NASA SP-7037 (285)
December 1992

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AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(NASA-SP-7037(285)) AERONAUTICAL ENGINEERING: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 285) (NASA) 157 p

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NASA SP-7037 (285)
December 1992

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

National Aeronautics and Space Administration
Scientific and Technical Information Program
Washington, DC 1992

INTRODUCTION

This issue of *Aeronautical Engineering—A Continuing Bibliography* (NASA SP-7037) lists 534 reports, journal articles, and other documents originally announced in November 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)	N92-30233 — N92-32242
IAA (A-10000 Series)	A92-49230 — A92-53429

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 CASI price schedules are located at the back of this issue.

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

Category 09 Research and Support Facilities (Air) 980
Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

Category 10 Astronautics 984
Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; space communications, spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

Category 11 Chemistry and Materials 985
Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; propellants and fuels; and materials processing.

Category 12 Engineering 989
Includes engineering (general); communications and radar; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

Category 13 Geosciences 1003
Includes geosciences (general); earth resources and remote sensing; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

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

Category 15 Mathematical and Computer Sciences 1005
Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

Category 16 Physics 1010
Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

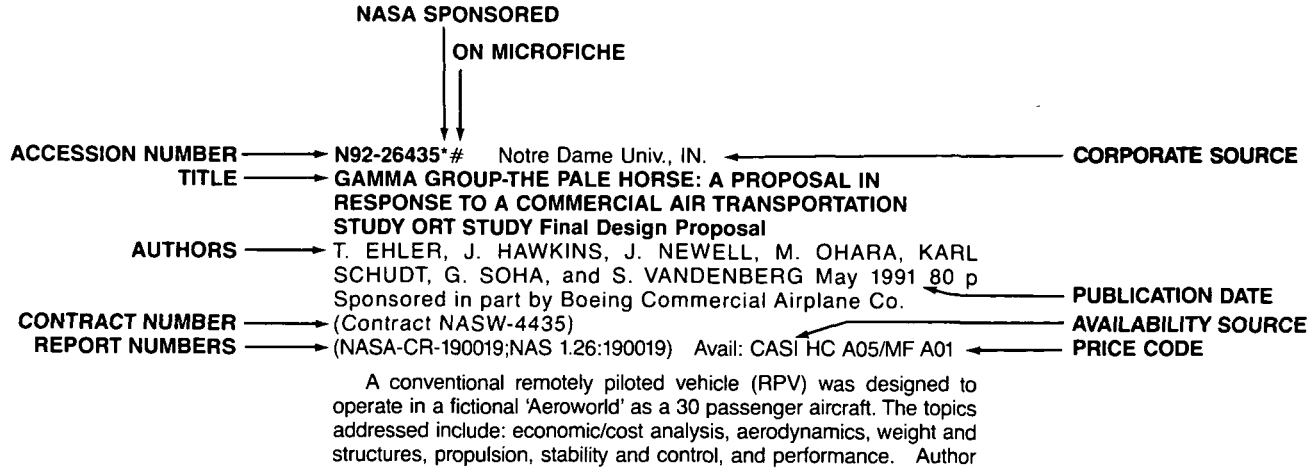
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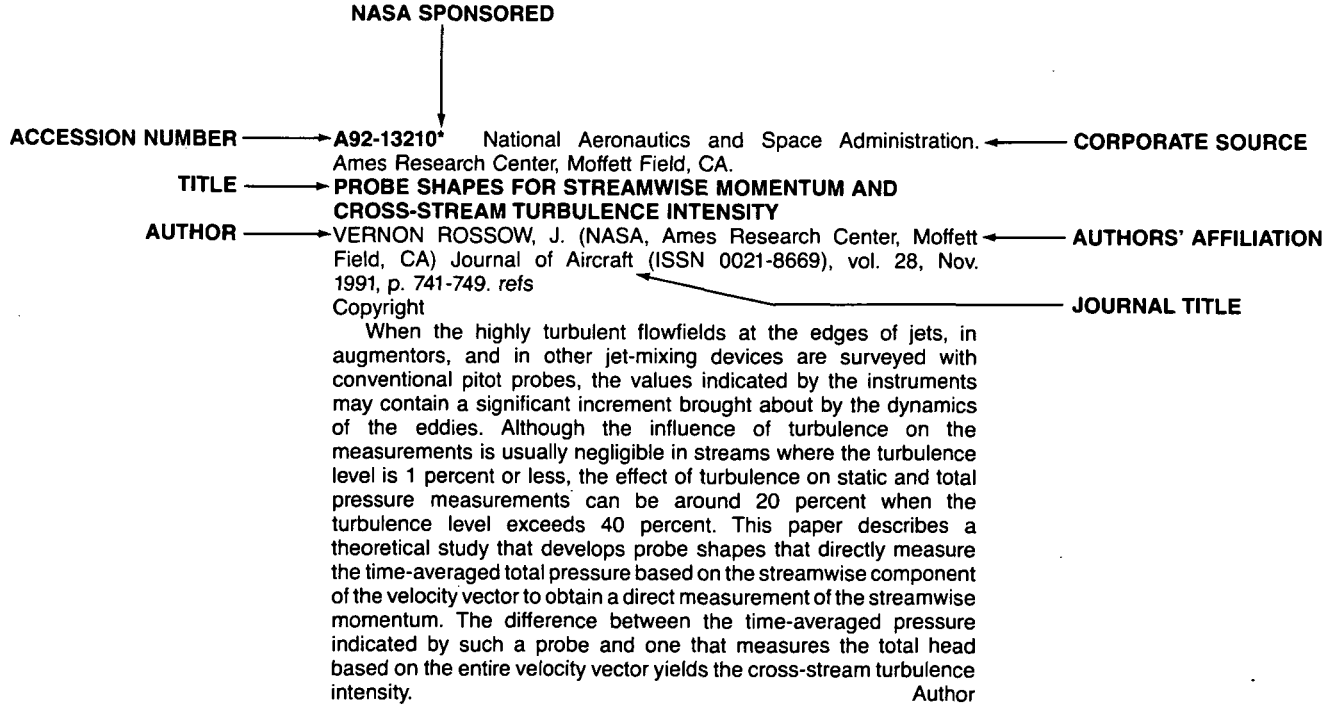
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TYPICAL REPORT CITATION AND ABSTRACT



TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT



AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 285)

December 1992

01

AERONAUTICS (GENERAL)

A92-49305
ARE WE DOING HIRF TESTING SENSIBLY?
GERRY FULLER (CKC Laboratories, Inc., Mariposa, CA) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 346-350. refs
Copyright

The author presents observations on a simplified and cost-effective HIRF certification procedure for aircraft and avionics systems. The objective of performing avionics system tests at the bench level as embodied in the RTCA DO-160 test procedures and at the aircraft level as in the new HIRF advisory circular is an attempt to perform meaningful tests of these systems. The premise is if the system is not upset by the test signal then the system would not be upset by flying in the existing electromagnetic environment. The problem is in how to be reasonably sure that the tests are practical, economical, and safe. Most importantly, these measures are truly of the susceptibility of the systems as they will be operated. The author attempts to trace some fairly simple but logical observations from recent experiments and analysis that make this complicated process yield itself to some order. I.E.

A92-51399
AGING AIRCRAFT AND AIRWORTHINESS
Aerospace Engineering (ISSN 0736-2536), vol. 12, no. 7, July 1992, p. 23-30.
Copyright

A review is presented of the ongoing research to examine airframe and engine inspection and maintenance activities, as well as the structural designs themselves, to ensure continued safe operation of the U.S. commercial airplane fleet. Research on aircraft structural design, including the design of repairs, addresses degradation of structural integrity from levels that were in place when an aircraft first went into service. It is anticipated that successful completion of the tasks in aging aircraft research will provide a technology that will develop tools needed for an effective service life extension program for the civil fleet. R.E.P.

A92-51400
THE 'WHITE PELICAN' PROJECT - DESIGN AND CONSTRUCTION OF THE WORLD'S LARGEST PAPER AIRPLANE
FERDINAND GROSVELD (Lockheed Engineering and Sciences Co., Hampton, VA) AIAA Student Journal (ISSN 0001-1460), vol. 30, no. 2, Summer 1992, p. 6-10.
Copyright

To illustrate the basic principles of aerodynamics to the public, a 'world's largest paper airplane exhibit' was proposed, displaying a 10 ft folded paper airplane in the Virginia Air and Space Center. The various designs and flights of the record-breaking 28-foot and 30.5-foot gliders, which flew distances of 106 feet and 114.75 feet respectively are presented. R.E.P.

A92-51808
SUCCESSFUL TRANSFER OF TECHNOLOGY FROM A RESEARCH AND DEVELOPMENT LABORATORY TO AN AEROSPATIALE PRODUCTION UNIT
S. ZOLOTOVSKY (Aerospatiale, Centre Louis Bleriot, Suresnes, France) and B. MIGUET (Aerospatiale, Toulouse, France) IN: Welding in space and the construction of space vehicles by welding; Proceedings of the Conference, New Carrollton, MD, Sept. 24-26, 1991. Miami, FL, American Welding Society, 1991, p. 106-143.
Copyright

The osmosis of the 'Louis Bleriot' Joint Research Center and the Aerospatiale production unit in Toulouse St. Eloi has made it possible for Laser CO2 cutting and welding technologies to become a reality and be incorporated into the assembly lines for aircraft structures belonging to the Airbus family. The integration of the two 5-axis, robotized laser cells in direct combination with computers and CAD systems produces extremely diverse unit parts at a high production rate. The reliability and savings provided by this technique make it possible to very quickly recoup investments which are entirely compatible with mass production. Author

A92-52022
THE CHALLENGE OF COMMERCIAL AIRCRAFT SURVIVABILITY
JEREMY BARNES (USAF, Davis-Monthan AFB, AZ) and RICKY L. PETERS (USAF, Wright Laboratory, Wright-Patterson AFB, OH) Aerospace America (ISSN 0740-722X), vol. 30, no. 8, Aug. 1992, p. 55, 56.
Copyright

The transfer of survivability improvements for military aircraft to commercial applications is examined with attention given to its impact on terrorist attacks. Vulnerability reduction philosophies such as shielding and explosion protection are shown to be economically feasible and effective in commercial aircraft. C.C.S.

A92-53111
A COMMON ENGINEERING-TO-MANUFACTURING-TO-FIELD TEST STRATEGY TO ACHIEVE SYSTEMS READINESS BEYOND THE '90S
ROGER L. WILLIAMS (Boeing Defense & Space Group, Seattle, WA) IN: AUTOTESTCON '91; IEEE Systems Readiness Technology Conference, Anaheim, CA, Sept. 24-26, 1991, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 217-227. refs
Copyright

To achieve test program commonality an automated test equipment (ATE) architecture that provides a common platform for the separate test disciplines is defined using integrating standards. This common ATE architecture is amenable to engineering electronics design so that prime equipment designers can use it in conjunction with design-for-test strategies for equipment proof-of-design and qualification testing. In its use for manufacturing test, the standard ATE architecture is functional (performance) test oriented (versus component or in-circuit) to ensure reusability of functional tests for depot return for issue purposes and fault isolation techniques. The common ATE

architecture promises to integrate various program requirements imposed by differing field ATEs such as MATE, IFTE, CASS, and SMART into a unified factory solution. I.E.

A92-53250
RUSSIAN REALITIES
PAUL DUFFY Flight International (ISSN 0015-3710), vol. 142, no. 4329, July 29, 1992, p. 23-25.
Copyright

An overview is presented of the Aviastar Aviation Complex in Ulyanovsk to evaluate how this organization has faced up to the changing political and economic circumstances affecting the aviation industry in Russia. Attention is given to the restructuring, not only of the basic infrastructure of the complex, but of the personnel/management organization which is now based on Western design, development and manufacturing system guidelines. Consideration is given to the ongoing negotiations with other international aeronautics firms and to the projects currently being pursued including the Thermoplane, a rigid-structure airship heavylifter. R.E.P.

N92-30253# North Carolina Agricultural and Technical State Univ., Greensboro.
MODEL ANALYSIS AND EXPERT SYSTEM DEVELOPMENT FOR PLANNING AND SCHEDULING TELEOPERATIONS FOR AIRCRAFT TURNAROUND FUNCTIONS, VOLUME 1 Final Report, Jun. 1988 - Jul. 1991
EUI H. PARK and CELESTINE A. NTUEN Feb. 1992 98 p
(Contract F33615-88-C-3400)
(AD-A251037; WL-TR-91-3107-VOL-1) Avail: CASI HC A05/MF A02

This report summarizes the results of a 3-year effort to study the planning and scheduling of aircraft turnaround functions using an expert system to minimize the turnaround time. This effort established the feasibility of using expert system technology to model aircraft turnaround functions in a teleoperated environment. The model 'opportunistically' generates schedules based on aircraft turnaround functions (refueling, weapons loading, aircraft inspection, maintenance, etc.) and personnel assignments and automation technologies. The model is conceptualized for a dynamic environment. Thus, it is possible for the model to consult its knowledge base in order to identify scheduling strategies to maximize aircraft turnaround efficiency for a particular function. GRA

N92-30258# North Carolina Agricultural and Technical State Univ., Greensboro.
MODEL ANALYSIS AND EXPERT SYSTEM DEVELOPMENT FOR PLANNING AND SCHEDULING TELEOPERATIONS FOR AIRCRAFT TURNAROUND FUNCTIONS. VOLUME 2: TOP USER'S GUIDE Final Report, Jul. 1988 - Jul. 1991
EUI H. PARK and CELESTINE A. NTUEN Feb. 1992 48 p
(Contract F33615-88-C-3400)
(AD-A251083; WL-TR-91-3107-VOL-2) Avail: CASI HC A03/MF A01

This report summarizes the results of a 3-year effort to study the planning and scheduling of aircraft turnaround functions using an expert system to minimize the turnaround time. This effort established the feasibility of using expert system technology to model aircraft turnaround functions in a teleoperated environment. The model opportunistically generates schedules based on aircraft turnaround functions (refueling, weapons loading, aircraft inspection, maintenance, etc.) and personnel assignments and automation technologies. The model is conceptualized for a dynamic environment. Thus, it is possible for the model to consult its knowledge base in order to identify scheduling strategies to maximize aircraft turnaround efficiency for a particular function. GRA

N92-30675# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany). Military Aircraft Div.
NUMERICAL OPTIMIZATION IN GERMANY: A NON-EXHAUSTIVE SURVEY ON CURRENT ACTIVITIES WITH EMPHASIS ON AERONAUTICS
LUCIANO FORNASIER Oct. 1991 21 p Presented at the 3rd Internatiaonal Conference on Inverse Design Concept and Optimization in Engineering Sciences, Washington, DC, 23-25 Oct. 1991
(MBB/FE211/S/PUB/474; ETN-92-91906) Copyright Avail: CASI HC A03/MF A01

Without claim to completeness, some recent progresses achieved in development and application of numerical optimization methods are presented. With emphasis lying on aeronautical problems, the activities in the field of aerodynamic design by Computational Fluid Dynamics (CFD) methods, structural optimization and determination of optimal flight trajectories are surveyed. As the reviewed methods show different levels of mathematical background, capability, maturity and applicability, the need for a stronger exchange of information and experience between the different disciplines emerges as a key factor for increasing the impact of numerical optimization strategies in the design process. ESA

N92-31267*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PRELIMINARY EVALUATION OF ADHESION STRENGTH MEASUREMENT DEVICES FOR CERAMIC/TITANIUM MATRIX COMPOSITE BONDS
BOBBY POHLCHUCK (Kent State Univ., OH.) and MARY V. ZELLER Aug. 1992 24 p
(Contract NCC3-189; RTOP 763-22-51)
(NASA-TM-105803; E-7233; NAS 1.15:105803) Avail: CASI HC A03/MF A01

The adhesive bond between ceramic cement and a titanium matrix composite substrate to be used in the National Aerospace *Plane program is evaluated. Two commercially available adhesion* testers, the Sebastian Adherence Tester and the CSEM REVETEST Scratch Tester, are evaluated to determine their suitability for quantitatively measuring adhesion strength. Various thicknesses of cements are applied to several substrates, and bond strengths are determined with both testers. The Sabastian Adherence Tester has provided limited data due to an interference from the sample mounting procedure, and has been shown to be incapable of distinguishing adhesion strength from tensile and shear properties of the cement itself. The data from the scratch tester has been found to be difficult to interpret due to the porosity and hardness of the cement. Recommendations are proposed for a more reliable adhesion test method. Author

N92-31615# Federal Aviation Administration, Atlantic City, NJ.
GNAS MAINTENANCE CONTROL CENTER (GMCC) DESIGN QUALIFICATION TEST AND EVALUATION (DQT/E) TEST REPORT
RICHARD VANSUETENDAEL Jul: 1992 133 p
(DOT/FAA/CT-TN91/39) Avail: CASI HC A07/MF A02

This report presents the results of Design Qualification Test and Evaluation (DQT&E) testing of the General National Airspace System (GNAS) Maintenance Control Center (GMCC). As Test Director, ACN-250 conducted testing at the Federal Aviation Administration (FAA) Technical Center, Atlantic City International Airport, New Jersey. The purpose of DQT&E testing is to verify that the phase 1 and phase 2 GMCC design requirements are met. The requirements were successfully demonstrated with some minor problems. However, due to an incomplete test configuration, ACN-250 recommended retesting the system with a four GMCC network. Author

N92-31861# Israel Society of Aeronautics and Astronautics, Tel Aviv.
COLLECTION OF PAPERS OF THE 31ST ISRAEL ANNUAL CONFERENCE ON AVIATION AND ASTRONAUTICS
22 Feb. 1990 239 p Conference held in Tel-Aviv, Israel, February

21-22, 1990; sponsored by Technion - Israel Inst. of Tech., Tel-Aviv Univ., Ben Gurion Univ. of the Negev, Rafael Armament Development Authority, National Committee for Space Research, Israel Space Agency
(ITN-92-85124) Avail: CASI HC A11/MF A03

Subjects covered by the 28 papers include aging aircraft maintenance, automatic airfoil design, computerized aircraft design and manufacture, single-rotor helicopter simulation, robotics, skewed sensor arrays in flight-control systems, combustion chambers and processes in rocket and ramjet systems, orbital vehicle control and guidance, aluminum alloy testing, structural design, missile guidance, unmanned air vehicle trajectories, single and two-target differential games, fuel combustion, turbulent flow vortices, and Euler codes for aerodynamic problems.

