, CA.
PROCESSING COMPLEXITY OF TWO APPROACHES TO OBJECT DETECTION AND RECOGNITION
TODD GUTSCHOW and ROBERT HECHT-NIELSEN *In* AGARD, Artificial Neural Network Approaches in Guidance and Control 12 p Sep. 1991 Prepared in cooperation with California Univ., San Diego, La Jolla
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The computational complexity of a processing function is a driving factor in the implementation of that function in an operational system. Artificial neural networks offer the potential for significant improvements in the computational complexity of a number of guidance and control functions. To illustrate such an improvement, a comparison is considered between two different approaches to object detection and recognition: a traditional approach using a wide field of view and constant spatial resolution throughout the image sensing and processing chain; and a foveal approach using a roving eyeball circularly symmetric sampling grid with a radially variant resolution in the processing chain. The rationale and characteristics of these two approaches are described and compared. Quantitative evaluations of the processing loads and data transfer rates are then carried out for both approaches. These processing requirements are then compared and the operational implications of this comparison are discussed. While the efficacy of the foveal approach is not explicitly discussed, references are provided to relevant research results in this regard. Author

N92-15658*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
APPROXIMATION METHODS FOR CONTROL OF ACOUSTIC/STRUCTURE MODELS WITH PIEZOCERAMIC ACTUATORS Final Report
H. T. BANKS, W. FANG (California Univ., Los Angeles.), R. J. SILCOX, and R. C. SMITH Dec. 1991 31 p Submitted for publication
(Contract NAS1-18605; NAS1-18107; NAG1-1116; AF-AFOSR-0091-90)
(NASA-CR-189578; NAS 1.26:189578; ICASE-91-88) Avail: NTIS HC/MF A03 CSCL 12/1

The active control of acoustic pressure in a 2-D cavity with a flexible boundary (a beam) is considered. Specifically, this control is implemented via piezoceramic patches on the beam which produces pure bending moments. The incorporation of the feedback control in this manner leads to a system with an unbounded input term. Approximation methods in this manner leads to a system with an unbounded input term. Approximation methods in the context of linear quadratic regulator (LQR) state space control formulation are discussed and numerical results demonstrating the effectiveness of this approach in computing feedback controls for noise reduction are presented. Author

N92-15870*# City Univ. of New York, Bronx. Dept. of Engineering Technologies.
DEVELOPMENT OF A CALIBRATED SOFTWARE RELIABILITY MODEL FOR FLIGHT AND SUPPORTING GROUND SOFTWARE FOR AVIONIC SYSTEMS
STELLA LAWRENCE *In* Alabama Univ., Research Reports: 1991 NASA/ASEE Summer Faculty Fellowship Program 4 p Oct. 1991
(Contract NGT-01-008-021)
Avail: NTIS HC/MF A12 CSCL 09/2

The object of this project was to develop and calibrate quantitative models for predicting the quality of software. Reliable flight and supporting ground software is a highly important factor in the successful operation of the space shuttle program. The models used in the present study consisted of SMERFS (Statistical Modeling and Estimation of Reliability Functions for Software). There are ten models in SMERFS. For a first run, the results obtained in modeling the cumulative number of failures versus execution time showed fairly good results for our data. Plots of cumulative software failures versus calendar weeks were made and the model results were compared with the historical data on the same graph. If the model agrees with actual historical behavior for a set of data then there is confidence in future predictions for this data. Considering the quality of the data, the models have given some significant results, even at this early stage. With better care in data collection, data analysis, recording of the fixing of failures and CPU execution times, the models should prove extremely helpful in making predictions regarding the future pattern of failures, including an estimate of the number of errors remaining in the software and the additional testing time required for the software quality to reach acceptable levels. It appears that there is no one 'best' model for all cases. It is for this reason that the aim of this project was to test several models. One of the recommendations resulting from this study is that great care must be taken in the collection of data. When using a model, the data should satisfy the model assumptions. Author

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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.