02

AERODYNAMICS

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

A92-49498
CRITICAL MACH NUMBER ESTIMATES FOR DENSE GASES
M. S. CRAMER, L. M. TARKENTON, and G. M. TARKENTON (Virginia Polytechnic Institute and State University, Blacksburg) Physics of Fluids A (ISSN 0899-8213), vol. 4, no. 8, Aug. 1992, p. 1840-1847. refs
(Contract NSF CTS-89-13198)
Copyright

The present study provides estimates for the critical Mach number at free-stream pressures and temperatures corresponding to the dense gas regime. A range of stable fluorocarbons is identified for which the critical Mach number exceeds 0.95 for practical airfoil or turbine blade configurations. Conditions under which the classical transonic similarity laws break down are also delineated. Author

A92-49508
IMPROVED ARTIFICIAL DISSIPATION SCHEMES FOR THE EULER EQUATIONS
M. P. THOMADAKIS and S. TSANGARIS (Athens, National Technical University, Greece) International Journal for Numerical Methods in Fluids (ISSN 0271-2091), vol. 14, no. 12, June 30, 1992, p. 1391-1405. refs
Copyright

The influence of artificial dissipation schemes on the accuracy and stability of the numerical solution of compressible flow is extensively examined. Using an implicit central difference factored scheme, an improved form of artificial dissipation is introduced which highly reduces the errors due to numerical viscosity. A function of the local Mach number is used to scale the amount of numerical damping added into the solution according to the character of the flow in several flow regimes. The resulting scheme is validated through several inviscid flow test cases. Author

A92-49510
AN INVISCID/VISCOUS COUPLING APPROACH FOR VORTEX FLOW FIELD CALCULATIONS
K. D. LEE and S. A. BRANDT (Illinois, University, Urbana) International Journal for Numerical Methods in Fluids (ISSN 0271-2091), vol. 14, no. 12, June 30, 1992, p. 1437-1452. refs
Copyright

A new computational approach is developed for the analysis of vortex-dominated flowfields around highly swept wings at high angles of attack. In this approach an inviscid Euler technology is coupled with viscous models, similar to inviscid/boundary layer coupling. The viscous nature of the vortex core is represented by an algebraic model derived from the Navier-Stokes equations. The approach also accounts for the effects of the viscous shear layer near a wing surface through a modified surface boundary condition. The inviscid/viscous coupling consistently provides improved predictions of leading edge separation, vortex bursting and secondary vortex formation at relatively low computational cost. Results for several cases are compared with wind tunnel tests and other Euler and Navier-Stokes solutions. Author

A92-49515
THE SIMULATION OF INVISCID, COMPRESSIBLE FLOWS USING AN UPWIND KINETIC METHOD ON UNSTRUCTURED GRIDS
J. S. MATHUR and N. P. WEATHERILL (Swansea, University College, Wales) International Journal for Numerical Methods in Fluids (ISSN 0271-2091), vol. 15, no. 1, July 15, 1992, p. 59-82. Research supported by Ministry of Defence Procurement Executive. refs
Copyright

A kinetic flux-vector-splitting method has been used to solve the Euler equations for inviscid, compressible flow on unstructured grids. This method is derived from the Boltzmann equation and is an upwind, cell-centered, finite volume scheme with an explicit time-stepping procedure. The Delaunay triangulation has been used to generate the grids. The approach is demonstrated for three flowfield simulations, namely the subsonic flow over a two-component high-lift-aerofoil, the transonic flow over an aerofoil and the supersonic flow in a channel. Author

A92-49556
DESIGN AND OPTIMIZATION OF AIRFOILS IN NON-STALLING INCOMPRESSIBLE FLOW WITH A PRESCRIBED RANGE OF THE ANGLE OF ATTACK
A. M. ELIZAROV and D. A. FOKIN (Kazan State University, Russia) International Journal for Numerical Methods in Engineering (ISSN 0029-5981), vol. 35, no. 1, July 30, 1992, p. 121-132. refs
Copyright

A simple and reliable method of aerodynamic design of airfoils is proposed for a given range of the angle of attack. The method is based on the solution of a new inverse boundary-value problem of aerohydrodynamics. In the problem the initial velocity distributions are given along the contour of the required airfoil as a function of the arc coordinate for extreme values of the angle of attack from a fixed range. A method of choice of these distributions is justified which guarantees a nonstalling flow around the airfoil. The problem of airfoil optimization is also considered. Results of numerical calculations are presented. Author

A92-49832
APPLICATION OF SUBMERGED VORTEX GENERATORS FOR SEPARATION CONTROL OF A SUBSONIC DIFFUSER
XIAO CHEN and PING JIANG (Nanjing Aeronautical Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 3, July 1992, p. 226-228. In Chinese. refs

The effects of the main geometrical parameters of the submerged vortex generators on diffuser performance are analyzed. A combination of corotating and counter-rotating vortex generators was used in the study. In the center part of the channel, four pairs of counter-rotating vortex generators were used to eliminate the flow separation. At the two corners, two corotating vortex generator blades and one pair of counter-rotating blades were used respectively to improve the three-dimensional separation flow fields in these corner regions. The experimental results show that the static pressure recovery coefficient is enhanced remarkably and the total pressure loss is also reduced, if the geometrical parameters and the location of the vortex generators are selected properly. A comparative study between the submerged vortex generators of concave shape and the conventional vane-type vortex generators is also presented. Both of them have almost the same efficiency for separation control, but the parasitic drag of the former is less due to its submergence in the boundary layer; and it is convenient for practical application because its distance to the separation starting point on the diverging wall of the generator is much shorter. Author

A92-50121
A REVIEW OF SCALE EFFECTS IN UNSTEADY AERODYNAMICS
D. G. MABEY (Imperial College of Science, Technology, and Medicine, London, England) Progress in Aerospace Sciences (ISSN 0376-0421), vol. 28, no. 4, 1991, p. 273-321. refs
Copyright

The importance of scale effects is recognized generally in steady aerodynamics but is often ignored in unsteady aerodynamics. An attempt is made to remedy this situation by the compilation of a review of information on the influence of Reynolds number from a wide range of unsteady aerodynamic tests, with particular reference to wing flows. The unsteady tests considered are buffet and buffeting, dynamic tests of airfoils and wings, pressure measurements, oscillatory control surface derivatives, and stability derivatives. The review suggests that for the usual recommended model conditions with fixed transition, scale effects are small for fully-attached or well-separated flows, but may be large close to incipient separation. With fixed transition extrapolation from model to full scale Reynolds numbers is usually possible. In contrast, with free transition scale effects can be large for both attached and separated flows. Much more research is needed into the magnitude of scale effects in unsteady flows at transonic speeds. Some test cases for the prediction of scale effects in unsteady aerodynamics are suggested. Author

A92-50210
THE INFLUENCES OF FORCED OSCILLATIONS TOWARD VORTEX-BREAKDOWN
YAN-QIU CHEN, ZHI-YONG LU, and CHUN-HIAN LEE (Beijing University of Aeronautics and Astronautics, People's Republic of China) Chinese Journal of Aeronautics (ISSN 1000-9361), vol. 4, no. 4, Nov. 1991, p. 327-332. refs
Copyright

Experimental results on the influences of oscillating leading edge vortex-flaps of triangular wings on vortex breakdown are presented in this paper. The results reveal that forced oscillations can delay the breakdown of concentrated vortices, and large reversed-flowregions which originally appear at the upper surface of the fixed wing at high angles of attack are suppressed to some extent, depending on the oscillation frequencies. As a consequence, the influences can be optimized by selecting proper oscillation frequenices. Author

A92-50211
A COMPLETE BOUNDARY INTEGRAL FORMULATION FOR STEADY COMPRESSIBLE INVISCID FLOWS GOVERNED BY NONLINEAR EQUATIONS
ZUO-SHENG YANG (Nanjing Aeronautical Institute, People's Republic of China) Chinese Journal of Aeronautics (ISSN 1000-9361), vol. 4, no. 4, Nov. 1991, p. 333-338. refs
Copyright

A complete boundary integral formulation for 2D and 3D steady compressible inviscid flows governed by nonlinear potential equations is established by using rho V as the dependent variable. The dimensionality of the problem to be solved is reduced by exactly one. C.D.

A92-50215
TRANSONIC FLOW CALCULATION OF EULER EQUATIONS BY IMPLICIT ITERATING SCHEME WITH FLUX SPLITTING
DAO-ZHI LIU and GE-CHENG ZHA (Beijing University of Aeronautics and Astronautics, People's Republic of China) Chinese Journal of Aeronautics (ISSN 1000-9361), vol. 4, no. 4, Nov. 1991, p. 361-368. Research supported by Aeronautics Science Foundation of the People's Republic of China. Previously cited in issue 08, p. 1193, Accession no. A91-22755. refs
Copyright

A92-50216
NUMERICAL INVESTIGATION OF AXIAL FLOW COMPRESSOR CASING TREATMENT
PING ZHUANG (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China), YA-JUN LU, and JI-YA CUI (Beijing University of Aeronautics and Astronautics, People's Republic of China) Chinese Journal of Aeronautics (ISSN 1000-9361), vol. 4, no. 4, Nov. 1991, p. 369-379. refs
Copyright

An inviscid model with an inlet total pressure gradient and a Denton scheme are used to calculate the 3D flow in a compressor with a slotted casing. Spatial analytical geometry is used to derive the general tangency with body surface relations. A reverse distribution scheme for Denton's parameter distribution method is proposed which is compatible with fluid particle propagation along flow characteristics in hyperbolic equations. The results indicate that the stability problem of the hyperbolic equation finite difference scheme should obey the rule of message propagation along flow characteristics. The results are in good agreement with experimental findings. C.D.

A92-50233
THE EFFECT OF ATMOSPHERIC TURBULENCE ON THE EXTERNAL STORE SEPARATION FROM AN AIRCRAFT
ZHEN-YAN ZHAO and DONG-LI MA (Beijing University of Aeronautics and Astronautics, People's Republic of China) Chinese Journal of Aeronautics (ISSN 1000-9361), vol. 5, no. 2, May 1992, p. 69-82. refs
Copyright

The equations of motion for both aircraft and external store in atmospheric turbulence are established in this paper. The calculating method of aerodynamic forces and moments acting on an external store in consideration of the aircraft interference aerodynamic field is described. The method of calculating the external store trajectories relative to the aircraft and the method of determining the separation safety after the release of external stores are presented. Taking the separation of an empty auxiliary fuel tank under the fuselage of a fighter as an example, the separation safety of this external store in atmospheric turbulence field is investigated. Author

A92-50269
EFFECTS OF VORTEX GENERATORS ON THE GROWTH OF A COMPRESSIBLE SHEAR LAYER
D. S. DOLLING, E. FOURNIER, and Y. R. SHAU (Texas, University, Austin) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, no. 5, Sept.-Oct. 1992, p. 1049-1056. refs
(Contract N00014-89-J-1221)
(AIAA PAPER 90-1979) Copyright

An experimental study is made of the effects of initial conditions on the growth rate of a high Reynolds number compressible turbulent-shear layer bounded by Mach 5 and Mach 3 airstreams. The shear layer was generated by the turbulent boundary layer leaving the trailing edge of a thick flat plate with an internal 2D Mach 3 nozzle. The objective of the study was to determine if the shear-layer growth rate could be increased by placing cylindrical and wedge-shaped vortex generators in the turbulent boundary layer upstream of the shear-layer origin. Mean pitot pressure surveys were made in the initial boundary layer and in the shear layer at several streamwise stations using a rake with seven tips oriented spanwise. Shear-layer growth rate can be increased by about 20 percent using cylindrical vortex generator arrangements, whereas with wedge-shaped arrangements the growth rate is unaffected or even reduced. Author

A92-50272
FULL NAVIER-STOKES ANALYSIS OF A THREE-DIMENSIONAL SCRAMJET INLET
YEU-CHUAN HSIA, ENDWELL O. DASO, and VIDYA A. PADHYE (Rockwell International Corp., Rocketdyne Div., Canoga Park, CA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, no. 5, Sept.-Oct. 1992, p. 1071-1078. Previously cited in issue 06, p. 795, Accession no. A91-19152. refs
(Contract F33657-87-C-2214)
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A92-50273* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
APPLICATION OF AN UNSTEADY NAVIER-STOKES SOLVER TO TRANSONIC TURBINE DESIGN
AKIL A. RANGWALLA, NATERI K. MADAVAN (NASA, Ames Research Center, Moffett Field, CA), and PAUL D. JOHNSON (Pratt & Whitney Group, West Palm Beach, FL) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, no. 5, Sept.-Oct. 1992, p. 1079-1086. Research supported by NASA. Previously cited in issue 18, p. 3061, Accession no. A91-44254. refs
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A92-50293
TRANSONIC FLOWS OF BETHE-ZEL'DOVICH-THOMPSON FLUIDS
M. S. CRAMER (Virginia Polytechnic Institute and State University, Blacksburg) and G. M. TARKENTON (Texas, University, Austin) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 240, July 1992, p. 197-228. refs
(Contract NSF CTS-89-13198)
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The steady transonic flow of Bethe-Zel'dovich-Thompson fluids over two-dimensional thin wings and turbine blades is examined. The free-stream state is taken to be in the neighborhood of one of the zeros of the fundamental derivative. It is shown that a modified form of the classical transonic small-disturbance equation governs such flows. Critical Mach number estimates are provided which take into account the nonmonotone variation of the Mach number with pressure predicted in previous investigations. Critical Mach numbers well over 0.95 are predicted for conventional airfoil sections. Numerical solutions reveal substantial reductions in the strength of the compression shocks occurring in supercritical flows. Author

A92-50301
EFFECTS OF A LEADING-EDGE FILLET ON THE FLOW PAST AN APPENDAGE-BODY JUNCTION
WILLIAM J. DEVENPORT, ROGER L. SIMPSON, MICHAEL B. DEWITZ, and NAVAL K. AGARWAL (Virginia Polytechnic Institute and State University, Blacksburg) AIAA Journal (ISSN 0001-1452), vol. 30, no. 9, Sept. 1992, p. 2177-2183. Previously cited in issue 06, p. 797, Accession no. A91-19202. refs
(Contract N00014-88-C-0291)
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A92-50302
LOWER UPPER IMPLICIT TOTAL VARIATION DIMINISHING SOLUTION OF VISCOUS HYPERSONIC FLOWS
F. GRASSO and M. MARINI (Roma I, Universita, Rome, Italy) AIAA Journal (ISSN 0001-1452), vol. 30, no. 9, Sept. 1992, p. 2184, 2185. Abridged. Previously cited in issue 17, p. 2849, Accession no. A91-40747. refs
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A92-50303
EFFECT OF WING TIP VORTICES ON A TRAILING AIRCRAFT
IBRAHIM OLWI and MOHAMMAD GHAZI (King Abdulaziz University, Jeddah, Saudi Arabia) AIAA Journal (ISSN 0001-1452), vol. 30, no. 9, Sept. 1992, p. 2186, 2187. Abridged. Research supported by King Abdulaziz University. Previously cited in issue 23, p. 4004, Accession no. A91-53800. refs
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A92-50304 National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EXPLORATORY STUDY OF WALL PRESSURE FLUCTUATIONS IN A MACH 5, SHARP FIN-INDUCED TURBULENT INTERACTION
BERRY T. GIBSON and DAVID S. DOLLING (Texas, University, Austin) AIAA Journal (ISSN 0001-1452), vol. 30, no. 9, Sept. 1992, p. 2188-2195. Research supported by University of Texas, USAF, and U.S. Navy. Previously cited in issue 07, p. 974, Accession no. A91-21576. refs
(Contract NAG1-1005; NAGW-964)
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A92-50307* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CROSSFLOW VORTEX AND TRANSITION MEASUREMENTS BY USE OF MULTIELEMENT HOT FILMS
NAVAL K. AGARWAL (Analytical Services and Materials, Inc., Hampton, VA), DAL V. MADDALON (NASA, Langley Research Center, Hampton, VA), SIVA M. MANGALAM (Analytical Services and Materials, Inc., Hampton, VA), and FAYETTE S. COLLIER, JR. (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 30, no. 9, Sept. 1992, p. 2212-2218. Previously cited in issue 07, p. 970, Accession no. A91-21389. refs
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A92-50309* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
APPLICATION OF A SOLUTION ADAPTIVE GRID SCHEME TO COMPLEX THREE-DIMENSIONAL FLOWS
CAROL B. DAVIES (Sterling Software, Inc., Palo Alto; NASA, Ames Research Center, Moffett Field, CA) and ETHIRAJ VENKATAPATHY (Eloret Institute, Sunnyvale; NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 30, no. 9, Sept. 1992, p. 2227-2233. Previously cited in issue 17, p. 2850, Accession no. A91-40768. refs
(Contract NCC2-420)
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A92-50310* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MIXING STUDIES OF HELIUM IN AIR AT HIGH SUPERSONIC SPEEDS
E. J. FULLER, R. B. MAYS, R. H. THOMAS, and J. A. SCHETZ (Virginia Polytechnic Institute and State University, Blacksburg) AIAA Journal (ISSN 0001-1452), vol. 30, no. 9, Sept. 1992, p. 2234-2243. Research supported by NASA. Previously cited in issue 17, p. 2854, Accession no. A91-41739. refs
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A92-50312
PHYSICAL MODEL OF THE SWEPT SHOCK WAVE/BOUNDARY-LAYER INTERACTION FLOWFIELD
F. S. ALVI and G. S. SETTLES (Pennsylvania State University, University Park) AIAA Journal (ISSN 0001-1452), vol. 30, no. 9, Sept. 1992, p. 2252-2258. Previously cited in issue 17, p. 2859, Accession no. A91-42582. refs
(Contract AF-AFOSR-89-0315)
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A92-50313* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FOURIER FUNCTIONAL ANALYSIS FOR UNSTEADY AERODYNAMIC MODELING
SUEI CHIN and C. E. LAN (Kansas, University, Lawrence) AIAA Journal (ISSN 0001-1452), vol. 30, no. 9, Sept. 1992, p. 2259-2266. Previously cited in issue 20, p. 3408, Accession no. A91-47170. refs
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A92-50314* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ASYMMETRIC TURBULENT VORTICAL FLOWS OVER SLENDER BODIES
DAVID DEGANI (Technion - Israel Institute of Technology, Haifa) and YUVAL LEVY (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 30, no. 9, Sept. 1992, p. 2267-2273. Previously cited in issue 23, p. 4004, Accession no. A91-53793. refs
(Contract NCA2-578)
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A92-50322
THREE-DIMENSIONAL WINGS AND WAVERIDERS WITH ATTACHED SHOCK WAVES
HAMDI T. HEMDAN (King Saud University, Riyadh, Saudi Arabia) AIAA Journal (ISSN 0001-1452), vol. 30, no. 9, Sept. 1992, p. 2332-2334. refs
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At the off-design point, with waveriders using the stream surfaces of other flowfields, the shock wave will separate from the leading edge, thereby reducing the lifting force, and the 3D flowfield will not be mathematically tractable. The use of Messiter's thin shock layer theory that eliminates this drawback, through direct study of flow past 3D bodies with attached shock waves is demonstrated. R.E.P.

A92-50325
COMPARISON OF TRANSONIC FLOW MODELS
KEVIN MCGRATTAN (New York University, NY) AIAA Journal (ISSN 0001-1452), vol. 30, no. 9, Sept. 1992, p. 2340-2343. refs
(Contract NSF DMS-90-0024; NSF DMS-89-22805; AF-AFOSR-91-0042; DE-FG02-88ER-25053)
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For the past 10 years there has been much discussion of the relative merits of the potential and the Euler formulations of the equations of motion of transonic flow over supercritical wing sections. To study the two models in a common framework, a finite difference version of the Euler solver is incorporated into the potential code described by Bauer et al. (1975). This paper highlights some of the more pertinent discoveries of the study. R.E.P.

A92-50327
INDUCED DRAG OF A WING IN A CIRCULAR WIND TUNNEL
YUZO YAMAMOTO (Gifu National College of Technology, Motosu, Japan) AIAA Journal (ISSN 0001-1452), vol. 30, no. 9, Sept. 1992, p. 2344-2346. refs
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The closed forms of both the minimum induced drag and the spanwise optimum lift distribution in the closed tunnel case are obtained. Open-tunnel case explicit expressions of both the minimum induced drag and the spanwise optimum lift distribution are obtained. R.E.P.

A92-50473 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
TIME DOMAIN NUMERICAL CALCULATIONS OF UNSTEADY VORTICAL FLOWS ABOUT A FLAT PLATE AIRFOIL
S. I. HARIHARAN, YU PING (Akron, University, OH), and J. R. SCOTT (NASA, Lewis Research Center, Cleveland, OH) Journal of Computational Physics (ISSN 0021-9991), vol. 101, no. 2, Aug. 1992, p. 419-430. Research supported by Ohio Supercomputer Center. refs
(Contract RTOP 505-62-21)
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A time domain numerical scheme is developed to solve for the unsteady flow about a flat plate airfoil due to imposed upstream, small amplitude, transverse velocity perturbations. The governing equation for the resulting unsteady potential is a homogeneous, constant coefficient, convective wave equation. Accurate solution of the problem requires the development of approximate boundary conditions which correctly model the physics of the unsteady flow in the far field. A uniformly valid far field boundary condition is developed, and numerical results are presented using this condition. The stability of the scheme is discussed, and the stability restriction for the scheme is established as a function of the Mach number. Finally, comparisons are made with the frequency domain calculation by Scott and Atassi, and the relative strengths and weaknesses of each approach are assessed. Author

A92-51593
THREE-DIMENSIONAL RELAXATION EFFECT ON QUASI-3D FLOW IN A BLADE ROW WITH SPANWISE LOADING DISTRIBUTION
TAE W. KIM, MASATO FURUKAWA, MASAHIRO INOUE (Kyushu University, Fukuoka, Japan), KUZUTO SASAKI, and SUMIO YAMAGUCHI (Fukuoka University, Japan) Kyushu University, Faculty of Engineering, Memoirs (ISSN 0023-6160), vol. 52, no. 1, March 1992, p. 117-129. refs
This paper presents a quasi-3D flow calculation method including the 3D flow relaxation effect in turbomachinery. A meridional flow solution is obtained by a streamline curvature method with an equilibrium equation formulated by exactly averaging the equation of continuity, momentum, and energy equation in the circumferential direction. To verify the validity of the method, it is applied to the flow analysis of a diagonal flow fan designed under a vortex type of constant circumferential velocity. The comparison of the calculated results with the experimental data shows a good agreement except in the region where the flow field is affected by the tip leakage flow. Author

A92-51896
A STUDY OF SUPERSONIC FLOW OVER THE OGIVAL BODIES WITH ATTACHED SHOCK WAVES AT ZERO INCIDENCE
N. S. TOMESCU (Polytechnic Institute, Bucharest, Romania) Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee (ISSN 0035-4074), vol. 37, no. 1, Jan.-Feb. 1992, p. 59-74. refs
A method for linearizing the equations of motion is proposed in order to obtain an analytical expression for the velocity and pressure distributions in supersonic flow over ogival bodies with attached waves at zero incidence. The proposed method is based on the fact that the motion behind the shock wave attached to the sharp tip of the body differs slightly from the flow around a cone coincident with that tangent to the body at its apex; this is the basic flow. Unitary analytical solutions applicable to both supersonic and hypersonic flow regimes are obtained. L.M.

A92-51943
ON THE APPLICATION OF PARABOLIZED NAVIER-STOKES EQUATIONS TO FLOW FIELD SIMULATIONS
V. SWAMINATHAN and N. S. MADHAVAN (ISRO, Vikram Sarabhai Space Centre, Trivandrum, India) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 43, no. 4, Nov. 1991, p. 293-305. refs
The paper reviews the effectiveness of parabolized Navier-Stokes (PNS) equations for simulating flowfields for use in the design of aerospace vehicles. PNS equations for axisymmetric flows and 2D flows with high Mach numbers are discussed, and a space-march integration is conducted with MacCormack's (1969) implicit predictor-corrector space-marching algorithm extended for the special cases. Specific flow analyses are undertaken for: (1) supersonic laminar flow over a body of revolution; (2) axisymmetric shock wave-boundary layer interaction; and (3) compression corner flows. The PNS equations are shown to be particularly effective in the solutions for the high supersonic and hypersonic flow regimes. Computation varies directly with Mach number with the PNS method, but the results show an order of magnitude reduction over other methods. C.C.S.

A92-52028
A DIRECT VISCOUS-INVISCID INTERACTION METHOD FOR THE FLOW CALCULATION AROUND AIRFOILS
V. MUSAT (Applied Mathematics Institute, Bucharest, Romania) Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee (ISSN 0035-4074), vol. 37, no. 3, May-June 1992, p. 275-287. refs
A direct viscous-inviscid interaction method is presented together with results obtained for flows around three different airfoils as a function of the angle of attack. The method, comprising a simple inviscid flow method and an integral method for viscous flow, takes the wake effect into account. The results obtained with this method agree well with those obtained with other methods and with experiments, for angles up to separation. L.M.

A92-52029
NON-SLENDER SHAPES OF MINIMUM DRAG
M. SINGH and J. S. AHUJA (Defence Science Centre, Delhi, India) Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee (ISSN 0035-4074), vol. 37, no. 3, May-June 1992, p. 289-299. refs

The problem of determining the geometry of a nonslender axisymmetric missile of minimum drag has been solved using the conjugate gradient method under the assumption that the angle of attack is zero and the flow is Newtonian. This method has been used to obtain minimum-drag nonslender shapes for three cases: (1) when the diameter and length are specified, (2) when the surface area and length are specified, and (3) when the surface area and diameter are specified. L.M.

A92-52034
AN AERODYNAMICAL ANALYSIS OF 'SEESAW' TYPE ROTOR FOR AUTOGYRO
D. MIRICA (Aviation Institute, Bucharest, Romania) Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee (ISSN 0035-4074), vol. 37, no. 2, Mar.-Apr. 1992, p. 187-202. refs

An aerodynamic analysis of an autogyro rotor having a seesaw-type flapping hinge is presented, with particular attention given to the calculation of the overall rotor-aerodynamic characteristics. Calculation results are compared with those obtained previously concerning a three-blade rotor having independent flapping and a three-blade rotor fitted with a variation device for a spider-type blade incidence. L.M.

A92-52035
METHOD OF LARGE PARTICLES IN ARBITRARY CURVILINEAR ORTHOGONAL COORDINATES FOR THE SOLUTION OF PROBLEMS OF HYDRO AND AERODYNAMICS [METOD KRUPNYKH CHASTITS V PROIZVOL'NYKH KRIVOLINEINYKH ORTOGONAL'NYKH KOORDINATAKH DLIA RESHENIIA ZADACH GIDROAERODINAMIKI]
A. P. SMIRNOV and V. P. SHIDLOVSKII (Rossiiskaia Akademiia Nauk, Vychislitel'nyi Tsentr, Moscow, Russia) Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee (ISSN 0035-4074), vol. 37, no. 2, Mar.-Apr. 1992, p. 203-211. In Russian. refs

The method of large particles in curvilinear coordinates is used to calculate the parameters of flow around a body whose surface boundary does not coincide with the computational grid. The method of differential approximations is used to study viscosity effects of the difference schemes that are obtained. L.M.

A92-52682 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A GENERAL EXPLICIT OR SEMI-EXPLICIT ALGORITHM FOR COMPRESSIBLE AND INCOMPRESSIBLE FLOWS
O. C. ZIENKIEWICZ and J. WU (Swansea, University College, United Kingdom) International Journal for Numerical Methods in Engineering (ISSN 0029-5981), vol. 35, no. 3, Aug. 30, 1992, p. 457-479. Research supported by NASA. refs
(Contract NAGW-2127)
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A unified finite element algorithm is developed which is applicable to a wide range of problems of fluid mechanics without recourse to artificial, empirically determined factors. In its explicit form, the algorithm is similar to the Taylor-Galerkin scheme and is easily adopted to standard codes. The scheme proposed here possesses sufficient natural balancing diffusion and thus reduces and sometimes eliminates the need for special 'shock capturing' diffusion. The efficiency of the algorithm is demonstrated using several examples ranging from incompressible through transonic regions to supersonic flows. V.L.

A92-52726
FLOW OF A RAREFIED GAS PAST A TWO-DIMENSIONAL BODY OF AN ARBITRARY SHAPE AT SMALL MACH NUMBERS
KYOJI YAMAMOTO and TAKUJI SANRYO (Okayama University, Japan) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 255-262. refs
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This paper is concerned with a method of analysis of a rarefied gas flow past a two-dimensional body of an arbitrary shape when the rarefaction is not too high and when the Mach number is small. The main flow around the body is treated by the Oseen-Stokes equation, while the flow in the kinetic region adjacent to the body surface whose thickness is of the order of the mean free path is analyzed by the linearized BGK equation. Both solutions are matched at the outer edge of the kinetic region. As an example of the present analysis, the flows past a circular and an elliptic cylinder are considered. Author

A92-52730* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
KINETIC THEORY MODEL FOR THE FLOW OF A SIMPLE GAS FROM A THREE-DIMENSIONAL AXISYMMETRIC NOZZLE
B. R. RILEY (Evansville, University, IN) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 291-298. refs
(Contract NAG3-746)
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A system of nonlinear integral equations equivalent to the Krook kinetic equations for the steady state is the mathematical basis used to develop a computer code to model the flowfields for low-thrust three-dimensional axisymmetric nozzles. The method of characteristics is used to solve numerically by an iteration process the approximated Boltzmann equation for the number density, temperature, and velocity profiles of a simple gas as it expands into a vacuum. Results predict backscatter and show the effect of the nozzle wall boundary layer on the external flowfields. Author

A92-52734
HYPERSONIC FLOW CALCULATIONS AROUND A 3D DELTA WING AT LOW KNUDSEN NUMBERS
F. GROPENGIESSER, H. NEUNZERT, J. STRUCKMEIER, and B. WIESEN (Kaiserslautern, Universitaet, Germany) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 332-336. refs
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This paper presents numerical results for hypersonic flows around a 3D delta-wing at low Knudsen numbers (i.e., near the continuum regime). The underlying body geometry corresponds to one of the test cases on rarefied gas regime proposed for the workshop on hypersonic flow, which was held in Antibes (France), January 1990. The numerical method used in the calculations is the so-called finite-pointset-method (FPM) developed at the university of Kaiserslautern during the last year. The paper shows that the FPM is an efficient alternative method beside the well-known Monte-Carlo-methods. Author

A92-52748
HEAT TRANSFER TO A DELTA WING AND TWO WAVERIDER WINGS IN RAREFIED HYPERSONIC FLOW
E. M. GALLOWAY, M. R. GILMORE, R. W. JEFFERY, and J. K. HARVEY (Imperial College of Science, Technology, and Medicine, London, United Kingdom) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 505-513. Sponsorship: Ministry of Defence of United Kingdom. refs
(Contract MOD-AT/2037/331)
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This paper presents data on the heat transfer to a family of wings of the same planform. The flow conditions fall within the hypersonic rarefied regime. The 'off design' high altitude performance of the waverider wings is thus being examined in

comparison with the delta. Wind tunnel measurements for the compression side of the wings are presented and, for the case of the 5 deg waverider, comparisons are made with 3D DSMC computations. The agreement is good. Computed results for the leeward surface heat transfer and for the overall force coefficients are also presented. Author

A92-52749
THERMAL AND CHEMICAL NONEQUILIBRIUM VISCOUS SHOCK LAYER FLOWS OVER A BLUNT BODY AT HIGH ALTITUDES
MICHIO NISHIDA and YOSHITAKA SAKAMURA (Kyushu University, Fukuoka, Japan) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 514-521. refs
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Numerical studies of hypersonic flows with thermal and chemical nonequilibrium around a blunt body have been conducted related to reentry at high altitudes. A two-temperature model of translational-rotational and vibrational temperatures was employed and nonequilibrium air chemistry was considered. The analysis was performed using axisymmetric viscous shock layer equations for multicomponent gas mixture. The effect of the profile of vibrational temperature on the flowfield was investigated for four different wall conditions for vibrations temperature. The result indicates that the translational temperature profile is not significantly dependent on such wall condition. The vibrational temperature profiles for four wall conditions are almost the same except for in the vicinity of the wall. The wall temperature obtained from the radiative equilibrium condition is much influenced by surface catalysis rather than the wall condition for the vibrational temperature. Author

A92-52750
INFLUENCE OF ATMOSPHERIC RAREFACTION ON AERODYNAMIC CHARACTERISTICS OF FLYING VEHICLES
S. G. ANTONOV, M. S. IVANOV, A. V. KASHKOVSKII (Russian Academy of Sciences, Institute of Theoretical and Applied Mechanics, Novosibirsk, Russia), and V. G. CHISTOLINOV (NPO Molniia, Moscow, Russia) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 522-530. refs
Copyright

The effect of atmospheric rarefaction on the movements of a spacecraft was investigated by studying the aerodynamic characteristics of a flying vehicle with the lifting body of the 'Himes' type, in the orbital and the reentry sections, using the approximate 'local interaction' method. Also examined was the efficiency of aerodynamic controls for the flying vehicle trimming at flight in the upper atmosphere. Results show that the approximate 'local interaction' method can correctly estimate the aerodynamic forces on a complex-shape flying vehicle. The study of the control effects showed that the displacement of the pressure center forward with the decrease of the flight height (increase of Re0) can be compensated for by the elevon deviation. I.S.

A92-52751
ONE-DIMENSIONAL KINETIC MODEL FOR FLOWS NEAR A STAGNATION POINT OF A HIGHLY COOLED BODY IN HYPERSONIC RAREFIED STREAMS
EVGENII SHAKHOV (Russian Academy of Sciences, Computing Center, Moscow, Russia) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 531-538. refs
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In the paper a quasi-1D kinetic model for the boundary Knudsen layer is proposed. The approximation is based on the assumption that the distribution function in the derivatives along the tangent to the body can be replaced by the local Maxwellian one. In this approximation the parabolized Navier-Stokes equations are obtained from the kinetic equation. The main attention is paid to the problem on flow and heat transfer at the front stagnation point. This problem is solved using a model kinetic equation in the approximation above. The obtained numerical results are compared with available data. Author

A92-52752
INFLUENCE OF INTERNAL MOLECULAR DEGREES OF FREEDOM ON THE HYPERSONIC RAREFIED GAS FLOW ABOUT A CONICAL BODY
I. N. LARINA and V. A. RYKOV (Russian Academy of Sciences, Computing Center, Moscow, Russia) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 539-545. refs
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The numerical method for calculating a hypersonic 3D flow past a cold conical body is proposed. The method is based on the solution of model kinetic equations. To study the flow of the diatomic gas the kinetic model equations with regard for rotation DOF are used. Author

A92-52753
RAREFIED GAS FLOW AROUND A DISC WITH DIFFERENT ANGLES OF ATTACK
F. GROPENGIESSER, H. NEUNZERT, J. STRUCKMEIER, and B. WIESEN (Kaiserslautern, Universitaet, Germany) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 546-553. refs
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This paper presents a comparison between measurements from a windtunnel and calculations performed by the Finite-Point-set-Method (FPM) for solving the Boltzmann equation. The case considered is the flow around a circular disk at different angles of attack. The comparison covers the whole range of Knudsen numbers from nearly continuum flow to nearly free molecular flow. The dependence of the aerodynamic coefficients on different gas-surface interaction models, especially the Maxwell-model with an accomodation models, especially the Maxwell-model with an accommodation coefficient, is also investigated. Author

A92-52754
APPROXIMATE AERODYNAMIC ANALYSIS FOR COMPLICATED BODIES IN RAREFIED GAS FLOWS
V. D. PERMINOV, S. L. GORELOV, O. G. FRIDLENDER, and A. A. KHMEL'NITSKII (Central Aero-Hydrodynamics Institute, Zhukovski, Russia) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 554-561. refs
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In this paper the old and new numerical methods of aerodynamical coefficients determination in free molecular hypersonic flow are reviewed. Based on correlation of available numerical and experimental data the procedures for estimating drag, lift and pitch moment coefficients of three-dimensional bodies in the hypersonic transitional flow regime are presented. Author

A92-52755
EXPERIMENTS ON SEPARATION AT A COMPRESSION CORNER IN RAREFIED HYPERSONIC FLOWS
CH.-H. CHUN (DLR, Institut fuer Experimentelle Stroemungsmechanik, Goettingen, Germany) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 562-569. Research supported by AMDBA. refs
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The shock/boundary layer interaction and flow separation induced by a 2-dimensional compression corner is studied by flow

visualizations in the merged-layer flow regime of low-density hypersonic flow. Flow visualizations are carried out by means of gas glow discharge and oil flow picture. Author

A92-52757* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
HYPERSONIC MERGED LAYER BLUNT BODY FLOWS WITH WAKES
AMOLAK C. JAIN (Remtech, Inc., Huntsville, AL) and WERNER K. DAHM (NASA, Marshall Space Flight Center, Huntsville, AL) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 578-587. refs
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An attempt is made here to understand the basic physics of the flowfield with wake on a blunt body of revolution under hypersonic rarefied conditions. A merged layer model of flow is envisioned. Full steady-state Navier-Stokes equations in spherical polar coordinate system are computed from the surface with slip and temperature jump conditions to the free stream by the Accelerated Successive Replacement method of numerical integration. Analysis is developed for bodies of arbitrary shape, but actual computations have been carried out for a sphere and sphere-cone body. Particular attention is paid to set the limit of the onset of separation, wake closure, shear-layer impingement, formation and dissipation of the shocks in the flowfield. Validity of the results is established by comparing the present results for sphere with the corresponding results of the SOFIA code in the common region of their validity and with the experimental data. Author

A92-52761* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ENHANCEMENTS AND APPLICATIONS OF DSMC FOR HYPERSONIC RAREFIED FLOWS
JAMES N. MOSS (NASA, Langley Research Center, Hampton, VA) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 643-654. refs
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A review of the direct simulation Monte Carlo (DSMC) method of Bird is presented. The DSMC method provides the capability of simulating real gas flows in the rarefied flow regime. Recent developments and applications of the method for hypersonic flows are reported for both ground-based tests and during entry. The flows considered were three-dimensional, and both an existing general code and a new code under development were used. Author

A92-52764
FORCE AND HEAT TRANSFER ON A DISC IN RAREFIED FLOW
H. LEGGE (DLR, Institut fuer Experimentelle Stroemungsmechanik, Goettingen, Germany), K. NANBU, and S. IGARASHI (Tohoku University, Katahira, Japan) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 679-686. Research supported by AMDBA. refs
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Force and heat transfer measurements on a disk at angles of attack 45, 60, 75, and 90 deg in the hypersonic transition flow regime are compared to results of the Direct Simulation Monte Carlo Method. Good agreement was obtained for argon with complete accommodation and helium assuming a mixture of complete accommodation and diffuse elastic reflection with an energy accommodation coefficient 0.6. Author

A92-52766
DIRECT SIMULATION OF VORTEX SHEDDING IN DILUTE GAS FLOWS PAST BLUFF BODIES
KATSUHISA KOURA (National Aerospace Laboratory, Chofu, Japan) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 695-702. refs
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The vortex shedding in dilute gas flows past the bluff bodies of a normal flat plate and a circular cylinder is studied using the null-collision direct-simulation Monte Carlo method for the M(infinity) = 0.7 and Kn(infinity) = 1/60 and 1/200, for which the Reynolds number, Re(infinity) = 69.2 and 231, respectively. When a bluff body is instantaneously inserted in the free stream without any artificial velocity perturbation, a symmetric flow pattern with a pair of contrarotating vortices is obtained and no vortex shedding occurs. Introducing a temporary (sufficiently large) perturbation into the flow velocity generates the vortex shedding for Re(infinity) = 231 but no vortex shedding for Re(infinity) = 69.2. The Strouhal number evaluated from the vortex generation at Re(infinity) = 231 is about 0.25 and 0.2 for a normal flat plate and a circular cylinder, respectively. Author

A92-52767
AERODYNAMICS OF COMPLEX SHAPE BODIES WITHIN A WIDE RANGE OF SUPERSONIC FLOWS OF RAREFIED GASES
M. S. IVANOV (Russian Academy of Sciences, Institute of Theoretical and Applied Mechanics, Novosibirsk, Russia), V. M. KOTOV, A. N. KRYLOV, A. G. RESHETIN, and A. M. SHELKONOGOV (NPO Energiia, Kaliningrad, Russia) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 703-708. refs
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Computational results are presented of spacecraft and space station of a complex shape obtained by the approximate 'local interaction' method and the direct simulation Monte Carlo method within a wide range of flight heights. The comparison of computational data with flight experiment is made. Author

A92-52770
MONTE CARLO SIMULATION OF THE HYPERSONIC MON- AND DIATOMIC GAS FLOW PAST A DISK AT AN ANGLE OF ATTACK
FRANK BERGEMANN (DLR, Institut fuer Theoretische Stroemungsmechanik, Goettingen, Germany) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 737-744. refs
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The 3D hypersonic flow past a disk at an angle of attack is investigated for mon- and diatomic gases by the direct simulation Monte Carlo (DSMC) method. Hard sphere molecules, diffuse reflection and, for the diatomic gas, the Larsen-Borgnakke model are assumed. The drag, lift and heat transfer coefficients and in the monatomic case the recovery temperature for Knudsen numbers Kn = 0.05-infinity are presented and compared with experimental data for argon and nitrogen from Legge. For the monatomic case the values of a previous DSMC simulation by Nanbu are also given for comparison. Generally there is good agreement between DSMC simulations and the experimental results. In the diatomic case force and heat transfer coefficients agree with the experimental data as good as in the monatomic case. Furthermore in the diatomic gas flow at an angle of attack of 90 deg, significant nonequilibrium of the translational and the rotational temperature is observed on the stagnation streamline. Author

A92-52772
DSMC SIMULATION OF HYPERSONIC FLOWS PAST 2-DIMENSIONAL BODIES
MICHIRU YASUHARA, YOSHIAKI NAKAMURA, and JUNICHI TANAKA (Nagoya University, Japan) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen,

Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 755-762. refs
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Two-dimensional flows about three body shapes (a flat plate with sharp leading edge, a cylinder, and a blunt wedge) are simulated using the direct simulation Monte Carlo (DSMC) method, and several acrodynamic coefficients, including Cf, Cp, and the Reynolds analogy factor Cf/2C(ll) are calculated on the body surfaces. The investigation of the effect of accommodating the rotational energy at the wall on the flow in the case of flat plate showed that, while the Cf is not affected by the rotational energy accommodation, the Cp depends on it. Along a cold wall, the value of Cf/2(ll) became constant, while at a hot wall the value of Cf/2C(ll) increased with the distance from the leading edge. Calculation of the drag coefficient for the cylinder showed that the drag coefficient is almost independent on the mass temperature but increases with the Knudsen number. I.S.