A92-18388
RESONANCE PREDICTION FOR SLOTTED CIRCULAR WIND TUNNEL USING FINITE ELEMENT
IN LEE and KI-YOUNG BAIK (Korea Advanced Institute of Science and Technology, Taejon, Republic of Korea) AIAA Journal (ISSN 0001-1452), vol. 29, Dec. 1991, p. 2266-2269. refs
Copyright

A resonance analysis is presented for a circular cross-section with slots; while it is in principle difficult to analytically predict the resonant frequencies of a slotted wind tunnel, FEM is shown to be a useful approach. An eight-node FEM analysis shows that, for the same open ratio, both horizontal and vertical vibration-mode frequencies for three slots are higher than those for one slot. O.C.

A92-18683* Florida State Univ., Tallahassee.
BROADBAND SHOCK-ASSOCIATED NOISE FROM SUPERSONIC JETS IN FLIGHT
C. K. W. TAM (Florida State University, Tallahassee) Journal of Sound and Vibration (ISSN 0022-460X), vol. 151, Nov. 22, 1991, p. 131-147. refs
(Contract NAG1-421)
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The stochastic model theory of broadband shock-associated noise from supersonic jets, developed earlier (Tam, 1987, 1990), is extended to jets in flight. Forward flight affects broadband shock-associated noise generation through noise source modification. It also affects the intensity and characteristics of the noise radiated in a given direction through the mean flow convection effect. Noise source modification arises when the external flow associated with forward flight alters the mean velocity profile and shock cell structure of the jet. The mean flow convection effect arises because the radiated sound waves now have to propagate through a moving medium to reach the observation point. The present theory suggests that both the noise source modification effect and the mean flow convection effect would produce narrower broadband shock-associated noise spectral peaks with lower peak frequencies. The theory is further extended to the case of a supersonic jet embedded in an open wind tunnel bounded by a vortex sheet. Detailed comparisons between the calculated results and the measurements of Norum and Shearin (1984, 1986) are reported here. Very good agreements are found over a broad range of jet Mach numbers and wind tunnel Mach numbers. Author

A92-19982
NUMERICAL CALCULATION OF MODULATION TRANSFER FUNCTIONS FOR LOW FREQUENCY MECHANICAL VIBRATIONS
M. FISHER, O. HADAR, and N. S. KOPEIKA (Negev, University, Beersheba, Israel) IN: Airborne reconnaissance XIV; Proceedings of the Meeting, San Diego, CA, July 10-12, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 72-83. Research supported by Paul Ivanier Center for Robotics and Production Management. refs
Copyright

Numerical calculations of modulation transfer functions (MTFs) for low-frequency mechanical vibrations are presented. The problem is significant in practical reconnaissance where primary vibrations are at frequencies too low to be described by the usual closed form Bessel function MTF. The low vibration frequency situation involves random process blur radii and MTFs which can only be handled statistically since no closed form solution is possible. This is illustrated here. Comparisons are made to a closed form approximate MTF solution suggested previously. Agreement is generally good, especially for relatively large and linear blur radius situations. Author

A92-20301* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
RATE PARAMETERS FOR COUPLED VIBRATION-DISSOCIATION IN A GENERALIZED SSH APPROXIMATION
SURENDRA P. SHARMA, WINIFRED M. HUO, and CHUL PARK (NASA, Ames Research Center, Moffett Field, CA) Journal of Thermophysics and Heat Transfer (ISSN 0887-8722), vol. 6, Jan.-Mar. 1992, p. 9-21. Previously cited in issue 19, p. 3193, Accession no. A88-47075. refs
Copyright

A92-20729* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
REMOVAL OF SPURIOUS REFLECTIONS FROM COMPUTATIONAL FLUID DYNAMIC SOLUTIONS WITH THE COMPLEX CEPSTRUM
KRISTINE R. MEADOWS and JAY C. HARDIN (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 30, Jan. 1992, p. 29-34. Previously cited in issue 02, p. 229, Accession no. A91-12463. refs
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N92-14779*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AEROACOUSTICS OF FLIGHT VEHICLES: THEORY AND PRACTICE. VOLUME 2: NOISE CONTROL
HARVEY H. HUBBARD, ed. Washington Aug. 1991 443 p Sponsored in cooperation with the Army Aviation Systems Command
(Contract F33615-84-C-3202)
(NASA-RP-1258-VOL-2; L-16926-VOL-2; NAS 1.61:1258-VOL-2; WRDC-TR-90-3052-VOL-2) Avail: NTIS HC/MF A19 CSCL 20/1