A92-52775* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
APPLICATION OF THE DSMC METHOD TO HYPERSONIC FLOW ABOUT A DELTA WING
M. C. CELENLIGIL (Vigyan Research Associates, Inc., Hampton, VA) and JAMES N. MOSS (NASA, Langley Research Center, Hampton, VA) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 778-783. refs
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The direct simulation Monte Carlo method was applied to a hypersonic rarefied flow about a delta wing at angle of incidence. Three-dimensional calculations were performed using a single-species gas model that accounts for energy exchange with the internal modes. Computed results were compared with the available experimental data obtained in a nitrogen wind-tunnel experiment. Discrepancies were shown to exist between the experimental and calculated results. These differences may be caused by the inadequately defined freestream conditions.
Author

A92-52777* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
MONTE CARLO STUDY OF VIBRATIONAL RELAXATION PROCESSES
IAIN D. BOYD (Eloret Institute, Palo Alto; NASA, Ames Research Center, Moffett Field, CA) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 792-799. refs
(Contract NCC2-582)
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A new model is proposed for the computation of vibrational nonequilibrium in the direct simulation Monte Carlo method (DSMC). This model permits level to level vibrational transitions for the first time in a Monte Carlo flowfield simulation. The model follows the Landau-Teller theory for a harmonic oscillator in which the rates of transition are related to an experimental correlation for the vibrational relaxation time. The usual method for simulating such processes in the DSMC technique applies a constant exchange probability to each collision and the vibrational energy is treated as a continuum. A comparison of these two methods is made for the flow of nitrogen over a wedge. Significant differences exist for the vibrational temperatures computed. These arise as a consequence of the incorrect application of a constant exchange probability in the old method. It is found that the numerical performances of the two vibrational relaxation models are equal.
Author

A92-52797
NUMERICAL AND EXPERIMENTAL INVESTIGATIONS OF RAREFIED GAS FLOWS THROUGH NOZZLES AND COMPOSITE SYSTEMS
A. K. SREEKANTH, ANIL PRASAD, and DILIP PRASAD (Indian Institute of Technology, Madras, India) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 987-994. Research supported by Ministry of Defence of India. refs
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The flow of a rarefied gas through a long radius ASME nozzle and an equivalent conical nozzle have been experimentally studied to determine their discharge coefficients as a function of the Reynolds number. The range of the Reynolds number based on the exit diameter and choked flow conditions varied from 0.3 to 3 x 10 exp 4. The equivalent Knudsen number range based on the upstream conditions and inlet diameter varied from 10 exp -5 to 2. Under free molecular flow conditions, the transmission probabilities for both nozzles have been determined using the test particle Monte Carlo method. The transmission probabilities of individual cylindrical tubes and a composite tube consisting of a sudden expansion and a sudden contraction have been determined under free molecular conditions. Experimental flow resistance factors for individual components and also for the composite system have been determined in the Knudsen number range of 5.0 to 10 exp -5 and comparison has been made with the relevant theory.
Author

A92-52818
AERODYNAMIC CHARACTERISTICS OF A STANDARD CORRUGATED BODY IN A FREE-MOLECULAR FLOW
IU. A. RYZHOV, S. B. SVIRCHEVSKII, K. N. KUZOVKIN, and A. V. ATAMANENKO (Moscow Aviation Institute, Russia) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 1442-1449. refs
Copyright

New numerical and experimental results are presented for aerodynamic characteristics of bodies wit conical cavities of periodic structure. A comparison analysis is made for test-bodies to measure the velocity head of a molecular flow.
Author

A92-52821
MEASUREMENT OF THE FREESTREAM DENSITY FOR RE-ENTRY VEHICLES - A DESIGN STUDY
T. J. BARTEL, B. F. BLACKWELL, and R. E. SHELDAHL (Sandia National Laboratories, Albuquerque, NM) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 1474-1481. refs
(Contract DE-AC04-76DP-00789)
Copyright

This work will present a design to obtain the freestream density for a re-entry vehicle in the altitude range from 60 to 120 km. The vehicle velocity will be approximately 7 km/s. An impact tube probe has been designed to be mounted on the nose of the vehible. DSMC simulations have been performed to obtain an inlet geometry which will yield a gauge measurement which is invariant to the gas/surface interaction. Therefore, surface accommodation coefficients do not have to be assumed. The vehicle velocity is the only additional parameter needed to determine the freestream density and can be obtained via ground-based radar. A proposed validation test in a ground based facility will also be discussed.
Author

A92-52844
SUPERSONIC FLOW PAST POINTED-NOSE THIN AIRFOILS
HAMDI T. HEMDAN and ABDULFATAH A. SELIM (King Saud University, Riyadh, Saudi Arabia) Acta Astronautica (ISSN 0094-5765), vol. 26, no. 5, May 1992, p. 317-323. refs
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Accurate results for steady inviscid supersonic flow past any pointed-nose thin airfoil at small angle of attack are obtained in this paper. Straightforward perturbation from some basic wedge flow is applied to a recently developed hypersonic theory with second-order terms in the longitudinal curvature included. The hypersonic equations are thus reduced to two systems of simple

linear ordinary differential equations for which polynomial solutions of the first and second degree are obtained. Further, the hypersonic theory is extended to include second-order effects on the basic wedge flow. This resulted in great increase in the accuracy of the results for curved airfoils besides, the range of validity of the theory extended to cover moderate supersonic speeds with quite reasonable accuracy. Author

A92-52848
THE NUMERICAL SIMULATION OF FLOW ABOUT INSTALLED AERO ENGINE NACELLE USING A FINITE ELEMENT EULER SOLVER ON UNSTRUCTURED MESHES
J. PEIRO, J. PERAIRE (Imperial College of Science, Technology, and Medicine, London, United Kingdom), K. MORGAN, O. HASSAN (Swansea, University College, United Kingdom), and N. BIRCH (Rolls Royce, PLC, Derby, United Kingdom) Aeronautical Journal (ISSN 0001-9240), vol. 96, no. 956, June-July 1992, p. 224-232. Research supported by Rolls Royce, PLC and Royal Aerospace Establishment. refs
Copyright

The application of the unstructured mesh system FLITE3D.0 to the numerical analysis of the inviscid Euler flow past installed aero-engine nacelle is described. The main features of the system are detailed and the approach is demonstrated by simulating the flow over a Rolls-Royce model of a twin-engined civil transport aircraft with long-cowl nacelle powerplants. The computed pressure distributions are compared with the measurements produced by transonic wind tunnel experiments. Author

A92-52973
SOLUTION OF EULER EQUATIONS WITH UNSTRUCTURED MESH - 3-D CASE
G. D. MORTCHELEWICZ (ONERA, Chatillon, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 6, 1991, p. 17-25. refs
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An effective and reliable FEM for solving the nonsteady 3D Euler equations is presented. The small-motion hypothesis offers the possibility of realizing nonsteady solutions for fairly reasonable computation costs. A satisfactory comparison of experimental and numerical data is achieved, despite the rarefied grids employed. R.E.P.

A92-53009
MEASUREMENT OF ANGLE OF ATTACK USING A FIVE-HOLE ARROW HEAD PITOT TUBE
HIROBUMI OHTA and NAOYA WAKAMATSU Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 40, no. 463, 1992, p. 464-466. In Japanese.

A five-hole arrow head pitot tube is tested to measure flight velocity and angle of attack. This paper presents experimental equations with corrective coefficients. These equations make it possible to calculate flight velocity and angle of attack in terms of the measured pressure. The time lag corresponding to the change of angle of attack is also reported. Author

A92-53010
MEASUREMENT OF TURBULENT BOUNDARY LAYER IN TRANSONIC FLOW
QILIN YUN and CHANGAN ZHAO (China Aerodynamic Research and Development Center, Mianyang) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 11, Nov. 1991, p. A563-A567. In Chinese. refs

Hot-wire probes were calibrated in a FL-23 transonic and supersonic wind tunnel, and the mean and fluctuating flow characteristics within the boundary layer of the wind tunnel test section sidewall were measured by hot wire. These flow characteristics are found to be in good agreement with those measured by pitot tube. Neither fluctuating velocity nor density decrease monotonically with increasing distance from the tunnel wall. C.D.

A92-53021
CALCULATION OF THE TRANSONIC FULL-POTENTIAL FLOWFIELD ABOUT 3D FUSELAGE
LI ZHANG and MINGKE HUANG (Nanjing Aeronautical Institute, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 11, Nov. 1991, p. A635-A638. In Chinese. refs

A highly efficient computer program for analysis of 3D transonic conservative full-potential flowfields about axisymmetric and asymmetric fuselage configurations at nonzero incidence and nonzero sideslip has been developed according to Holst's highly efficient algorithm of finite difference method. The nearly orthogonal bodyfitted C-O type and H-O type grids, obtained by an algebraic method, are used in the computation. Calculations were performed for hemisphere-cylinder, ogive-cylinder, and noncircular sectional fuselage with canopy and the results obtained agree very well with available data of experiments and other theories. It is shown that the present method can be applied not only to subsonic free streams but also to supersonic free streams, and so it covers the calculations of all the range of transonic free streams. Author

A92-53022
THE RELATION AMONG THE GENERAL UNSTEADY AERODYNAMIC COEFFICIENTS OF A WING IN SUBSONIC AND SUPERSONIC SPEED
SHOUFENG SONG, DONG AN, and QING CHEN (Beijing University of Aeronautics and Astronautics, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 11, Nov. 1991, p. A639-A643. In Chinese. refs

The approximate dominant pole values of the linearized aerodynamic system can be obtained only with the concept of 'equivalent system' and an indicial function of general unsteady aerodynamics obtained by a numerical method if the flight Mach number and the wing parameters are given. According to the principle of the indicial function, it can be considered that there are two dominant poles for the linearized aerodynamic system. This simplifies the calculation of the unsteady aerodynamic wing coefficient and reduces the order of the dynamic system eigenfunction. C.D.

A92-53078
HOT-WIRE MEASUREMENTS IN TURBULENT TRANSONIC FLOWS
S. BARRE, P. DUPONT, and J. P. DUSSAUGE (Institut de Mecanique Statistique de la Turbulence, Marseille, France) European Journal of Mechanics, B/Fluids (ISSN 0997-7546), vol. 11, no. 4, 1992, p. 439-454. Research supported by CNRS and DRET. refs
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In transonic flows, problems arise in hot-wire anemometry at moderate Reynolds number, and at low and moderate overheat of the wire. However, these operating parameters are necessary if velocity and temperature fluctuations are to be measured by the technique of fluctuation diagrams. A measurement method adapted to this range is proposed. The sensitivities of the hot wire to the mass flux, Mach number and total temperature are defined and determined by calibration. The results are verified in known turbulent flows: an equilibrium boundary layer and a free shear flow containing large transonic zones. The present method gives results in agreement with classical results. In contrast, neglecting the sensitivity to the Mach number, as is usual with supersonic flows, would lead to unrealistically low levels of turbulence. A simplified method, already used for supersonic flows, in which the hot wire is operated at a single overheat, is proposed and validated for the transonic range. Author

A92-53079
REMARKS ON THE RELATION BETWEEN LIFT INDUCED DRAG AND VORTEX DRAG
P. ARDONCEAU and G. AMANI (Ecole Nationale Superieure de Mecanique et d'Aerotechnique, Poitiers, France) European Journal of Mechanics, B/Fluids (ISSN 0997-7546), vol. 11, no. 4, 1992, p. 455-460. refs
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Some results concerning the relation between vortex drag and lift-induced drag recently published in the literature (Chometon and Laurent, 1990) are reexamined in quantitative terms. In particular, it is noted that the momentum balance in the wake of a lifting wing gives a correct estimate of the lift-induced drag, provided that the survey area is large enough to include all the vortex energy. V.L.

A92-53080* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NONLINEAR DEVELOPMENT AND SECONDARY INSTABILITY OF LARGE-AMPLITUDE GOERTLER VORTICES IN HYPERSONIC BOUNDARY LAYERS
Y. FU and P. HALL (Manchester, Victoria University, United Kingdom) European Journal of Mechanics, B/Fluids (ISSN 0997-7546), vol. 11, no. 4, 1992, p. 465-510. refs
(Contract NAS1-18605; NAS1-18107; AF-AFOSR-89-0042)
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The weakly nonlinear development of large-amplitude Goertler vortices in a small neighborhood of the neutral stability position given by the linear theory is considered. It is shown that if the basic state and the wall curvature satisfy a certain condition, the Goertler vortices will grow until they become so large as to drive a mean flow correction as large as the basic state. Attention is then given to the further downstream evolution of these large-amplitude vortices, and it is shown that the vortices have a triple layer structure which consists of a region of vortex activity bounded by two transition layers over which the amplitude of the harmonic part of the vortex decays to zero exponentially. The positions of the two transition layers are found to be governed by a free boundary problem, which is solved for a number of curvature distribution cases. The secondary instability of the two transition layers is investigated with respect to traveling waves which are pi/2 out of phase in the spanwise direction with the steady Goertler vortices. V.L.

A92-53087
THE WALL INTERFERENCE CORRECTION AND TEST DATA PROCESSING METHODS FOR AIRFOIL WIND TUNNEL TEST WITH ENDPLATES
GUIQING JIANG (China Aerodynamics Research and Development Center, Mianyang) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 8, Aug. 1991, p. B332-B338. In Chinese. refs

In the conventional airfoil tests using endplates, the free vortex may be drawn around endplates. Based on the experimental observations, the vortex system model for such an airfoil test was established. Using the model, the effective aspect ratio of the wing with the endplates may be found, and then the results can be transformed into 2D data by lifting line theory and the wall interference can be corrected by image method. Even for the pressure results on middle sections of the model with endplates, 2D transformation and wall correction are necessary, similar to force tests. The data reduction process will ensure accurate and reliable airfoil results. Some experimental demonstration evidences are presented in this paper for several different airfoils in two wind tunnels with closed and open jets, respectively. Author

A92-53097
THE EFFECT OF AFTERBODY DEVICES ON DRAG REDUCTION
XUEJIAN XIA and SHULIN MA (Beijing University of Aeronautics and Astronautics, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 8, Aug. 1991, p. B435-B438. In Chinese. refs

The effect of three kinds of devices, the base drag reducing plate, drag reducing strakes on tail and afterbody terraces, on drag reduction are experimentally investigated. Series of experiments are completed for selecting the geometric parameters and setting locations. The efficiencies are compared for different drag reduction devices. The results show that the base drag reducing plate is a simple and effective afterbody device of drag reduction. At alpha = 0, one of the base drag reducing plate, which has L = 0.8D and compatible setting locations, results in drag reduction of 0.027 for body alone, with the relative value about 10.9 percent of body drag, and results in drag reduction of 0.018 for configurations of body and tail, with relative value about 5.7 percent. The drag reducing strakes on the tail also decrease drag, while afterbody terraces result in an increase of drag. Author

A92-53253
INVESTIGATION OF THE TAIL BUFFETING OF THE C-101 [INVESTIGACION DEL BATANEO DE COLA DEL C-101]
F. J. SIMON and T. M. PUCHE (Construcciones Aeronauticas, S.A., Madrid, Spain) Ingenieria Aeronautica y Astronautica (ISSN 0020-1006), no. 328, July 1992, p. 19-32. In Spanish. refs
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A systematic analysis is conducted of the Spanish C-101 training aircraft including theoretical and experimental study to identify the origin of high-velocity buffeting and possible remedies. Attention is given to the limits of theoretical calculations as well as to the selection of a suitable figure of merit and the Mach number related to the shock wave. The analysis is used to design a modified wing form which can be used to increase the aircraft's ability to withstand stronger loading during flight. Experimental investigations are conducted in hydrodynamic and aerodynamic tunnels and in flight. The modifications to the aircraft are shown to augment its operative capacity for acceptable performance at achievable Mach numbers without significant tail buffeting. C.C.S.

A92-53288
A BI-DIRECTIONAL MARCHING FINITE ELEMENT ALGORITHM FOR THREE-DIMENSIONAL BOUNDARY LAYER SEPARATION FLOW COMPUTATIONS
CHUN-HIAN LEE and SHENG JIN (Beijing University of Aeronautics and Astronautics, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 7, July 1991, p. A321-A330. In Chinese. refs

A finite element algorithm is proposed for solving the direct and the inverse problems of three-dimensional boundary layers. The algorithm is constructed based on a Galerkin discretization along the traversal direction across the boundary layer, and a subdomain discretization in conjunction with a bidirectional marching procedure along the body surface. The present algorithm would yield an explicit form of the CFL condition by incorporating the isoparametric elements, and thus provide an assurance for fast-solving the problems of both modes. For the inverse mode, the displacement thicknesses are considered as a set of constrains, and are integrated into the finite element analog of the boundary layer equations via Lagrange multipliers. Several test cases are computed by the present technique, and the results show that the technique provides an economical as well as efficient tool for computing 3D boundary layer flows. Author

A92-53290
DISCUSSION OF IMPROVED TRANSONIC POTENTIAL METHOD
ZIQIANG ZHU and XUESONG BAI (Beijing University of Aeronautics and Astronautics, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 7, July 1991, p. A337-A344. In Chinese. refs

Some points concerning transonic potential method are briefly reviewed. The correction orders (nonisentropic jump condition and the vorticity generated behind the shock) are analyzed and then estimated under the condition of small disturbance. Two correction orders shows that vorticity correction is indeed of higher order. A nonisentropic potential formulation is described. Numerical examples demonstrate that this nonisentropic method can simulate inviscid flow better than the traditional potential method, while it has the advantage of simplicity in mathematical aspect. Author

A92-53381
A NUMERICAL INVESTIGATION OF AXIAL FLOW COMPRESSOR CASING TREATMENT
PING ZHUANG (Chinese Academy of Sciences, Institute of

Engineering Thermophysics, Beijing, China), YAJUN LU, and JIYA CUI (Beijing University of Aeronautics and Astronautics, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 3, March 1991, p. A149-A158. In Chinese. refs

A numerical simulation of a 3D flowfield of casing treatment is developed using results of experimental studies, and a new procedure for theoretical computations of the flowfield with casing treatment is explored. Using an inviscid model with inlet total pressure gradient and Denton's (1982) scheme, the 3D flowfield of compressor casing treatment is solved numerically, and some boundary singularities are examined. I.S.