Flight vehicles and the underlying concepts of noise generation, noise propagation, noise prediction, and noise control are studied. This volume includes those chapters that relate to flight vehicle noise control and operations: human response to aircraft noise; atmospheric propagation; theoretical models for duct acoustic propagation and radiation; design and performance of duct acoustic

treatment; jet noise suppression; interior noise; flyover noise measurement and prediction; and quiet aircraft design and operational characteristics.

N92-14780*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HUMAN RESPONSE TO AIRCRAFT NOISE
CLEMANS A. POWELL and JAMES M. FIELDS (General Accounting Office, Washington, DC.) *In its* Aeroacoustics of Flight Vehicles: Theory and Practice. Volume 2: Noise Control p 1-52 Aug. 1991
Avail: NTIS HC/MF A19 CSCL 20/1

The human auditory system and the perception of sound are discussed. The major concentration is on the annnoyance response and methods for relating the physical characteristics of sound to those psychosociological attributes associated with human response. Results selected from the extensive laboratory and field research conducted on human response to aircraft noise over the past several decades are presented along with discussions of the methodology commonly used in conducting that research. Finally, some of the more common criteria, regulations, and recommended practices for the control or limitation of aircraft noise are examined in light of the research findings on human response. Author

N92-14782*# Missouri Univ., Rolla.
THEORETICAL MODELS FOR DUCT ACOUSTIC PROPAGATION AND RADIATION
WALTER EVERSMAN *In* NASA. Langley Research Center, Aeroacoustics of Flight Vehicles: Theory and Practice. Volume 2: Noise Control p 101-163 Aug. 1991
Avail: NTIS HC/MF A19 CSCL 20/1

The development of computational methods in acoustics has led to the introduction of analysis and design procedures which model the turbofan inlet as a coupled system, simultaneously modeling propagation and radiation in the presence of realistic internal and external flows. Such models are generally large, require substantial computer speed and capacity, and can be expected to be used in the final design stages, with the simpler models being used in the early design iterations. Emphasis is given to practical modeling methods that have been applied to the acoustical design problem in turbofan engines. The mathematical model is established and the simplest case of propagation in a duct with hard walls is solved to introduce concepts and terminologies. An extensive overview is given of methods for the calculation of attenuation in uniform ducts with uniform flow and with shear flow. Subsequent sections deal with numerical techniques which provide an integrated representation of duct propagation and near- and far-field radiation for realistic geometries and flight conditions. Author

N92-14783*# General Electric Co., Cincinnati, OH.
DESIGN AND PERFORMANCE OF DUCT ACOUSTIC TREATMENT
R. E. MOTSINGER and R. E. KRAFT *In* NASA. Langley Research Center, Aeroacoustics of Flight Vehicles: Theory and Practice. Volume 2: Noise Control p 165-206 Aug. 1991
Avail: NTIS HC/MF A19 CSCL 20/1

The procedure for designing acoustic treatment panels used to line the walls of aircraft engine ducts and for estimating the resulting suppression of turbofan engine duct noise is discussed. This procedure is intended to be used for estimating noise suppression of existing designs or for designing new acoustic treatment panels and duct configurations to achieve desired suppression levels. Author

N92-14784*# General Electric Co., Cincinnati, OH.
JET NOISE SUPPRESSION
P. R. GLIEBE, J. F. BRAUSCH, R. K. MAJJIGI, and R. LEE *In* NASA. Langley Research Center, Aeroacoustics of Flight Vehicles: Theory and Practice. Volume 2: Noise Control p 207-269 Aug. 1991
Avail: NTIS HC/MF A19 CSCL 20/1