A92-53386
A PENALTY-GALERKIN FINITE ELEMENT METHOD FOR CALCULATING TRANSONIC FLOW OVER WINGS
QINGBING ZHANG and SHOUQIN YU (Nanjing Aeronautical Institute, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 3, March 1991, p. A193-A197. In Chinese. refs

An upwind technique is usually used in order to capture the shocks in the Galerkin full potential finite element method for calculating supercritical transonic flows. But it leads to the vibration of the equation of mass conservation. The present formulation extends the Galerkin finite element method by modifying it with a penalty function to enforce the conservation of mass across the element interfaces, while allowing sudden changes in velocities and densities in 2D transonic flows over airfoils. The algorithm is then extended to three-dimensional wings. Author

N92-30239# Lowell Univ., MA.
SELECTION OF OPENING MODEL FOR PARACHUTE SCALING STUDIES Final Report, Jan. 1990 - Jun. 1991
EUGENE E. NIEMI, JR. Mar. 1992 50 p
(AD-A250882; NATICK-TR-92/009) Avail: CASI HC A03/MF A01

This report consists of a summary of work to program an existing parachute opening dynamics theory for use with research into the scaling laws governing relationships between model and full-scale parachutes during the opening phase. The theory forms a basis to which modifications can be made to predict the opening dynamics of small-scale models. The object is eventually to be able to predict canopy stiffness effects on opening behavior. GRA

N92-30295*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
VALIDATION OF THREE-DIMENSIONAL INCOMPRESSIBLE SPATIAL DIRECT NUMERICAL SIMULATION CODE: A COMPARISON WITH LINEAR STABILITY AND PARABOLIC STABILITY EQUATION THEORIES FOR BOUNDARY-LAYER TRANSITION ON A FLAT PLATE
RONALD D. JOSLIN, CRAIG L. STREETT, and CHAU-LYAN CHANG (High Technology Corp., Hampton, VA.) Jul. 1992 49 p
(Contract RTOP 505-59-50-01)
(NASA-TP-3205; L-17026; NAS 1.60:3205) Avail: CASI HC A03/MF A01

Spatially evolving instabilities in a boundary layer on a flat plate are computed by direct numerical simulation (DNS) of the incompressible Navier-Stokes equations. In a truncated physical domain, a nonstaggered mesh is used for the grid. A Chebyshev-collocation method is used normal to the wall; finite difference and compact difference methods are used in the streamwise direction; and a Fourier series is used in the spanwise direction. For time stepping, implicit Crank-Nicolson and explicit Runge-Kutta schemes are used to the time-splitting method. The influence-matrix technique is used to solve the pressure equation. At the outflow boundary, the buffer-domain technique is used to prevent convective wave reflection or upstream propagation of information from the boundary. Results of the DNS are compared with those from both linear stability theory (LST) and parabolized stability equation (PSE) theory. Computed disturbance amplitudes and phases are in very good agreement with those of LST (for small inflow disturbance amplitudes). A measure of the sensitivity of the inflow condition is demonstrated with both LST and PSE theory used to approximate inflows. Although the DNS numerics are very different than those of PSE theory, the results are in good agreement. A small discrepancy in the results that does occur is likely a result of the variation in PSE boundary condition treatment in the far field. Finally, a small-amplitude wave triad is forced at the inflow, and simulation results are compared with those of LST. Again, very good agreement is found between DNS and LST results for the 3-D simulations, the implication being that the disturbance amplitudes are sufficiently small that nonlinear interactions are negligible. Author

N92-30298*# Pratt and Whitney Aircraft, East Hartford, CT. Commercial Engine Business.
ULTRA HIGH BYPASS NACELLE AERODYNAMICS INLET FLOW-THROUGH HIGH ANGLE OF ATTACK DISTORTION TEST Final Report
MICHAEL J. LARKIN and PAUL S. SCHWEIGER Jul. 1992 73 p
(Contract NAS3-25952; RTOP 535-03-10)
(NASA-CR-189149; NAS 1.26:189149; PWA-6354) Avail: CASI HC A04/MF A01

A flow-through inlet test program was conducted to evaluate inlet test methods and determine the impact of the fan on inlet separation when operating at large angles of attack. A total of 16 model configurations of approximately 1/6 scale were tested. A comparison of these flow-through results with powered data indicates the presence of the fan increased separation operation 3 degrees to 4 degrees over the flow through inlet. Rods and screens located at the fan face station, that redistribute the flow, achieved simulation of the powered-fan results for separation angle of attack. Concepts to reduce inlet distortion and increase angle of attack capability were also evaluated. Vortex generators located on the inlet surface increased inlet angle of attack capability up to 2 degrees and reduced inlet distortion in the separated region. Finally, a method of simulating the fan/inlet aerodynamic interaction using blockage sizing method has been defined. With this method, a static blockage device used with a flow-through model will approximate the same inlet onset of separation angle of attack and distortion pattern that would be obtained with an inlet model containing a powered fan. Author

N92-30367# Sandia National Labs., Albuquerque, NM.
JOINT COMPUTATIONAL AND EXPERIMENTAL AERODYNAMICS RESEARCH ON A HYPERSONIC VEHICLE
W. L. OBERKAMPF, D. P. AESCHLIMAN, and M. M. WALKER 1992 35 p Presented at the Advisory Group for Aerospace Research and Development (AGARD) Fluid Dynamics Panel Symposium on Theoretical and Experimental Methods in Hypersonic Flows, Torino (Italy), 5-7 May 1992
(Contract DE-AC04-76DP-00789)
(DE92-013439; SAND-92-0919C; CONF-920534-2) Avail: CASI HC A03/MF A01

A closely coupled computational and experimental aerodynamics research program was conducted on a hypersonic vehicle configuration at Mach 8. Aerodynamic force and moment measurements and flow visualization results were obtained in the Sandia National Laboratories hypersonic wind tunnel for laminar boundary layer conditions. Parabolized and iterative Navier-Stokes simulations were used to predict flow fields and forces and moments on the hypersonic configuration. The basic vehicle configuration is a spherically blunted 10 degree cone with a slice parallel with the axis of the vehicle. On the slice portion of the vehicle, a flap can be attached so that deflection angles of 10, 20, and 30 degrees can be obtained. Comparisons are made between experimental and computational results to evaluate quality of each and to identify areas where improvements are needed. This extensive set of high-quality experimental force and moment measurements is recommended for use in the calibration and validation of computational aerodynamics codes. DOE

N92-30392*# Maryland Univ., College Park. Dept. of Aerospace Engineering.
NAVIER-STOKES COMPUTATIONS OF A VISCOUS OPTIMIZED WAVERIDER M.S. Thesis
NARUHISA TAKASHIMA Jun. 1992 102 p
(Contract NAG1-1192; RTOP 505-59-40-10)
(NASA-CR-189658; NAS 1.26:189658; UM-AERO-92-08) Avail: CASI HC A06/MF A02

The performance of a Mach 6 viscous optimized waverider was calculated using the 3-D Navier-Stokes equations. The Mach 6 viscous optimized waverider was generated using MAXWARP, a code developed at the University of Maryland. The computations were performed using CFL3D, an implicit upwind-biased finite-volume algorithm developed at NASA Langley. Results show that good agreement was found between the calculated performance by MAXWARP and results from the Mach 6 Navier-Stokes computation. Furthermore, off-design performance of the Mach 6 optimized waverider was computed at Mach 4 and 8. The performance at these Mach numbers compared well with the performance of the viscous optimized waveriders specifically designed for these Mach numbers. Finally, contours of different flow parameters in the cross-flow plane were examined for the three calculations. The results indicate that the flow gradients are relatively small within the captured flow, and the variation itself is well behaved; thus, making the waverider configuration a promising choice for an engine/airframe design, especially for cruise-type applications. Author

N92-30393*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PROGRESS IN UNSTRUCTURED-GRID METHODS DEVELOPMENT FOR UNSTEADY AERODYNAMIC APPLICATIONS
JOHN T. BATINA Jul. 1992 13 p Presented at the 7th IMACS International Conference on Computer Methods for Partial Differential Equations, New Brunswick, NJ, 22-24 Jun. 1992
(Contract RTOP 505-63-50-12)
(NASA-TM-107643; NAS 1.15:107643) Avail: CASI HC A03/MF A01

The development of unstructured-grid methods for the solution of the equations of fluid flow and what was learned over the course of the research are summarized. The focus of the discussion is on the solution of the time-dependent Euler equations including spatial discretizations, temporal discretizations, and boundary conditions. An example calculation with an implicit upwind method using a CFL number of infinity is presented for the Boeing 747 aircraft. The results were obtained in less than one hour CPU time on a Cray-2 computer, thus, demonstrating the speed and robustness of the capability. Additional calculations for the ONERA M6 wing demonstrate the accuracy of the method through the good agreement between calculated results and experimental data for a standard transonic flow case. Author

N92-30394*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TWO-DIMENSIONAL AERODYNAMIC CHARACTERISTICS OF SEVERAL POLYGON-SHAPED CROSS-SECTIONAL MODELS APPLICABLE TO HELICOPTER FUSELAGES
HENRY L. KELLEY, CYNTHIA A. CROWELL, and JOHN C. WILSON Aug. 1992 30 p
(Contract DA PROJ. 1L2-36003-D-313; RTOP 505-59-36-01)
(NASA-TP-3233; L-16951; NAS 1.60:3233; AVSCOM-TR-92-B-002) Avail: CASI HC A03/MF A01

A wind-tunnel investigation was conducted to determine 2-D aerodynamic characteristics of nine polygon-shaped models applicable to helicopter fuselages. The models varied from 1/2 to 1/5 scale and were nominally triangular, diamond, and rectangular in shape. Side force and normal force were obtained at increments of angle of flow incidence from -45 to 90 degrees. The data were compared with results from a baseline UH-60 tail-boom cross-section model. The results indicate that the overall shapes of the plots of normal force and side force were similar to the characteristic shape of the baseline data; however, there were important differences in magnitude. At a flow incidence of 0 degrees, larger values of normal force for the polygon models indicate an increase in fuselage down load of 1 to 2.5 percent of main-rotor thrust compared with the baseline value. Also, potential was indicated among some of the configurations to produce high fuselage side forces and yawing moments compared with the baseline model. Author

N92-30514# European Space Agency, Paris (France).
COMPUTATION OF UNSTEADY TRANSONIC FLOWS USING AN IMPLICIT CENTERED EULER SOLVER WITHOUT ARTIFICIAL VISCOSITY
ANNE-SOPHIE SENS (Office National d'Etudes et de Recherches Aerospatiales, Paris, France) Mar. 1992 105 p Transl. into ENGLISH of Calcul d'Ecoulements Transsoniques Instationnaires par Resolution Implicite Centree des Equations d'Euler sans Viscosite Artificielle (Paris, France, ONERA), Sep. 1990 98 p Original language document was announced as N91-12633
(ESA-TT-1235; ONERA-NT-1990-8; ETN-92-91709) Avail: CASI HC A06/MF A02

The numerical simulation of unsteady transonic flows is presented. The solution of the Euler equations using an extension of Lerat's second order accurate, centered implicit scheme is used. When applied as an unsteady method for determining steady solutions, the scheme has the advantage of working without artificial viscosity, and the aim of this study is to extend this property to the case of truly unsteady problems. The approximations are developed in one dimension. The two timestep scheme is extended to two dimensions following the approach of Lerat and Sides for the steady case. A stability result on the scalar case is given. The method is applied to the computation of the unsteady transonic flow around an airfoil in rigid body motion. A three dimensional validation of the two timestep method is proposed for the problem of the swept wing oscillating in translation between parallel walls. ESA

N92-30570*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A GRIDLESS EULER/NAVIER-STOKES SOLUTION ALGORITHM FOR COMPLEX TWO-DIMENSIONAL APPLICATIONS
JOHN T. BATINA Jun. 1992 25 p
(Contract RTOP 505-63-50-12)
(NASA-TM-107631; NAS 1.15:107631) Avail: CASI HC A03/MF A01

The development of a gridless computational fluid dynamics (CFD) method for the solution of the two-dimensional Euler and Navier-Stokes equations is described. The method uses only clouds of points and does not require that the points be connected to form a grid as is necessary in conventional CFD algorithms. The gridless CFD approach appears to resolve the problems and inefficiencies encountered with structured or unstructured grid methods. As a result, the method offers the greatest potential for accurately and efficiently solving viscous flows about complex aircraft configurations. The method is described in detail, and calculations are presented for standard Euler and Navier-Stokes cases to assess the accuracy and efficiency of the capability. Author

N92-30676# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany). Military Aircraft Div.
CFD CONTRIBUTIONS DURING HYPERSONIC AIRPLANE INTAKE DESIGN
N. C. BISSINGER and A. EBERLE Jul. 1991 28 p
(MBB/FE213/S/PUB/459; ETN-92-91907) Copyright Avail: CASI HC A03/MF A01

Numerical elements of an advanced Computational Fluid Dynamics (CFD) code regarding computational speed and accuracy are addressed. With increasing Mach number of high speed vehicles there is a growing need for the design people to get information on the steadily growing complexity of the flows outside and inside these airplanes. Results of several calculations

performed to gain insight into the flow in hypersonic intakes are presented. ESA

N92-30691*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
IMPLICIT UPWIND-EULER SOLUTION ALGORITHMS FOR UNSTRUCTURED-GRID APPLICATIONS
JOHN T. BATINA Jul. 1992 9 p Presented at the First European Computational Dynamics Conference, Brussels, Belgium, 7-11 Sep. 1992
(Contract RTOP 505-63-50-12)
(NASA-TM-107645; NAS 1.15:107645) Avail: CASI HC A02/MF A01

The development of implicit upwind algorithms for the solution of the three-dimensional, time-dependent Euler equations on unstructured tetrahedral meshes is described. The implicit temporal discretization involves either a two-sweep Gauss-Seide relaxation procedure, a two-sweep Point-Jacobi relaxation procedure, or a single-sweep Point-Implicit procedure; the upwind spatial discretization is based on the flux-difference splitting of Roe. Detailed descriptions of the three implicit solution algorithms are given, and calculations for the Boeing 747 transport configuration are presented to demonstrate the algorithms. Advantages and disadvantages of the implicit algorithms are discussed. A steady-state solution for the 747 configuration, obtained at transonic flow conditions using a mesh of over 100,000 cells, required less than one hour of CPU time on a Cray-2 computer, thus demonstrating the speed and robustness of the general capability. Author

N92-30713# Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.
MATGRID, A PROGRAM FOR GENERATION OF C-H AND C-O TOPOLOGY GRIDS AROUND WING/BODY CONFIGURATIONS: SOFTWARE DESCRIPTION DOCUMENT
LARS G. TYSELL and SVEN G. HEDMAN Dec. 1991 101 p Sponsored by Swedish Board for Technical Development
(FFA-TN-1990-20; ETN-92-91704) Avail: CASI HC A06/MF A02

The software description of MATGRID is given. MATGRID is a computer program for generation of C-H or C-O topology grids for the discretization of flow fields around configurations consisting of a wing alone or a wing and a fuselage. MATRICS (Multicomponent Aircraft Transonic Inviscid Computation System) and MATGRID together form a system of computer programs for the calculation of the flow at cruise condition around wing/body combinations of the type of commercial airliners. The general layout of the program and all major subroutines are described. Also included are subroutine, common block and file cross reference lists, an installation guide, a user's guide, and a mathematical definition document. ESA

N92-30740*# MCAT Inst., San Jose, CA.
NUMERICAL METHODS FOR THE SIMULATION OF COMPLEX MULTI-BODY FLOWS WITH APPLICATIONS FOR THE INTEGRATED SPACE SHUTTLE VEHICLE Progress Report
WILLIAM M. CHAN Apr. 1992 42 p
(Contract NCC2-654)
(NASA-CR-190045; NAS 1.26:190045; MCAT-92-009) Avail: CASI HC A03/MF A01

The following papers are presented: (1) numerical methods for the simulation of complex multi-body flows with applications for the Integrated Space Shuttle vehicle; (2) a generalized scheme for 3-D hyperbolic grid generation; (3) collar grids for intersecting geometric components within the Chimera overlapped grid scheme; and (4) application of the Chimera overlapped grid scheme to simulation of Space Shuttle ascent flows.

N92-30741*# MCAT Inst., San Jose, CA.
NUMERICAL METHODS FOR THE SIMULATION OF COMPLEX MULTI-BODY FLOWS WITH APPLICATIONS FOR THE INTEGRATED SPACE SHUTTLE VEHICLE
WILLIAM M. CHAN *In its* Numerical Methods for the Simulation of Complex Multi-Body Flows with Applications for the Integrated Space Shuttle Vehicle 5 p Apr. 1992
Avail: CASI HC A01/MF A01

This project forms part of the long term computational effort to simulate the time dependent flow over the integrated Space Shuttle vehicle (orbiter, solid rocket boosters (SRB's), external tank (ET), and attach hardware) during its ascent mode for various nominal and abort flight conditions. Due to the limitations of experimental data such as wind tunnel wall effects and the difficulty of safely obtaining valid flight data, numerical simulations are undertaken to supplement the existing data base. This data can then be used to predict the aerodynamic behavior over a wide range of flight conditions. Existing computational results show relatively good overall comparison with experiments but further refinement is required to reduce numerical errors and to obtain finer agreements over a larger parameter space. One of the important goals of this project is to obtain better comparisons between numerical simulations and experiments. In the simulations performed so far, the geometry has been simplified in various ways to reduce the complexity so that useful results can be obtained in a reasonable time frame due to limitations in computer resources. In this project, the finer details of the major components of the Space Shuttle are modeled better by including more complexity in the geometry definition. Smaller components not included in early Space Shuttle simulations will now be modeled and gridded. Author

N92-30742*# MCAT Inst., San Jose, CA.
APPLICATION OF THE CHIMERA OVERLAPPED GRID SCHEME TO SIMULATION OF SPACE SHUTTLE ASCENT FLOWS
PIETER G. BUNING (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.), STEVEN J. PARKS (Lockheed Engineering and Sciences Co., Houston, TX.), WILLIAM M. CHAN, and KEVIN J. RENZE (Iowa State Univ. of Science and Technology, Ames.) *In its* Numerical Methods for the Simulation of Complex Multi-Body Flows with Applications for the Integrated Space Shuttle Vehicle 7 p Apr. 1992 Presented at the 4th International Symposium on Computational Fluid Dynamics, Davis, CA, 9-12 Sep. 1991
Avail: CASI HC A02/MF A01

Several issues relating to the application of Chimera overlapped grids to complex geometries and flowfields are discussed. These include the addition of geometric components with different grid topologies, gridding for intersecting pieces of geometry, and turbulence modeling in grid overlap regions. Sample results are presented for transonic flow about the Space Shuttle launch vehicle. Comparisons with wind tunnel and flight measured pressures are shown. Author

N92-30747*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TRAJECTORY FITTING IN FUNCTION SPACE WITH APPLICATION TO ANALYTIC MODELING OF SURFACES
RAYMOND L. BARGER Jul. 1992 15 p
(Contract RTOP 505-59-53-01)
(NASA-TP-3232; L-17054; NAS 1.60:3232) Avail: CASI HC A03/MF A01

A theory for representing a parameter-dependent function as a function trajectory is described. Additionally, a theory for determining a piecewise analytic fit to the trajectory is described. An example is given that illustrates the application of the theory to generating a smooth surface through a discrete set of input cross-section shapes. A simple procedure for smoothing in the parameter direction is discussed, and a computed example is given. Application of the theory to aerodynamic surface modeling is demonstrated by applying it to a blended wing-fuselage surface. Author

N92-30909*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DIRECT SIMULATION OF HIGH-SPEED MIXING LAYERS
H. S. MUKUNDA, B. SEKAR (General Electric Co., Cincinnati, OH.),

M. H. CARPENTER, J. PHILIP DRUMMOND, and AJAY KUMAR Jul. 1992 63 p
(Contract RTOP 505-62-40-06)
(NASA-TP-3186; L-16929; NAS 1.60:3186) Avail: CASI HC A04/MF A01

A computational study of a nonreacting high-speed mixing layer is performed. A higher order algorithm with sufficient grid points is used to resolve all relevant scales. In all cases, a temporal free-stream disturbance is introduced. The resulting flow is time-sampled to generate a statistical cross section of the flow properties. The studies are conducted at two convective Mach numbers, three free-stream turbulence intensities, three Reynolds numbers, and two types of initial profiles-hyperbolic tangent (tanh) and boundary layer. The boundary-layer profile leads to more realistic predictions of the transition processes. The predicted transition Reynolds number of 0.18 x 10(exp 6) compares well with experimental data. Normalized vortex spacings for the boundary-layer case are about 3.5 and compare favorably with the 1.5 to 2.5 found in experimental measurements. The tanh profile produces spacings of about 10. The growth rate of the layer is shown to be moderately affected by the initial disturbance field, but comparison with experimental data shows moderate agreement. For the boundary-layer case, it is shown that noise at the Strouhal number of 0.007 is selectively amplified and shows little Reynolds number dependence. Author

N92-30947# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics Panel.
VORTEX FLOW AERODYNAMICS [L'AERODYNAMIQUE DES ECOULEMENTS TOURBILLONNAIRES]
J. H. B. SMITH (Royal Aircraft Establishment, Farnborough, England), J. F. CAMPBELL (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.), and A. D. YOUNG, ed. Apr. 1992 27 p Presented at the Fluid Dynamics Panel Symposium, Scheveningen, The Netherlands, 1-4 Oct. 1990
(AGARD-AR-299; ISBN-92-835-0670-7) Copyright Avail: CASI HC A03/MF A01

The principal emphasis of the meeting was to be on the understanding and prediction of separation-induced vortex flows and their effects on vehicle performance, stability, control, and structural design loads. This report shows that a substantial amount of the papers covering this area were received from a wide range of countries, together with an attendance that was even more diverse. In itself, this testifies to the current interest in the subject and to the appropriateness of the Panel's choice of topic and approach. An attempt is made to summarize each paper delivered, and to relate the contributions made in the papers and in the discussions to some of the important aspects of vortex flow aerodynamics. This reveals significant progress and important clarifications, but also brings out remaining weaknesses in predictive capability and gaps in understanding. Where possible, conclusions are drawn and areas of continuing concern are identified. Author

N92-30977*# Iowa State Univ. of Science and Technology, Ames. Coll. of Engineering.
DEVELOPMENT OF A 3-D UPWIND PNS CODE FOR CHEMICALLY REACTING HYPERSONIC FLOWFIELDS Final Report, 1 Feb. 1988 - 31 Jan. 1992
J. C. TANNEHILL and G. WADAWADIGI 31 Jan. 1992 29 p
(Contract NAG2-502; ERI PROJ. 3051)
(NASA-CR-190182; NAS 1.26:190182; CFD-26) Avail: CASI HC A03/MF A01

Two new parabolized Navier-Stokes (PNS) codes were developed to compute the three-dimensional, viscous, chemically reacting flow of air around hypersonic vehicles such as the National Aero-Space Plane (NASP). The first code (TONIC) solves the gas dynamic and species conservation equations in a fully coupled manner using an implicit, approximately-factored, central-difference algorithm. This code was upgraded to include shock fitting and the capability of computing the flow around complex body shapes. The revised TONIC code was validated by computing the chemically-reacting (M(sub infinity) = 25.3) flow around a 10 deg half-angle cone at various angles of attack and the Ames All-Body model at 0 deg angle of attack. The results of these calculations were in good agreement with the results from the UPS code. One of the major drawbacks of the TONIC code is that the central-differencing of fluxes across interior flowfield discontinuities tends to introduce errors into the solution in the form of local flow property oscillations. The second code (UPS), originally developed for a perfect gas, has been extended to permit either perfect gas, equilibrium air, or nonequilibrium air computations. The code solves the PNS equations using a finite-volume, upwind TVD method based on Roe's approximate Riemann solver that was modified to account for real gas effects. The dissipation term associated with this algorithm is sufficiently adaptive to flow conditions that, even when attempting to capture very strong shock waves, no additional smoothing is required. For nonequilibrium calculations, the code solves the fluid dynamic and species continuity equations in a loosely-coupled manner. This code was used to calculate the hypersonic, laminar flow of chemically reacting air over cones at various angles of attack. In addition, the flow around the McDonnel Douglas generic option blended-wing-body was computed and comparisons were made between the perfect gas, equilibrium air, and the nonequilibrium air results. Author