The objectives of this chapter are to review and summarize the jet noise suppression technology, to provide a physical and theoretical model to explain the measured jet noise suppression characteristics of different concepts, and to provide a set of guidelines for evolving jet noise suppression designs. The underlying principle for all jet noise suppression devices is to enhance rapid mixing (i.e., diffusion) of the jet plume by geometric and aerothermodynamic means. In the case of supersonic jets, the shock-cell broadband noise reduction is effectively accomplished by the elimination or mitigation of the shock-cell structure. So far, the diffusion concepts have predominantly concentrated on jet momentum and energy (kinetic and thermal) diffusion, in that order, and have yielded better noise reduction than the simple conical nozzles. A critical technology issue that needs resolution is the effect of flight on the noise suppression potential of mechanical suppressor nozzles. A more thorough investigation of this mechanism is necessary for the successful development and design of an acceptable noise suppression device for future high-speed civil transports. M.G.

N92-14785*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INTERIOR NOISE
JOHN S. MIXSON and JOHN F. WILBY (Atlantic Applied Research Corp., Los Angeles, CA.) *In its* Aeroacoustics of Flight Vehicles: Theory and Practice. Volume 2: Noise Control p 271-355 Aug. 1991
Avail: NTIS HC/MF A19 CSCL 20/1

The generation and control of flight vehicle interior noise is discussed. Emphasis is placed on the mechanisms of transmission through airborne and structure-borne paths and the control of cabin noise by path modification. Techniques for identifying the relative contributions of the various source-path combinations are also discussed along with methods for the prediction of aircraft interior noise such as those based on the general modal theory and statistical energy analysis. M.G.

N92-14786*# Boeing Co., Seattle, WA. Noise Engineering Organization.
FLYOVER-NOISE MEASUREMENT AND PREDICTION
NOEL A. PEART *In* NASA. Langley Research Center, Aeroacoustics of Flight Vehicles: Theory and Practice. Volume 2: Noise Control p 357-382 Aug. 1991
Avail: NTIS HC/MF A19 CSCL 20/1

Details are presented for the measurement and prediction of aircraft flyover noise to be used for certification, research and development, community noise surveys, airport monitors, and pass fail criteria. Test details presented are applicable to all types of aircraft, both large and small, and the use of Federal Aviation Regulations (FAR) Part 36 (ref. 1) is emphasized. Accuracy of noise measurements is important. Thus, a pass-fail criterion should be used for all noise measurements. Finally, factors which influence the sound propagation and noise prediction procedures, such as atmospheric and ground effects, are also presented. Author

N92-14787*# Boeing Co., Seattle, WA.
QUIET AIRCRAFT DESIGN AND OPERATIONAL CHARACTERISTICS
CHARLES G. HODGE *In* NASA. Langley Research Center, Aeroacoustics of Flight Vehicles: Theory and Practice. Volume 2: Noise Control p 383-413 Aug. 1991
Avail: NTIS HC/MF A19 CSCL 20/1

The application of aircraft noise technology to the design and operation of aircraft is discussed. Areas of discussion include the setting of target airplane noise levels, operational considerations and their effect on noise, and the sequencing and timing of the design and development process. Primary emphasis is placed on commercial transport aircraft of the type operated by major airlines. Additionally, noise control engineering of other types of aircraft is briefly discussed. Author

N92-14788*# AeroChem Research Labs., Inc., Princeton, NJ.
DIRECT COMPUTATION OF TURBULENCE AND NOISE Final Report, 29 Mar. 1989 - 29 Jun. 1991

C. BERMAN, G. GORDON, G. KARNIADAKIS, P. BATCHO, E. JACKSON, and S. ORSZAG (Vector Technology, Inc., Princeton, NJ.) Sep. 1991 77 p
(Contract NAS1-18849)
(NASA-CR-187616; NAS 1.26:187616; TP-499) Avail: NTIS HC/MF A05 CSCL 20/1

Jet exhaust turbulence noise is computed using a time dependent solution of the three dimensional Navier-Stokes equations to supply the source terms for an acoustic computation based on the Phillips convected wave equation. An extrapolation procedure is then used to determine the far field noise spectrum in terms of the near field sound. This will lay the groundwork for studies of more complex flows typical of noise suppression nozzles. Author

N92-14789*# Florida Atlantic Univ., Boca Raton. Dept. of Ocean Engineering.
THE APPLICATION OF EXPERIMENTAL DATA TO BLADE WAKE INTERACTION NOISE PREDICTION
STEWART A. L. GLEGG and WILLIAM J. DEVENPORT Oct. 1991 20 p Presented at the 6th International Symposium on Unsteady Aerodynamics, Aeroacoustics and Aeroelasticity of Turbomachines and Propellers, Notre Dame, IN, 15-19 Sep. 1991
(Contract NAG1-1119)
(NASA-CR-189461; NAS 1.26:189461) Avail: NTIS HC/MF A03 CSCL 20/1

Blade wake interaction noise (BWI) has been defined as the broadband noise generated by the ingestion of turbulent trailing tip vortices by helicopter rotors. This has been shown to be the dominant contributor to the subjectively important part of the acoustic spectrum for the approach stage of a helicopter flyover. A prediction method for BWI noise based on the calculated trailing vortex trajectories has been developed and estimates of the vortex turbulence have been made. These measurements were made on a trailing vortex from a split wing arrangement and did not give the spectrum of the velocity fluctuations. A recent experiment carried out to measure the turbulence associated with a trailing vortex and the application of the results to BWI noise prediction is described. Author

N92-14791# Institute for Water Resources, Fort Belvoir, VA.
REDUCING ENVIRONMENTAL NOISE IMPACTS: A USAREUR NOISE MANAGEMENT PROGRAM HANDBOOK Final Report
TIMOTHY D. FEATHER and TED K. SHEKELL Jun. 1991 167 p Prepared in cooperation with Planning and Management Consultants Ltd., Carbondale, IL
(AD-A240797; IWR-91-R-5) Avail: NTIS HC/MF A08 CSCL 20/1

Noise pollution is a major environmental problem faced by the U.S. Army in Europe. Noise-related complaints from German citizens can escalate into intense political issues in German communities. This in turn hampers efficient operation of military training and often times threatens the Army's mission. In order to remedy these problems, USAREUR has developed a noise management program. A successful noise management program will limit the impact of unavoidable noise on the populace. This report, a component of the noise management program, is a reference document for noise management planning. It contains guidelines and rules-of-thumb for noise management. This document contains procedures which operation and training level personnel can understand and apply in their day to day noise management planning. Noise mitigation tips are given. Basic technical information that will aid in understanding noise mitigation is provided along with noise management through land use planning. Noise management for specific components of the military community, (airfields, base operations, training areas, and housing and recreation areas) are addressed. The nature of noise generated, means of noise abatement at the source, path, and receiver (both physical and organizational/public relations methods), and a case study example are described. GRA

N92-14795*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
COMPUTATION OF SUPERSONIC JET MIXING NOISE FOR AN AXISYMMETRIC CD NOZZLE USING K-EPSILON TURBULENCE MODEL
ABBAS KHAVARAN (Sverdrup Technology, Inc., Brook Park, OH.), EUGENE A. KREJSA, and CHAN M. KIM 1991 16 p Proposed for presentation at the 30th Aerospace Sciences Meeting and Exhibit, Reno, NV, 6-9 Jan. 1992; sponsored by AIAA
(NASA-TM-105338; E-6705; NAS 1.15:105338; AIAA-92-0500)
Avail: NTIS HC/MF A03 CSCL 20/1

The turbulent mixing noise of a supersonic jet is calculated for a round convergent-divergent nozzle at the design pressure ratio. Aerodynamic computations are performed using the PARC code with a k-epsilon turbulence model. Lighthill's acoustic analogy combined with Ribner's assumption is adopted. The acoustics solution is based upon the methodology followed by GE in the MGB code. The source correlation function is expressed as a linear combination of second-order tensors. Assuming separable second-order correlations and incorporating Batchelor's isotropic turbulence model, the source term was calculated from the kinetic energy of turbulence. A Gaussian distribution for the time-delay of correlation was introduced. The computational fluid dynamics (CFD) solution was used to obtain the source strength as well as the characteristic time-delay of correlation. The effect of sound/flow interaction was incorporated using the high frequency asymptotic solution to Lilley's equation for axisymmetric geometries. Acoustic results include sound pressure level directivity and spectra at different polar angles. The aerodynamic and acoustic results demonstrate favorable agreement with experimental data.
Author