N92-31122# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace and Ocean Engineering.
AN EXPERIMENTAL STUDY OF THE RELATIONSHIP BETWEEN VELOCITY AND PRESSURE FLUCTUATIONS IN A WING-BODY JUNCTION Technical Report, 1 Dec. 1990 - 24 Jan. 1992
M. C. RIFE, W. J. DAVENPORT, and R. L. SIMPSON 25 Jan. 1992 231 p
(Contract N00014-90-J-1909)
(AD-A249628; VPI-AOE-188) Avail: CASI HC A11/MF A03

Velocity and pressure fluctuations were measured in a wind tunnel in the plane of symmetry in front of a wing-body junction at an approach free velocity of U(sub ref) = 28.3 m/s and momentum thickness Reynolds number R(sub e(theta)) = 6900. The cylindrical wing shape was a 3.2 elliptical nose attached to a NACA 0020 tail at maximum thickness. A two component laser Doppler anemometer was used to make the velocity measurements. Pressure measurements were made at two locations upstream of the wing by a pair of Sennheiser microphones. A relationship between the velocity and the pressure was determined to reveal the bimodal structure of the flow field. Histograms and power spectra of both quantities are presented along with cross-spectra and cross-correlations. The velocity power spectra revealed spectral slopes of -1 throughout the entire flow field. Author

N92-31157*# Stanford Univ., CA. Dept. of Aeronautics and Astronautics.
NONLINEAR AERODYNAMICS AND THE DESIGN OF WING TIPS Final Report, 1 Apr. 1991 - 31 Mar. 1992
ILAN KROO and SEAN WAKAYAMA Apr. 1992 17 p
(Contract NCC2-683)
(NASA-CR-190649; NAS 1.26:190649) Avail: CASI HC A03/MF A01

This report describes results of research conducted from April 1991 through March 1992. The general objective was to improve an existing wing optimization method, and apply the method to specific problems of interest. The method, while a valuable tool for wing tip design studies, can be applied to more general problems, and has been applied to some of these other problems during its development. Specific goals that were accomplished are listed and explained in more detail in the report. First, improvements were made to the portability and control flow of the existing code. The major iteration loop dealing with structural design was sped up and an alternate approach, using the optimizer to do structural sizing, was studied. Second, analysis methods were improved in the areas of structural and high lift modeling. The structural method was revised to give total wing weight and verified against data for particular commercial aircraft. The high lift analysis was improved to provide reasonable estimates of C(sub L max) in the flaps down condition. These improvements enabled

making wing area a design variable, where it had been a fixed variable in the original method. Third, the method was applied to the design of wings for a Learjet. Rough studies were done to determine the effects of laminar flow design on wing shape. Finally, studies on wingtip shape were begun. Author

N92-31171# Purdue Univ., West Lafayette, IN. School of Aeronautics and Astronautics.
EXTENSION OF THE INTEGRAL EQUATION FORMULATION OF LINEARIZED TIME DEPENDENT SUBSONIC FLOW Final Report, 3 May 1990 - 3 Sep. 1991
MARC H. WILLIAMS Feb. 1992 38 p
(Contract F33615-90-C-3206)
(AD-A250654; WL-TR-91-3120) Avail: CASI HC A03/MF A01

This report describes the results of a study of the feasibility of extending the time domain formulation of the linearized aerodynamics of flexible bodies that had been developed earlier for planar wings to the general case of arbitrary, complete aircraft configurations. The end products of that study are a formulation of the problem, an exact solution applicable to any geometry, a sample calculation for a simple nonplanar configuration, and some suggestions on how to proceed. The formulation is based on distributions of elementary sources and doublets over the mean solid surface. The problem is first formulated for arbitrary motion, and then specialized to the case of uniform translation. GRA

N92-31239*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CFD METHODS DEVELOPMENT CONSIDERATIONS FOR UNSTEADY AERODYNAMIC ANALYSIS
JOHN T. BATINA Jul. 1992 31 p Presented at the Workshop on Computational Aeroacoustics, Hampton VA, 6-9 Apr. 1992
(Contract RTOP 505-63-50-12)
(NASA-TM-107644; NAS 1.15:107644) Avail: CASI HC A03/MF A01

The development of computational fluid dynamics (CFD) methods for unsteady aerodynamic analysis is described. Special emphasis is placed on considerations that are required for application of the methods to unsteady aerodynamic flow problems. Two broad categories of topics are presented to illustrate the major points. Although primary application of these CFD methods is to relatively low frequency oscillatory phenomena such as flutter, the ideas that are presented may be of value to developers of computational aeroacoustic methods for predicting high frequency acoustics. Author

N92-31246*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HIGH REYNOLDS NUMBER TEST OF THE BOEING TR77 AIRFOIL IN THE LANGLEY 0.3-METER TRANSONIC CRYOGENIC TUNNEL
JULIO CHU, STUART G. FLECHNER, ACQUILLA S. HILL, and ROGER A. ROZENDAAL (Boeing Commercial Airplane Co., Seattle, WA.) Jul. 1990 79 p
(Contract RTOP 505-61-01-01)
(NASA-TM-4189; L-16724; NAS 1.15:4189) Avail: CASI HC A05/MF A01

A Boeing TR77 airfoil associated with the Advanced Technology Airfoil Test (ATAT) program was tested in the Langley 0.3 m Transonic Cryogenic Tunnel. Limited analysis of the data indicated that increasing Reynolds number for a fixed Mach number resulted in increased normal-force, nose-down pitching moment, and decreased drag coefficient. Increasing Mach number while keeping the Reynolds number constant yielded the expected increase in normal-force slopes, nose-down pitching moment coefficients, and decrease in angle of attack associated with maximum normal-force coefficient. Turbulent boundary layer flow was achieved over the airfoil at low Reynolds numbers for the test Mach number range using aluminum discs. Author

N92-31276*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
IN-FLIGHT LEADING-EDGE EXTENSION VORTEX FLOW-FIELD SURVEY MEASUREMENTS ON A F-18 AIRCRAFT AT HIGH ANGLE OF ATTACK
DAVID M. RICHWINE (PRC Kentron, Inc., Edwards, CA.) and DAVID F. FISHER Sep. 1992 49 p Presented at the AIAA 9th Applied Aerodynamics Conference, Baltimore, MD, 23-25 Sep. 1991 Previously announced in IAA as A91-53759
(Contract RTOP 505-68-71)
(NASA-TM-4398; H-1783; NAS 1.15:4398) Avail: CASI HC A03/MF A01

Flow-field measurements on the leading-edge extension (LEX) of the F-18 High Alpha Research Vehicle (HARV) were obtained using a rotating rake with 16 hemispherical-tipped five-hole probes. Detailed pressure, velocity, and flow direction data were obtained through the LEX vortex core. Data were gathered during 1-g quasi-stabilized flight conditions at angles of attack alpha from 10 degrees to 52 degrees and at Reynolds numbers based on mean aerodynamic cord up to 16 x 10(exp 6). Normalized dynamic pressures and crossflow velocities clearly showed the primary vortex above the LEX and formation of a secondary vortex at higher angles of attack. The vortex was characterized by a ring of high dynamic pressure surrounding a region of low dynamic pressure at the vortex core center. The vortex core, subcore diameter, and vertical location of the core above the LEX increased with angle of attack. Minimum values for static pressure were obtained in the vortex subcore and decreased nearly linearly with increasing angle of attack until vortex breakdown. Rake-measured static pressures were consistent with previously documented surface pressures and showed good agreement with flow visualization flight test results. Comparison of the LEX vortex flight test data to computational solutions at alpha approximately equals 19 degrees and 30 degrees showed fair correlation. Author

N92-31300# Naval Postgraduate School, Monterey, CA.
A COMPUTATIONAL INVESTIGATION OF AIRFOIL STALL FLUTTER M.S. Thesis
JEFFREY D. CLARKSON Mar. 1992 191 p
(AD-A247302) Avail: CASI HC A09/MF A02

A fully factorized two-dimensional Navier-Stokes flow solver has been developed and applied to the problem of predicting subsonic airfoil flutter in the light stall regime. The inviscid fluxes are evaluated with a central difference ADI scheme and fourth and second order numerical dissipation is used to obtain oscillation-free solutions. The performance of algebraic and one-equation turbulence models in predicting separated flow is explored for computing high Reynolds number steady flow and unsteady flows over an oscillating NACA 0012 airfoil. Comparisons of the computed results with available experimental data indicate that even though the lift response is fairly well predicted, the computation of the pitching moment hysteresis loops is very sensitive to turbulence modeling. Results computed with several current models are in good agreement whenever the steady stall angle is exceeded only slightly. However, they fail to capture the vortex shedding process leading to the onset of stall flutter. GRA

N92-31508# Laboratoire d'Aerothermique du CNRS, Meudon (France).
FLAT PLATES PLACED IN DEPLETED HYPERSONIC FLOW [PLAQUES PLANES PLACEES EN ECOULEMENTS HYPERSONIQUES RAREFIES: ANNEXE]
J. ALLEGRE (Societe d'Etudes et de Services pour Souffleries et Installations Aerothermodynamiques, Paris, France), M. RAFFIN (Societe d'Etudes et de Services pour Souffleries et Installations Aerothermodynamiques, Paris, France), J. C. LENGRAND, A. CHPOUN (Institut Univ. de Technologie, Evry, France), and L. GOTTESDIENER (Paris VI Univ., France) Mar. 1991 41 p In FRENCH
(Contract DRET-88-521)
(SESSIA-430/91.960; CNRS-RC-91-1; ETN-92-91319) Avail: CASI HC A03/MF A01

The present volume is the annex of the project's final report. It contains the experimental data obtained during wind tunnel tests. The purpose of the project was to measure the heat flow and the wall pressure of flat plates under hypersonic flow and low Reynolds number. Experimental and theoretical data, calculated by the Monte Carlo and Navier-Stokes methods, were compared. The three flow conditions were characterized by a Mach number approximately equal to 20 and Reynolds (Re) number equal to 2850, 8380, and 72770. Good agreement was observed between the theoretical and experimental values in the following cases: for Re = 2850, the best approach was the direct simulation Monte Carlo; for Re = 8380 and 72770, the best approach was obtained by the Navier Stokes method. ESA

N92-31514# Cranfield Inst. of Tech., Bedford (England). College of Aeronautics.

AN INVESTIGATION INTO THE INTERFACE BETWEEN THREE CLOSELY SPACED AXI-SYMMETRIC BODIES AT SUBSONIC SPEED

D. I. T. P. LLEWELYN-DAVIES Sep. 1991 200 p Sponsored by RAE/Defence Research Agency, Farnborough, England
(CRANFIELD-AERO-9114; ISBN-1-871564-387; ETN-92-91727)
Avail: CASI HC A09/MF A03

An experimental investigation into the interference effects present between three closely spaced bodies, over a range of 0 to 6 deg of either pitch or yaw, is presented. Detailed C(sub p) (pressure coefficient (p-p0(q))) distributions were obtained over the bodies and these were successively integrated to obtain the loading distribution along the bodies and the overall forces and moments. By analysis of contour maps representing the C(sub p) distribution over the bodies, the loading diagrams, and the overall loads, the extent of the interference regions and their effect on the aerodynamic characteristics of the bodies were determined. A panel method was used to estimate the C(sub p) distributions over the bodies and, as previously, the loading distributions along the bodies and the overall forces. Estimates were also made of the characteristics of the bodies when the attitude of the body combination was varied between 0 and -6 deg pitch, and when yaw was varied between 0 and +6 deg at pitch angles of +6 and -6 deg. ESA

N92-31532*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

WIND TUNNEL AERODYNAMIC CHARACTERISTICS OF A TRANSPORT-TYPE AIRFOIL IN A SIMULATED HEAVY RAIN ENVIRONMENT

GAUDY M. BEZOS, R. EARL DUNHAM, JR., GARL L. GENTRY, JR., and W. EDWARD MELSON, JR. (National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.) Aug. 1992 68 p
(Contract RTOP 505-68-01-02)
(NASA-TP-3184; L-16959; NAS 1.60:3184) Copyright Avail: CASI HC A04/MF A01

The effects of simulated heavy rain on the aerodynamic characteristics of an NACA 64-210 airfoil section equipped with leading-and trailing-edge high-lift devices were investigated in the Langley 14- by 22-Foot Subsonic Tunnel. The model had a chord of 2.5 ft, a span of 8 ft, and was mounted on the tunnel centerline between two large endplates. Aerodynamic measurements in and out of the simulated rain environment were obtained for dynamic pressures of 30 and 50 psf and an angle-of-attack range of 0 to 20 degrees for the cruise configuration. The rain intensity was varied to produce liquid water contents ranging from 16 to 46 gm/cu m. The results obtained for various rain intensity levels and tunnel speeds showed significant losses in maximum lift capability and increases in drag for a given lift as the liquid water content was increased. The results obtained on the landing configuration also indicate a progressive decrease in the angle of attack at which maximum lift occurred and an increase in the slope of the pitching-moment curve as the liquid water content was increased. The sensitivity of test results to the effects of the water surface tension was also investigated. A chemical was introduced into the rain environment that reduced the surface tension of water by a factor of 2. The reduction in the surface tension of water did not significantly alter the level of performance losses for the landing configuration. Author

N92-31533*# MCAT Inst., San Jose, CA.

HYPERSONIC CODE EFFICIENCY AND VALIDATION STUDIES Progress Report

BRADFORD C. BENNETT Aug. 1992 25 p Original contains color illustrations
(Contract NCC2-522)
(NASA-CR-190680; NAS 1.26:190680; MCAT-92-014) Avail: CASI HC A03/MF A01; 10 functional color pages

Renewed interest in hypersonic and supersonic flows spurred the development of the Compressible Navier-Stokes (CNS) code. Originally developed for external flows, CNS was modified to enable it to also be applied to internal high speed flows. In the initial phase of this study CNS was applied to both internal flow applications and fellow researchers were taught to run CNS. The second phase of this research was the development of surface grids over various aircraft configurations for the High Speed Research Program (HSRP). The complex nature of these configurations required the development of improved surface grid generation techniques. A significant portion of the grid generation effort was devoted to testing and recommending modifications to early versions of the S3D surface grid generation code. Author

N92-31555# Arizona State Univ., Tempe.

STABILITY AND TRANSITION OF HYPERSONIC BOUNDARY-LAYER FLOWS Final Report

HELEN L. REED and WILLIAM S. SARIC Apr. 1992 32 p
(Contract F49620-88-C-0076)
(AD-A250279; AFOSR-92-0399TR) Avail: CASI HC A03/MF A01

This final report describes our research of hypersonic and supersonic boundary-layer flows. In spite of its extreme importance to the accurate prediction of drag and heating requirements in high-speed flow, the study of boundary-layer transition in hypersonic (NASP) and supersonic (fighter and high-speed civil transport) flows is still very much in its infancy. Transition is well known, however, to depend strongly on such effects as pressure gradient, wall curvature, sweep, roughness, wall mass transfer, freestream and wall temperature, nose radius, nonequilibrium chemistry, and freestream disturbances. (These effects have been discussed in any number of workshops and U.S. Transition Study Group meetings under the direction of Eli Reshotko.) We have completed detailed studies of the stability of the laminar basic state of 2-D and axisymmetric boundary layers with non-equilibrium chemistry included and 3-D boundary-layer flows of an ideal gas. (Relatively simple geometries were considered due to the anticipated difficulties in performing basic-state analyses.) GRA

N92-31622# Air Force Academy, CO. Research Lab.

ACTIVE CONTROL OF THE SEPARATION REGION ON A TWO-DIMENSIONAL AIRFOIL

JULIE A. LOVATO Mar. 1992 145 p
(Contract AF PROJ. 2300)
(AD-A249739; FJSRL-TR-92-0001) Avail: CASI HC A07/MF A02

This experimental analysis presents a comprehensive study of the separating boundary layer over a static airfoil under natural and actively controlled conditions. Near-surface hot-film and surface pressure measurements, as well as flow visualization are used to analyze the large-scale nature of the flow over a two-dimensional NACA-0015 airfoil and determine forcing effects. Results from the static study are then extended for an initial evaluation of unsteady airfoil control. Results show that the fundamental frequency associated with free shear layer instabilities for this case is an integral multiple of the frequency associated with wake structures. The static separating boundary layer response to active control confirms that it is a boundary layer transitioning to a free shear layer. Qualitative analyses show that significant reduction in overall static separation can be achieved under forcing conditions. Upper airfoil surface suction values are also significantly increased over the natural values. Applying tangential pulsed air control at static fundamental frequencies to a dynamic airfoil results in delay of

the dynamic stall vortex formation and a delay of dynamic stall. These discoveries indicate that the developed control methodology may prove successful in increasing unsteady aircraft maneuverability. GRA

N92-31777# Boeing Aerospace and Electronics Co., Seattle, WA.
LOW DENSITY REAL GAS FLOWS ABOUT HYPERSONIC VEHICLES Final Report
J. J. HOFFMAN, R. S. WONG, and J. K. KRAUSS Nov. 1991 104 p
(Contract F33615-86-C-3006)
(AD-A250048; WL-TR-91-3072) Avail: CASI HC A06/MF A02

This document represents the final report for Air Force contract F33615-86-C-3006, 'Low Density Real Gas Flows About Hypersonic Vehicles'. The focus of this contract was the development of a computer code capable of predicting trends in hypersonic vehicle flowfield properties to support design trade studies for improved hypersonic vehicles. This report provides details of the Hypersonic Low Density Analysis (HYLDA) code developed for this contract. Included in this report are summaries of the HYLDA code, details of the HYLDA fully-coupled Navier-Stokes/finite rate chemistry solution algorithm, details of the thermochemistry models used by the code, and results from three Government-supplied demonstration cases. Code summaries discussed include code features, code design, and multiprocessing capability, while the algorithm discussion includes governing equations, development of the solution algorithm, and boundary conditions. The thermochemistry discussion includes details of the chemistry model transport properties model, and species thermodynamics properties model developed for the HYLDA code. The Government-supplied demonstration cases consist of a Mach 16 wedge flow, a Mach 12 biconic, and a Mach 5 catalytic hemisphere. GRA

N92-31853# Catholic Univ. of America, Washington, DC. Dept. of Mechanical Engineering.
ORGANIZED TURBULENT STRUCTURES AND THEIR INDUCED WALL PRESSURE FLUCTUATIONS Ph.D. Thesis Interim Report, Jun. 1991 - May 1992
VINCENT WILCZYNSKI 8 May 1992 286 p
(Contract N00014-91-J-1925)
Copyright Avail: CASI HC A13/MF A03

The interaction between the velocity fluctuations within and the wall pressure below a turbulent boundary layer was experimentally investigated. Simultaneous measurements of the velocity and wall pressure fluctuations were obtained using hot-wire anemometers and an acoustic microphone, respectively. The spectral, statistical, and temporal characteristics of the data were analyzed using long time averaging techniques and event detection methods. Five of the known classes of coherent structure were identified in the collected data by more than one signal processing method. Large scale structure was observed outside the boundary layer, transmitted across the boundary layer, and produced low frequency oscillations in the wall pressure signature. Intermittent, short duration velocity events, which are related to the production and dissipation of turbulence were identified across the boundary layer. These fluctuations produced a discernable pattern in the wall pressure signature, and the observations were used to produce a model of the wall pressure fluctuations during the turbulence production process. Author

N92-31863# Princeton Univ., NJ.
AUTOMATIC DESIGN OF TRANSONIC AIRFOILS TO REDUCE THE SHOCK INDUCED PRESSURE DRAG
ANTONY JAMESON *In* Israel Society of Aeronautics and Astronautics, 31st Israel Annual Conference on Aviation and Astronautics p 5-17 22 Feb. 1990 Previously announced in IAA as A91-43078
Avail: CASI HC A03/MF A03

This paper discusses the use of control theory for optimum design of aerodynamic configurations. Examples are presented of the application of this method to the reduction of shock induced pressure drag on airfoils in two-dimensional transonic flow. ISA