N92-14797*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A SURVEY OF THE BROADBAND SHOCK ASSOCIATED NOISE PREDICTION METHODS
CHAN M. KIM, EUGENE A. KREJSA, and ABBAS KHAVARAN (Sverdrup Technology, Inc., Brook Park, OH.) 1992 26 p Proposed for presentation at the 30th Aerospace Sciences Meeting and Exhibit, Reno, NV, 6-9 Jan. 1992; sponsored by AIAA
(Contract NAS3-25266)
(NASA-TM-105365; E-6743; NAS 1.15:105365; AIAA-92-0501)
Avail: NTIS HC/MF A03 CSCL 20/1

Several different prediction methods to estimate the broadband shock associated noise of a supersonic jet are introduced and compared with experimental data at various test conditions. The nozzle geometries considered for comparison include a convergent and a convergent-divergent nozzle, both axisymmetric. Capabilities and limitations of prediction methods in incorporating the two nozzle geometries, flight effect, and temperature effect are discussed. Predicted noise field shows the best agreement for a convergent nozzle geometry under static conditions. Predicted results for nozzles in flight show larger discrepancies from data and more dependable flight data are required for further comparison. Qualitative effects of jet temperature, as observed in experiment, are reproduced in predicted results. Author

N92-14798# Technische Univ., Delft (Netherlands). Faculty of Aerospace Engineering.
PROPELLER-DRIVEN-SMALL AIRPLANE NOISE CERTIFICATION
G. J. J. RUIJGROK and D. M. VANPAASSEN Dec. 1990 31 p
(LR-650; ETN-92-90417) Avail: NTIS HC/MF A03

The existing international standards and recommended practices for light propeller driven airplane noise as published in annex 16 to the Convention on International Civil Aviation are reviewed. These airplanes are defined as having a maximum certificated takeoff mass below 9000 kg. The determination of atmospheric attenuation rate and the establishment of a confidence level are discussed. ESA

N92-15013# Naples Univ. (Italy).
LINEAR ACOUSTICS IN GAS MIXTURES WITH RATE PROCESSES
LUIGI G. NAPOLITANO *In* ESA, Aerothermodynamics for Space Vehicles p 317-324 Jul. 1991
Copyright Avail: NTIS HC/MF A24; ESA, EPD, ESTEC, Noordwijk, Netherlands, HC 90 Dutch guilders

Linear acoustics in an unbounded medium in which an arbitrary number of independent rate processes (chemical reactions and/or excitations on internal degrees of freedom) take place are dealt with. The medium is supposed to be in an initial quiescent and full equilibrium state and all diffusion processes are assumed to be negligible. (Linear acoustics without neglection of diffusion processes or in nonquiescent media and nonlinear acoustics with and without diffusion processes are not dealt with). The extremely simplified case dealt with is nonetheless very useful. It allows for the following: elucidation of the role played by a number of basic notions of thermodynamics such as equilibrium and stability; quantification of the 'response' of the media to small disturbances; and suggestion of diagnostic techniques which may be used to study the kinetics of rate processes and their couplings, and so forth. Equilibrium and nonequilibrium thermodynamics of composite systems as specialized to the subject case are considered. The field equations and their linearized form appropriate to the study of linear acoustics are addressed, as are the general features of linear acoustics, dispersion equation, and properties of the acoustic susceptibility. ESA

N92-15761# Oak Ridge National Lab., TN.
SCOPING STUDIES FOR SMALL STEADY-STATE TOKAMAKS FOR DIVERTOR TESTING
J. D. GALAMBOS, Y. K. M. PENG, B. E. NELSON, S. P. HIRSHMAN, and P. J. FOGARTY 1991 6 p Presented at the 14th IEEE Symposium on Fusion Engineering, San Diego, CA, 30 Sep. - 3 Oct. 1991
(Contract DE-AC05-84OR-21400)
(DE92-000740; CONF-910968-10) Avail: NTIS HC/MF A02

A prime uncertainty in next-generation devices is the divertor performance. For the International Thermonuclear Experimental Reactor (ITER), the divertor limit often plays a more critical role in the operational scenario definition than do beta limit and energy confinement constraints. Hence, it is desirable to test the divertors in an environment as close as possible to that expected in next-step burning plasma experiments. Initial global scoping studies are done for small, steady-state, copper coil, beam-driven tokamaks that are dedicated to divertor testing. The usual ITER global physics models (beta limit, energy confinement, and analytic divertor heat load calculation) are incorporated, and for performance criteria we require that the divertor heat load and plasma collisionality in the edge region be similar to those expected in ITER. The smallest, lowest-cost devices satisfying these constraints tend to have major radius below 1 m, plasma current of 0.5 to 1 MA, and low aspect ratio and costs of a few tens of millions of dollars. Injection powers of about 4 to 5 MW are needed to sustain the plasma current, maintain plasma power balance, and provide the required divertor heat load. DOE

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SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

N92-14923# Congress of the United States, Washington, DC.
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
In its Departments of Veterans Affairs and Housing and Urban Development, and Independent Agencies Appropriations Act, 1992 p 83-90 18 Jul. 1991
Avail: Document Room, House of Representatives, Washington, DC 20515 HC free

House committee recommendations for appropriations for the National Aeronautics and Space Administration for the fiscal year ending September 30, 1992 are presented. The budget recommendations provide an outline of budgetary information for research and development; construction of facilities; space flight, control and data communication; research and program management; the Office of Inspector General; and administrative provisions. J.P.S.

N92-14925# Committee on Appropriations (U.S. Senate).
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
In its Departments of Veterans Affairs and Housing and Urban Development, and Independent Agencies Appropriations Bill, 1992 p 130-148 1991
Avail: Document Room, Senate, Washington, DC, 20510 HC free

Senate committee recommendations for appropriations for the National Aeronautics and Space Administration for the fiscal year ending September 30, 1992 are presented. The budget recommendations provide an outline of budgetary information for space transportation; space sciences; commercial, technology, and educational programs; air and space flight; communications; propulsion; international radio astronomy programs; construction of facilities; and research and program management. J.P.S.

N92-14927# Committee on Appropriations (U.S. Senate).
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
In its Departments of Veterans Affairs and Housing and Urban Development and Independent Agencies Appropriations for Fiscal Year 1992, Part 2 p 297-395 1991
Avail: Committee on Appropriations, Senate, Washington, DC, 20510 HC free

Following opening statements of members of the subcommittee of the Senate Committee on Appropriations, the National Aeronautics and Space Administration presents its fiscal year 1992 budget. Previous and planned programs are discussed. It is noted that the entire NASA budget equals only a little over 1 percent of the total Federal budget, and that 99 percent of NASA's $15.8 billion is needed for ongoing programs. The subcommittee noted that Congress and the General Accounting Office use different standards in measuring science and space programs. Concern was expressed for the future impact of current science and space program underfunding. Questions submitted to NASA after the hearing, and their answers, are included in the record. Topics discussed include NASA's priorities, a strategic plan, budget reserves, the space station, shuttles, the advanced solid rocket motor, Mission to Planet Earth, a new launch vehicle, the Mars Observer, Landsat, education, communications, management, commerce, NASA field Center maintenance, and technology and information transfer. J.P.S.

N92-14933# Office of Technology Assessment, Washington, DC.
NEW WAYS: TILTROTOR AIRCRAFT AND MAGNETICALLY LEVITATED VEHICLES
1992 118 p
(OTA-SET-507; ISBN-0-16-035630-X) Avail: NTIS HC/MF A06

The Office of Technology Assessment presents a study on tiltrotor aircraft and magnetically levitated (maglev) vehicular technology. The purpose of the study was to provide the House Committee on Appropriations with information that would aid their decisionmaking on how much and what kind of additional investment they should make in these new technologies to help resolve transportation congestion. Federal policy issues are presented, as well as various options for operational implementation. J.P.S.