N92-31888# Israel Aircraft Industries Ltd., Ben-Gurion Airport. Aerodynamics Dept.
EULER SOLVER FOR ARBITRARY CONFIGURATIONS: FURTHER APPLICATIONS
B. EPSTEIN, A. L. LUNTZ, and A. NACHSHON *In* Israel Society of Aeronautics and Astronautics, 31st Israel Annual Conference on Aviation and Astronautics p 205-216 22 Feb. 1990 Previously announced in IAA as A91-43100
Avail: CASI HC A03/MF A03

Further applications of a three-dimensional Euler code which is able to treat arbitrary aerodynamic configurations in a wide range of flight conditions are presented. Previous publications have demonstrated the ability of the code to handle complex aircraft configurations. The present applications verify the code in flight regimes not covered by potential codes (e.g., high supersonic flow and vortex flow) by comparison with reliable, internationally reported wind tunnel experiments and analytical solutions (where available). A short description of the code is also included. ISA

N92-31889# Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
THE THREE-DIMENSIONAL STABILITY OF THE FOEPPL VORTICES
Z. RUSAK and A. SEGINER *In* Israel Society of Aeronautics and Astronautics, 31st Israel Annual Conference on Aviation and Astronautics p 217-225 22 Feb. 1990 Previously announced in IAA as A91-43101
Avail: CASI HC A02/MF A03

The three-dimensional stability of a vortex pair in the cross flow behind an infinite solid circular cylinder (the Foeppl vortices), is investigated. The vortices are assumed to be parallel potential vortex filaments, and the cylinder is modelled by a potential source surface distribution. Small three-dimensional waves are imposed on the vortex filaments, concurrently with fluctuations in the intensity of the source distribution, and with a prescribed unsteady perturbation of the radius of the cylinder. A linearization of the flow-field equations results in first-order linear differential equations, that describe the time-history of the vortex perturbations in their symmetric and anti-symmetric modes. The development of the perturbations in both modes is analogous to the motion of a unit mass on a spring-and-damper combination. The generalized damping in each mode governs the static stability of the vortices. Results show that the well-known anti-symmetric two-dimensional dynamic instability of the Foeppl vortices vanishes as the wave number of the perturbations increases and they become stable, whereas the symmetric mode becomes unstable in a limited range of wave-numbers, and is governed mainly by the Crow instability of a free vortex pair. The Foeppl vortices can also tend to diverge statically at certain wave numbers and swirl ratios that characterize the vortices. ISA

N92-32062# Naval Postgraduate School, Monterey, CA.
EXPLORATORY EXPERIMENTAL INVESTIGATION OF A WAVE PROPELLER M.S. Thesis
CARL W. DANE Mar. 1992 67 p
(AD-A252175) Avail: CASI HC A04/MF A01

A low-speed wind tunnel investigation was conducted to determine if a small secondary airfoil, or wave propeller, oscillating in a rotary plunging motion, could significantly affect the airflow over a lifting airfoil surface enough to delay the onset of stall. The lifting airfoil shape was a NACA 66(215)-216, chosen for its chordwise pressure instrumentation. Testing consisted of measuring the pressure distribution of the NACA 66(215)-216 airfoil past the stall angle-of-attack, and then again in combination with the wave propeller. The wave propeller was located in two different positions: above the lifting airfoils trailing edge, and aft of the trailing edge. The propeller was operated in both clockwise and counter-clockwise directions. The propeller effectiveness was evaluated by comparing the pressure distributions and computed lift curve slopes with and without propeller operation. Reynolds number varied from 1.28 x 10(exp 5) to 2.56 x 10(exp 5). Mechanical limitations resulted in testing to only ten percent of the desired

wave propeller speeds. Results indicated that the wave propeller acted to block the air flow over the lifting wing causing early separation and loss of lift. GRA

N92-32114*# Virginia Polytechnic Inst. and State Univ., Blacksburg.
A COMPUTATIONAL EXAMINATION OF DIRECTIONAL STABILITY FOR SMOOTH AND CHINED FOREBODIES AT HIGH-ALPHA Report, 15 Aug. 1990 - 15 Aug. 1991
RAMAKRISHNAN RAVI and WILLIAM H. MASON Washington NASA. Langley Research Center Aug. 1992 84 p
(Contract NAG1-1037; RTOP 505-68-30-03)
(NASA-CR-4465; NAS 1.26:4465; VPI-AERO-182) Avail: CASI HC A05/MF A01

Computational Fluid Dynamics (CFD) has been used to study aircraft forebody flowfields at low-speed, angle-of-attack conditions with sideslip. The purpose is to define forebody geometries which provide good directional stability characteristics under these conditions. The flows over the experimentally investigated F-5A forebody and chine type configuration, previously computed by the authors, were recomputed with better grid topology and resolution. The results were obtained using a modified version of CFL3D (developed at NASA Langley) to solve either the Euler equations or the Reynolds equations employing the Baldwin-Lomax turbulence model with the Degani-Schiff modification to account for massive crossflow separation. Based on the results, it is concluded that current CFD methods can be used to investigate the aerodynamic characteristics of forebodies to achieve desirable high angle-of-attack characteristics. An analytically defined generic forebody model is described, and a parametric study of various forebody shapes was then conducted to determine which shapes promote a positive contribution to directional stability at high angle-of-attack. An unconventional approach for presenting the results is used to illustrate how the positive contribution arises. Based on the results of this initial parametric study, some guidelines for aerodynamic design to promote positive directional stability are presented. Author

N92-32162*# Texas Univ., Arlington. Dept. of Mechanical and Aerospace Engineering.
EXPERIMENTAL STUDIES OF HYPERSONIC SHOCK-WAVE BOUNDARY-LAYER INTERACTIONS Final Report
FRANK K. LU 10 Sep. 1992 66 p
(Contract NAG1-891)
(NASA-CR-190731; NAS 1.26:190731) Avail: CASI HC A01/MF A01

Two classes of shock-wave boundary-layer interactions were studied experimentally in a shock tunnel in which a low Reynolds number, turbulent flow at Mach 8 was developed on a cold, flat test surface. The two classes of interactions were: (1) a swept interaction generated by a wedge ('fin') mounted perpendicularly on the flat plate; and (2) a two-dimensional, unseparated interaction induced by a shock impinging near an expansion corner. The swept interaction, with wedge angles of 5-20 degrees, was separated and there was also indication that the strongest interactions prossessed secondary separation zones. The interaction spread out extensively from the inviscid shock location although no indication of quasi-conical symmetry was evident. The surface pressure from the upstream influence to the inviscid shock was relatively low compared to the inviscid downstream value but it rose rapidly past the inviscid shock location. However, the surface pressure did not reach the downstream inviscid value and reasons were proposed for this anomalous behavior compared to strongly separated, supersonic interactions. The second class of interactions involved weak shocks impinging near small expansion corners. As a prelude to studying this interaction, a hypersonic similarity parameter was identified for the pure, expansion corner flow. The expansion corner severely damped out surface pressure fluctuations. When a shock impinged upstream of the corner, no significant changes to the surface pressure were found as compared to the case when the shock impinged on a flat plate. But, when the shock impinged downstream of the corner, a close coupling existed between the two wave systems, unlike the supersonic case. This close coupling modified the upstream influence. Regardless of whether the shock impinged ahead or behind the corner, the downstream region was affected by the close coupling between the shock and the expansion. Not only was the mean pressure distribution modified but the unsteadiness in the surface pressure was reduced compared to the flat-plate case. Author

N92-32177*# MCAT Inst., San Jose, CA.
CONTROL OF UNSTEADY SEPARATED FLOW ASSOCIATED WITH THE DYNAMIC STALL OF AIRFOILS Final Report, 2 Mar. - 15 Jul. 1992
MICHAEL C. WILDER Aug. 1992 32 p
(Contract NCC2-637)
(NASA-CR-190688; NAS 1.26:190688; MCAT-92-015) Avail: CASI HC A03/MF A01

The two principal objectives of this research were to achieve an improved understanding of the mechanisms involved in the onset and development of dynamic stall under compressible flow conditions, and to investigate the feasibility of employing adaptive airfoil geometry as an active flow control device in the dynamic stall engine. Presented here are the results of a quantitative (PDI) study of the compressibility effects on dynamic stall over the transiently pitching airfoil, as well as a discussion of a preliminary technique developed to measure the deformation produced by the adaptive geometry control device, and bench test results obtained using an airfoil equipped with the device. Author

N92-32213*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
TRANSONIC WIND TUNNEL TEST OF A 14 PERCENT THICK OBLIQUE WING
ROBERT A. KENNELLY, JR., ILAN M. KROO (Stanford Univ., CA.), JAMES M. STRONG, and RALPH L. CARMICHAEL Aug. 1990 430 p
(Contract RTOP 533-06-01)
(NASA-TM-102230; A-89236; NAS 1.15:102230) Avail: CASI HC A19/MF A04

An experimental investigation was conducted at the ARC 11-by 11-Foot Transonic Wind Tunnel as part of the Oblique Wing Research Aircraft Program to study the aerodynamic performance and stability characteristics of a 0.087-scale model of an F-8 airplane fitted with an oblique wing designed by Rockwell International. The 10.3 aspect ratio, straight-tapered wing of 0.14 thickness/chord ratio was tested at two different mounting heights above the fuselage. Additional tests were conducted to assess low-speed behavior with and without flaps, aileron effectiveness at representative flight conditions, and transonic drag divergence with 0 degree wing sweep. Longitudinal stability data were obtained at sweep angles of 0, 30, 45, 60, and 65 degrees, at Mach numbers ranging from 0.25 to 1.40. Test Reynolds numbers varied from 3.2 to 6.6 x 10 exp 6/ft. and angle of attack ranged from -5 to +18 degrees. Most data were taken at zero sideslip, but a few runs were at sideslip angles of +/- 5 degrees. The raised wing position proved detrimental overall, although side force and yawing moment were reduced at some conditions. Maximum lift coefficient with the flaps deflected was found to fall short of the value predicted in the preliminary design document. The performance and trim characteristics of the present wing are generally inferior to those obtained for a previously tested wing designed at ARC. Author

N92-32226*# Boeing Commercial Airplane Co., Seattle, WA.
AN INSTALLED NACELLE DESIGN CODE USING A MULTIBLOCK EULER SOLVER. VOLUME 1: THEORY DOCUMENT Final Report
H. C. CHEN Sep. 1992 59 p
(Contract NAS1-18703)
(NASA-CR-189652-VOL-1; NAS 1.26:189652-VOL-1) Avail: CASI HC A04/MF A01

An efficient multiblock Euler design code was developed for designing a nacelle installed on geometrically complex airplane configurations. This approach employed a design driver based on a direct iterative surface curvature method developed at LaRC. A

general multiblock Euler flow solver was used for computing flow around complex geometries. The flow solver used a finite-volume formulation with explicit time-stepping to solve the Euler Equations. It used a multiblock version of the multigrid method to accelerate the convergence of the calculations. The design driver successively updated the surface geometry to reduce the difference between the computed and target pressure distributions. In the flow solver, the change in surface geometry was simulated by applying surface transpiration boundary conditions to avoid repeated grid generation during design iterations. Smoothness of the designed surface was ensured by alternate application of streamwise and circumferential smoothings. The capability and efficiency of the code was demonstrated through the design of both an isolated nacelle and an installed nacelle at various flow conditions. Information on the execution of the computer program is provided in volume 2.
Author

N92-32228*# Boeing Commercial Airplane Co., Seattle, WA.
AN INSTALLED NACELLE DESIGN CODE USING A MULTIBLOCK EULER SOLVER. VOLUME 2: USER GUIDE Final Report
H. C. CHEN Sep. 1992 74 p
(Contract NAS1-18703)
(NASA-CR-189652-VOL-2; NAS 1.26:189652-VOL-2) Avail: CASI HC A04/MF A01

This is a user manual for the general multiblock Euler design (GMBEDS) code. The code is for the design of a nacelle installed on a geometrically complex configuration such as a complete airplane with wing/body/nacelle/pylon. It consists of two major building blocks: a design module developed by LaRC using directive iterative surface curvature (DISC); and a general multiblock Euler (GMBE) flow solver. The flow field surrounding a complex configuration is divided into a number of topologically simple blocks to facilitate surface-fitted grid generation and improve flow solution efficiency. This user guide provides input data formats along with examples of input files and a Unix script for program execution in the UNICOS environment.
Author

N92-32240*# Sverdrup Technology, Inc., Brook Park, OH.
THREE-DIMENSIONAL COMPRESSIBLE TURBULENT COMPUTATIONS FOR A NONDIFFUSING S-DUCT Final Report
G. J. HARLOFF, J. R. DEBONIS, C. F. SMITH, and J. E. BRUNS
Washington NASA. Lewis Research Center Apr. 1992 31 p
(Contract NAS3-25266; RTOP 533-02-30)
(NASA-CR-4391; E-6173; NAS 1.26:4391) Avail: CASI HC A03/MF A01

The PARC3D code was used to compute the compressible turbulent flow within a three dimensional, nondiffusing S-duct. A frame of reference is provided for future computational fluid dynamics studies of internal flows with strong secondary flows and provides an understanding of the performance characteristics of a typical S-duct with attached flow. The predicted results, obtained with both H- and O-grids, are compared with the experimental wall pressure, static and total pressure fields, and velocity vectors. Additionally, computed boundary layer thickness, velocity profiles in wall coordinates, and skin friction values are presented.
Author

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AIR TRANSPORTATION AND SAFETY

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

A92-51439
AIRLINE INDUSTRY SAFETY MANAGEMENT SYSTEMS AND FEEDBACK
DAVID A. SIMMON (United Airlines, Elk Grove Village, IL) IN: Risk management - Expanding horizons in nuclear power and other industries. New York, Hemisphere Publishing Corp., 1991, p. 107-112.
Copyright

A review is presented of some of the safety management programs and feedback systems organized within United Airlines. Attention is given to the safety organizations, flight safety focus and functions, the duty manager briefing, and flight safety investigations. Consideration is given to flight safety awareness reports, training feedback, statistical goals, and the flight data recorder exceedance program.
R.E.P.

A92-51440* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
COCKPIT CREW RESEARCH
BARBARA G. KANKI (NASA, Ames Research Center, Moffett Field, CA) IN: Risk management - Expanding horizons in nuclear power and other industries. New York, Hemisphere Publishing Corp., 1991, p. 137-142. refs
Copyright

A review is presented of the cockpit crew research work conducted at Ames Research Center including an overview of the problem areas of risk in the aviation environment. Attention is given to transportation fatalities, accident and incident reports, cockpit resource management, and current aircrew research.
R.E.P.

A92-52645
MIDAIR COLLISION - THE LINKS IN A CHAIN
JOHN A. POPE (John A. Pope & Associates, Arlington, VA) SAFE Journal, vol. 22, no. 4, July-Aug. 1992, p. 19-24.
Copyright

The chain of events leading to a collision between a fixed-wing aircraft and a helicopter is described and analyzed to set forth recommendations for avoiding similar situations. Specific attention is given to the events which occurred after the helicopter pilot offered to fly beneath the chartered aircraft to inspect the landing gear. The conclusions of the National Transportation Safety Board are that: (1) deficiencies exist in operator training; (2) there lacked coordination for close-range maneuvering; and (3) the helicopter was responsible for maintaining safe separation. The critical factors proposed in the paper include human error and inexperience, the training of air taxi operators to meet the Federal Aviation Regulations, and lack of coordination between the pilots. The accident is shown to raise important questions regarding the market for on-demand air taxi operators in terms of ownership, management, financial condition, and knowledge of and adherence to air-traffic safety protocols.
C.C.S.

A92-53018
A STUDY ON THE MARGINAL ANALYSIS METHOD FOR THE AIRLINE YIELD MANAGEMENT
JIANCHENG GUAN (Beijing Institute of Aeronautics and Astronautics, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 11, Nov. 1991, p. A615-A620. In Chinese. refs

A new marginal analytical method for determining the optimal allotment for the two-fare class seat inventory control problem in air transportation is presented, emphasizing the theoretical aspects of the problem. The formulation derivation, based on the fact that passenger demand number is a discrete random variable, is demonstrated in detail. The formula obtained here shows that the optimal seat allotment relates to the distributions of both high-fare demand and low-fare demand, is an important corrective to traditional formulas in this field. The greater accuracy and practicality of the formula is shown by example.
C.D.

A92-53236
HUMAN FACTORS AND SIMULATION [LES FACTEURS HUMAINS A TRAVERS LA SIMULATION]
NOEL CHEVRIER (UTA French Airlines, Paris, France) (Institut Francais de Navigation, Colloque sur la Simulation Aerienne et Maritime, Paris, France, Dec. 11, 1991) Navigation (Paris) (ISSN

0028-1530), vol. 40, no. 159, July 1992, p. 287-303. In French. Copyright

A study of human performance factors involved in aircraft accidents is presented, focusing on cockpit human factors research requirements is presented. It is shown that, although, aircraft design and development and cockpit automation have made great progress, human errors in aircraft accidents continue to be prevalent. Attention is given to the role played by the ICAO in accident investigation and research in accident prevention, simulator training, cockpit resource management, and line oriented flight training. R.E.P.

A92-53340
A STUDY OF DYNAMIC RESPONSE TO BIRD IMPACT ON ARC WINDSHIELDS OF AIRCRAFTS
QIQIAO ZHANG and ZONGQING XU (Nanchang Aircraft Manufacture Co., China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 2, Feb. 1991, p. B100-B105. In Chinese. refs

Bird impact on aircraft windshields and canopies poses a significant hazard and results in unacceptable losses of aircrafts and crewmembers. This paper, based on the simulation of full-scale bird impact tests, describes the results of studies of the dynamic response to bird on arc windshields of aircraft. The method of calculating impact load is also investigated. Author

N92-30395*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
LEWIS ICING RESEARCH TUNNEL TEST OF THE AERODYNAMIC EFFECTS OF AIRCRAFT GROUND DEICING/ANTI-ICING FLUIDS
L. JAMES RUNYAN (Boeing Commercial Airplane Co., Seattle, WA.), THOMAS A. ZIERTEN (Boeing Commercial Airplane Co., Seattle, WA.), EUGENE G. HILL (Boeing Commercial Airplane Co., Seattle, WA.), and HAROLD E. ADDY, JR. Aug. 1992 134 p
(Contract RTOP 505-68-11)
(NASA-TP-3238; E-5808; NAS 1.15:3238) Avail: CASI HC A07/MF A02

A wind tunnel investigation of the effect of aircraft ground deicing/anti-icing fluids on the aerodynamic characteristics of a Boeing 737-200ADV airplane was conducted. The test was carried out in the NASA Lewis Icing Research Tunnel. Fluids tested include a Newtonian deicing fluid, three non-Newtonian anti-icing fluids commercially available during or before 1988, and eight new experimental non-Newtonian fluids developed by four fluid manufacturers. The results show that fluids remain on the wind after liftoff and cause a measurable lift loss and drag increase. These effects are dependent on the high-lift configuration and on the temperature. For a configuration with a high-lift leading-edge device, the fluid effect is largest at the maximum lift condition. The fluid aerodynamic effects are related to the magnitude of the fluid surface roughness, particularly in the first 30 percent chord. The experimental fluids show a significant reduction in aerodynamic effects. Author

N92-30418# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany).
THE EUROFAR PROGRAM: AN EUROPEAN OVERVIEW ON ADVANCED VTOL CIVIL TRANSPORTATION SYSTEM
J. RENAUD (Aerospatiale, Paris, France), H. HUBER, and G. VENN (Westland Helicopters Ltd., Yeovil, England) 1991 12 p Presented at the 17th European Rotorcraft Forum, Berlin, Fed. Republic of Germany, 24-27 Sep. 1991
(MBB-UD-0611-91-PUB; ETN-92-91890) Avail: CASI HC A03/MF A01

Some European overviews on the role which could be devoted to a Vertical Take Off and Landing (VTOL) transportation system based on the tilt rotor, and the conditions of introduction of this aircraft within civil community, are summarized. As regards these issues, the Eurofar approach is based on aircraft design activities, and on studies related to marketing, infrastructure and airspace system. ESA

N92-30474# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
EXAMINATION OF AIRCRAFT WARNING AND CAUTION LIGHTS AFTER SHOCK TESTING
W. J. A. BONNEE and H. J. KOLKMAN 15 Aug. 1989 16 p Presented at the International Symposium for Testing and Failure Analysis, Los Angeles, CA, 6-10 Nov. 1989 Sponsored by Royal Netherlands Air Force
(NLR-TP-89284-U; ETN-92-91525) Avail: CASI HC A03/MF A01