N92-15937# Committee of Conference (U.S. Congress).
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION RESEARCH AND DEVELOPMENT
In its Making Appropriations for the Depts. of Veterans Affairs

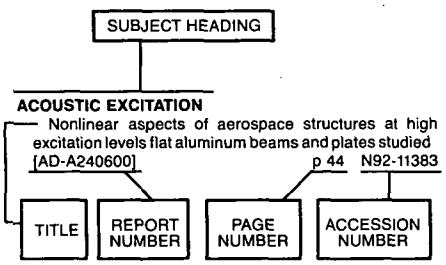
and Housing and Urban Development, and for Sundry Independent Agencies, Commissions, Corps., and Other Offices for the Fiscal Year Ending 30 Sep. 1992, and for Other Purposes p 51-61 1991
Avail: Document Room, House of Representatives, Washington, DC 20515 HC free

The Conference Committee presents its report on recommended appropriations for the National Aeronautics and Space Administration (NASA) for the fiscal year ending September 30, 1992. Items addressed by the Conference Committee include agreed upon changes, amendments, funding by program, and decisions that the Committee made regarding differences. Both NASA's ongoing programs and new initiatives are included in the list of appropriations considered. J.P.S.

N92-15938# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Dienstelistungsbereich.
THE ACOUSTIC FLASHLIGHT [DIE AKUSTISCHE TASCHENLAMPE]
STEPHAN BRUEHL 1990 6 p In GERMAN Original contains color illustrations
(MBB-Z-0359-90-PUB; REPT-3/1990; ETN-92-90610) Avail: NTIS HC/MF A02

It is shown that for traveling speeds over three hundred kilometers per hour, sound radiation is determined by aerodynamical effects, e.g., by local shedding of vortices and large area boundary layer noise. In order to obtain exact information on the position and strength of these aerodynamic sources of sound on vehicle surfaces, a measurement process aiming at localizing and analyzing quantitatively quick moving sources of sound was developed. The measuring equipment is described, e.g., a directional microphone which is placed at about five meters off the roadway. Using light cabinets, the vehicle position can be exactly determined, with regard to the measuring station at any overhaul time. ESA

Typical Subject Index Listing



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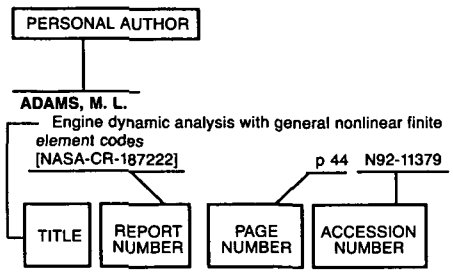

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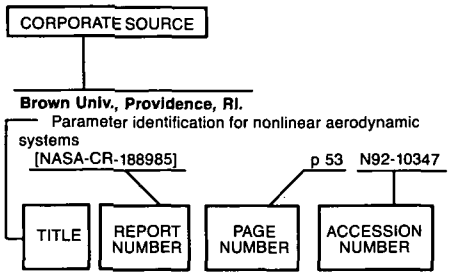

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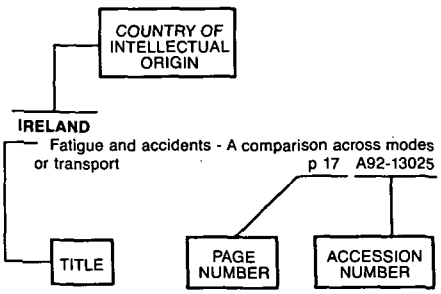

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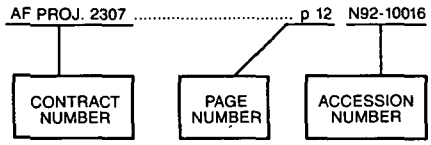

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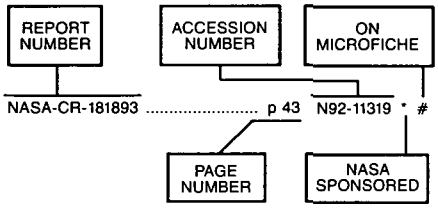

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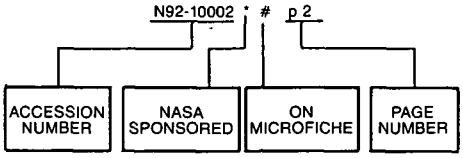

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