Warning and caution light bulbs recovered after aircraft accidents provide useful information. It is generally assumed that upon impact the filament of an unlit bulb will break without deformation, whereas a hot filament will show extensive elongation. Deviations from this idealized behavior were investigated by shock tests on F-16 warning and caution light bulbs. From the tests it could be concluded that relatively new lamps do not show the idealized behavior described above. This makes it necessary in certain cases to estimate the number of burning hours by a simple scanning electron microscopy (SEM) investigation of the surface morphology of the filament. Besides its age, the behavior of a filament upon impact is also influenced by the direction and especially the duration and maximum g-level of the impact. However, the behavior of a burning lamp is not influenced by deviations from the correct voltage. The above results are included in a recommended procedure for examining light bulbs after aircraft accidents. ESA

N92-30551# Federal Aviation Administration, Washington, DC. Office of Aviation Medicine.
EVALUATION OF HEAD IMPACT KINEMATICS FOR PASSENGERS SEATED BEHIND INTERIOR WALLS Final Report
VAN GOWDY and RICHARD DEWEESE May 1992 15 p
(AD-A252651; DOT/FAA/AM-92/20) Avail: CASI HC A03/MF A01

Federal Aviation Regulations for crashworthy seats include the Head Injury Criteria (HIC) as part of the pass-fail performance specifications. For passenger seats located behind interior walls to meet this requirement, the dynamics of head impact with the wall must be evaluated from a system approach. Procedures for conducting system tests and analyzing the head motion of an anthropomorphic test dummy (ATD) are described. Analyses of head kinematics from dynamic impact tests with a lap belt restrained ATD are presented. GRA

N92-30980# Advanced Aviation Concepts, Jupiter, FL.
INTRODUCTION TO COGNITIVE PROCESSES OF EXPERT PILOTS Final Report
RICHARD J. ADAMS and K. ANDERS ERICSSON (Colorado Univ., Boulder.) Jun. 1992 50 p
(Contract DTFA01-90-C-00042)
(DOT/FAA/RD-92/12) Avail: CASI HC A03/MF A01

This report addresses the historical problem that a very high percentage of accidents have been classified as involving 'pilot error'. Through extensive research since 1977, the Federal Aviation Administration determined that the predominant underlying cause of these types of accidents involved decisional problems or cognitive information processing. To attack these problems, Aeronautical Decision Making (ADM) training materials were developed and tested for ten years. Since the publication of the ADM training manuals in 1987, significant reductions in human performance error (HPE) accidents have been documented both in the U.S. and world wide. However, shortcomings have been observed in the use of these materials for recurrency training and in their relevance to more experienced pilots. The following discussion defines the differences between expert and novice decision makers from a cognitive information processing perspective, correlates the development of expert pilot cognitive processes with training and experience, and reviews accident scenarios which exemplify those processes. This introductory material is a necessary prerequisite to an understanding of how to formulate expert pilot decision making training innovations. Author

N92-31159# National Transportation Safety Board, Washington, DC.
AIRCRAFT ACCIDENT REPORT: EXPLOSIVE DECOMPRESSION - LOSS OF CARGO DOOR IN FLIGHT, UNITED AIRLINES FLIGHT 811, BOEING 747-122, N4713U, HONOLULU, HAWAII, FEBRUARY 24, 1989
18 Mar. 1992 119 p Supersedes NTSB/AAR-90/01; N90-21748
(PB92-910402; NTSB/AAR-92/02; NTSB/AAR-90/01) Avail: CASI HC A06/MF A02

This report explains the explosive decompression resulting from the loss of a cargo door in flight on United Airlines flight 811, a Boeing 747-122, near Honolulu, Hawaii, on Feb. 24, 1989. The safety issues discussed in this report are the design and certification of the B-747 cargo doors, the operation and maintenance to assure the continuing airworthiness of the doors, and emergency response. Recommendations concerning these issues were made to the Federal Aviation Administration, the State of Hawaii, and the U.S. Department of Defense. Author

N92-31193# Army Engineer Waterways Experiment Station, Vicksburg, MS. Geotechnical Lab.
EVALUATION OF GROUNDING AND MOORING POINTS FOR ARMY AIRCRAFT Final Report
RICHARD H. GRAU and DAVID L. COOKSEY Apr. 1992 68 p
(AD-A250749; WES/MP/GL-92-10) Avail: CASI HC A04/MF A01

This report presents results of tests conducted to evaluate the load capacity of aircraft mooring and grounding points. Both existing mooring points located at a military installation and newly designed systems were evaluated. Specifically, this report documents laboratory and field investigations on mooring systems to evaluate their ability to withstand anticipated forces applied by a moored Army aircraft during a 100-knot wind. GRA

N92-31211# Computer Resource Management, Inc., Herndon, VA.
NATIONAL AIRSPACE SYSTEM. AIR DEFENSE AND LAW ENFORCEMENT SURVEILLANCE OPERATIONAL CONCEPT NAS-SR-135
WILLIAM TRENT, THOMAS PICKERELL, and HAROLD NELSON, JR. Jul. 1992 29 p
(Contract DTFA01-91-Y-01004)
(DOT/FAA/SE-92/3) Avail: CASI HC A03/MF A01

This operational concept describes the Air Defense and Law Enforcement Surveillance system which will be in place upon implementation of the Federal Aviation Administration (FAA) National Airspace System (NAS) Plan. Air Defense and Law Enforcement Surveillance includes those activities necessary to provide for the detection of aircraft throughout an Air Defense Identification Zone and Distant Early Warning Identification Zone, as well as to ascertain aircraft position, velocity, and identity of unauthorized intruders. The objective is to describe the relationship between subsystems, facilities, information, and operators/users involved in requirements stated in the National Airspace System Requirement Specification (NAS-SR-1000). Several types of block diagrams are used to illustrate systems' connectivity and operational flow. Scenarios are also derived to describe the process from a user's perspective. This concept, and the other seven operational concepts, will complete the description of the system requirements as described in the NASSRS. Author

N92-31453# *General Accounting Office, Washington, DC.* Resources, Community, and Economic Development Div.
AVIATION SAFETY: CHANGES NEEDED IN FAA'S SERVICE DIFFICULTY REPORTING PROGRAM
Mar. 1991 18 p
(GAO/RCED-91-24; B-238393) Avail: CASI HC A03/MF A01; GAO, PO Box 6015, Gaithersburg, MD 20877 HC

As requested, this group has evaluated the effectiveness of the FAA's Service Difficulty Reporting (SDR) program. The programs objective is to help airline and FAA personnel to promptly correct conditions that could adversely affect air safety. This is accomplished by distributing reports on aircraft malfunctions to airline and FAA personnel. This report centered on the SDR program's impact on the safety of aging airliners in commercial aviation and excluded general aviation. This evaluation covered: (1) the usefulness of the SDR data to FAA and airline personnel; (2) factors affecting the SDR program's usefulness; and (3) changes needed to improve the program, if warranted. H.A.

N92-31549*# *Clemson Univ., SC. Radar Systems Lab.*
SPECTRUM MODAL ANALYSIS FOR THE DETECTION OF LOW-ALTITUDE WINDSHEAR WITH AIRBORNE DOPPLER RADAR Final Report
MATTHEW W. KUNKEL Washington NASA. Langley Research Center Aug. 1992 97 p
(Contract NAG1-928; RTOP 505-64-12-02)
(NASA-CR-4457; NAS 1.26:4457; CU-TR-15;
DOT/FAA/RD-92/21) Avail: CASI HC A05/MF A02

A major obstacle in the estimation of windspeed patterns associated with low-altitude windshear with an airborne pulsed Doppler radar system is the presence of strong levels of ground clutter which can strongly bias a windspeed estimate. Typical solutions attempt to remove the clutter energy from the return through clutter rejection filtering. Proposed is a method whereby both the weather and clutter modes present in a return spectrum can be identified to yield an unbiased estimate of the weather mode without the need for clutter rejection filtering. An attempt will be made to show that modeling through a second order extended Prony approach is sufficient for the identification of the weather mode. A pattern recognition approach to windspeed estimation from the identified modes is derived and applied to both simulated and actual flight data. Comparisons between windspeed estimates derived from modal analysis and the pulse-pair estimator are included as well as associated hazard factors. Also included is a computationally attractive method for estimating windspeeds directly from the coefficients of a second-order autoregressive model. Extensions and recommendations for further study are included. Author

N92-31813# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (Germany). Abtteilung Wolkenphysik.
THE ICING OF THE ELEVATOR OF THE DLR ICING RESEARCH AIRCRAFT OF DO 28 TYPE [DIE VEREISUNG DES HOEHENRUDERS DES VEREISUNGSFORSCHUNGSFLUGZEUGS DER DLR VOM TYP DO 28]
HANS-EBERHARD HOFFMANN, JOHANN DEMMEL, and JOACHIM SCHUSTER Aug. 1991 67 p In GEORGIAN
(DLR-MITT-91-12; ISSN-0939-298X; ETN-92-91732) Avail: CASI HC A04/MF A01; DLR, Wissenschaftlisches Berichtswesen, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC

Observations of the icing of the elevator for information on the type of accretion are addressed. Most of the coarse ice structures observed until now could be related to the following icing classes: 1st stripe of rime ice; 52 stripes of rime ice as borders of one stripe of clear ice; 3 stripes of rime ice with and without clear ice between them; and 3 stripes of rime ice growing together. The maximum extension of ice accretion on the upper and bottom side of the elevator amounted to 80 mm. In this case, the temperature was about -2.5 C, the median volume diameter of the cloud particles about 400 micrometers, and the total water content between 0.02 and 0.10 g/cu m. The roughness had its maximum value of 19 mm after an incomplete pneumatic deicing. Without influence of pneumatic deicing the maximum roughness was 15 mm. ESA

N92-31862# Boeing Commercial Airplane Co., Seattle, WA.
AGING FLEET: MAINTAINING AIRWORTHINESS
B. A. COSGROVE *In* Israel Society of Aeronautics and Astronautics, 31st Israel Annual Conference on Aviation and Astronautics p 1-4 22 Feb. 1990 Previously announced in IAA as A91-43077
Avail: CASI HC A01/MF A03

In the U.S., airliner safety involves information exchange among the manufacturer, the airline, and the Federal Aviation Administration (FAA). Results of airline inspections are reported to the manufacturer and the FAA and may result in service recommendations from the manufacturer and airworthiness directives from the FAA. Since 1985, Boeing has operated a system of inspecting long-service airliners, paying special attention to fatigue effects. Where corrosion cracks have been found unexpectedly early, the cause was usually corrosion. In 1988, the manufacturers, the FAA and the National Aeronautics and Space Administration (NASA) formed an aging aircraft task force which established working groups for each aircraft model. These groups can recommend mandatory actions to the FAA. ISA

N92-31928# Department of Energy, Washington, DC.
REPORT OF THE AVIATION SAFETY REVIEW OF DEPARTMENT OF ENERGY HELICOPTER OPERATIONS
Feb. 1992 123 p
(DE92-016346; DOE/EH-0242P) Avail: CASI HC A06/MF A02

In a memorandum dated November 27, 1991, the Secretary of Energy directed the Office of Environment, Safety and Health (EH) to lead, with Program Secretarial Office participation, an aviation safety review of the safe operation of the Department's helicopter program. The Aviation Safety Review Team comprised of aviation experts from the US Army, the Federal Aviation Administration, private consulting organizations, and Department of Energy (DOE) staff was assembled. The scope of the Aviation Safety Review Team's appraisals included the following as applicable: policy; operations; maintenance; crew training; previous appraisals; contract requirements; aviation safety analysis reports; refueling facilities and management; night vision goggle (NVG) operations; helicopter limited standdown initiative; Secretary of Energy Notice (SEN) -6D-91 Compliance; and, DOE/contractor organizational structures and responsibilities. The appraisals at each site included a review of aviation policy, manuals, procedures, facilities, and documentation pertaining to management, safety, operations, maintenance, and quality control. DOE

N92-31943# European Space Agency, Paris (France).
ANALYSIS OF THREE ICING TEST FLIGHTS REACHING THE AIRCRAFT-REFERRED ICING DEGREE OF SEVERE
HANS-EBERHARD HOFFMANN (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, Germany, F.R.) and JOHANN DEMMEL (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen, Germany, F.R.) Mar. 1992 107 p Transl. into ENGLISH of Eine Analyse von drei Vereisungsfluegen mit Erreichen des Luftfahrzeugbezogenen Vereisungsgrades Severe (Oberpfaffenhofen, Germany, DLR), Aug. 1990 118 p Original language document was announced as N91-21123
(ESA-TT-1254; DLR-FB-90-34; ETN-92-91711) Avail: CASI HC A06/MF A02

Three test flights in icing conditions are discussed: one in the range of a high pressure area, and the other two in the range of warm fronts, where the aircraft-referred icing degree of 'severe' was reached. The ice accretion on the underside of the wing of the Do28 extended (at 50 to 70 cm) beyond the area which can be pneumatically deiced. In the area of the pneumatic deicing boots, the deicing was totally ineffective or incomplete. The mean values of the cloud physics parameters which produced the aircraft referred icing degree of 'severe' were: total water content 0.20, 0.22, 0.30 g/cu m; temperature -1.8, -2.0, -4.5 C; and median volume diameter 20, 180, and 300 microns. The cloud flight paths in the range of the warm fronts were only 1/10 to 3/10 of the cloud flight path in the range of high pressure areas when it came to attaining the maximum icing characteristics achieved in the range of a high pressure area. The reason for this was the considerably higher value of the median volume diameter in the range of the warm fronts. ESA

N92-32219# Defence and Civil Inst. of Environmental Medicine, Downsview (Ontario).
CANADIAN AIRCREW SEA WATER SURVIVAL, 1952-1987
C. J. BROOKS Sep. 1988 36 p
(DCIEM-88-RR-39; CTN-92-60344) Avail: CASI HC A03/MF A01

A 36-year retrospective study of all Canadian military aircraft has been conducted. There have been 55 aircraft accidents where aircrew or passengers have landed in the sea. One hundred and fifty-eight personnel have been involved with 68 fatalities, an overall survival rate of 57 percent. Survivors were rescued in under 15 minutes in 40 percent of cases; the remainder were rescued in under three hours. The longest time spent in a life raft was 2 hours and 45 minutes. Seventy percent of aircrew had less than 15 seconds warning of impending water immersion. There were five cases where crew and passengers probably died from a combination of cold, drowning, and cardiac arrythmias. Immersion suits were worn in only six accidents and in two of these, leakage was reported. Aircrew who have received training in water survival, underwater escape trainers, who are strong swimmers or sports divers, have a better chance of survival. Therefore, it is strongly recommended that aircrew, particularly helicopter pilots flying over water, should receive underwater escape training. Author (CISTI)

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

A92-49255
FORMATION FLIGHT SYSTEM DESIGN CONCEPT
CECIL RICHARDSON and MICHAEL SCHOULTZ (IBM Corp., Owego, NY) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 18-25.
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IBM recently completed a baseline design study for a formation flight system to be used for rendezvous, joinup, and formation flight of US Air Force helicopters and fixed-wing aircraft. The baseline system uses a Global Positioning System/initial navigation system (GP/INS) relative navigation concept with backup data link range measurement as the basis of the precise position location for all aircraft both within the formation and among the separate formations. Part of the study included development of flight guidance algorithms for rendezvous of helicopters with tankers, joinup of individual aircraft into existing formations, and station keeping within formation flight. The situational awareness display, guidance algorithms, and flight control cues have been demonstrated in a pilot in the loop simulator and pilot comments have been favorable. I.E.

A92-49272* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
INERTIAL NAVIGATION SENSOR INTEGRATED MOTION ANALYSIS FOR OBSTACLE DETECTION
BARRY ROBERTS (Honeywell Systems and Research Center, Minneapolis, MN), BANAVAR SRIDHAR (NASA, Ames Research Center, Moffett Field, CA), and BIR BHANU (California, University, Riverside) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 131-136. refs
Copyright

The authors describe a maximally passive system for obstacle detection and avoidance designed for rotorcraft which benefits from the use of inertial data. The sensor options are briefly discussed, and sensor fusion needs are mentioned. Some critical system requirements and their effect on system implementation are discussed. In addition, high-level system implementation issues are presented. I.E.

A92-49291
PROGRAMMABLE CHANNELIZED DIGITAL RADIO/MODEM
ROBERT S. PRILL and MICHEL ANTONESCO (GEC-Marconi Electronic Systems Corp., Totowa, NJ) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 248-251.
Copyright

The authors describe ongoing work by GEC-Marconi-Electronic Systems Division in the development of a multifunction, common module, programmable digital radio/modem. The radio system handles both conventional narrowband and spread spectrum waveforms. The architecture developed is a programmable channelized approach. In the channelized approach the modules of one channel are identical to those of the next, and as such are ideally suited to channel reusability during different parts of a mission or during failure modes of higher-priority functional systems. The hardware implementation exploits latest RF, digital/RF, and digital signal processing component technologies. A PC-based brassboard was developed and used to demonstrate real-time programmable AM, FM and IFF (identification friend or foe) data reception. I.E.

A92-49306
A DSP-BASED MICROWAVE LANDING SYSTEM (MLS) POST-IF PROCESSOR
STEVE KOCZO and ANNE W. CLARK (Collins Commercial Avionics, Cedar Rapids, IA) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 351-361. refs
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The authors describe the digital signal processor (DSP)-based implementation of the microwave landing system's (MLS's) post-IF processing functions. An MLS overview, the DSP-based post-IF processing module and MLS post-IF processing algorithms are discussed. All MLS post-if processing functions, including carrier acquisition, differential phase shift keying (DPSK) demodulation and synchronization, data decoding and scanning beam processing are implemented in a single DSP, Analog Devices' ADSP2100A. An input signal sampling rate of 25 Ks/sec is accommodated by using decimating filters, a modified fast Fourier transform algorithm, and by setting up a direct memory access between the analog-to-digital (A/D) converter and memory. I.E.

A92-49382
GLONASS DATA ANALYSIS - INTERIM RESULTS
P. MISRA, E. BAYLISS, R. LAFREY, M. PRATT, and R. HOGABOOM (MIT, Lexington, MA) Navigation (ISSN 0028-1522), vol. 39, no. 1, Spring 1992, p. 93-109. refs
(Contract DTFA-01-84-Z-02030)
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A satellite navigation data collection and analysis facility, consisting of GLONASS and GPS receivers and the supporting computer systems, has been installed at Lincoln Laboratory under the sponsorship of the FAA. Results based on an analysis of the measurements from GLONASS collected at this facility over the period of February thru July 1991 are presented. Attention is focused in the positioning results from GLONASS and some significant issues related to the system operations are examined. R.E.P.

A92-49383
ON THE CALCULATION OF REPEATABLE ACCURACY, WITH SPECIAL REFERENCE TO GPS
BORJE FORSSELL (Norwegian Institute of Technology, Trondheim, Norway) Navigation (ISSN 0028-1522), vol. 39, no. 1, Spring 1992, p. 133-136. refs
Copyright

A general formula for the repeatable horizontal accuracy of a navigation system is derived, and the influence of biases is discussed. The result is simplified for the GPS case of directionally independent random position errors with zero bias. It is shown that in such a case, the (global) mean square error of the repeatable position error is twice that of the absolute error. The conclusion is that the 95 percent repeatable accuracy of GPS with selective availability is about 140 m, not 100 m as stated in the Federal Radionavigation Plan. Author

A92-50033
DETECTION AND IMAGING OF MOVING OBJECTS WITH SYNTHETIC APERTURE RADAR. I - OPTIMAL DETECTION AND PARAMETER ESTIMATION THEORY
S. BARBAROSSA (Roma I, Universita, Rome, Italy) IEE Proceedings, Part F: Radar and Signal Processing (ISSN 0956-375X), vol. 139, no. 1, Feb. 1992, p. 79-88. Research supported by Alenia S.p.A. refs
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The aim of the paper is to provide optimal schemes, according to the maximum likelihood criterion, for the detection of moving objects observed by airborne radars, and for the synthesis of a long aperture with respect to the moving objects, necessary to produce high-resolution images. The theoretical limits of detectability and of the accuracies achievable in the estimation of the motion parameters necessary for the synthesis of the long aperture are provided. Some simple suboptimal schemes, with limited performance losses, are then proposed. Author

A92-50122
TERMINAL AREA TRAFFIC MANAGEMENT
H. G. VISSER (Delft University of Technology, Netherlands) Progress in Aerospace Sciences (ISSN 0376-0421), vol. 28, no. 4, 1991, p. 323-368. refs
Copyright

The main theme in this article is the description of time-based traffic management procedures that have been proposed to increase the capacity of the air traffic system by the beginning of the next century. However, the article starts with a brief description of today's air traffic control systems. Their shortcomings are identified and the need for improved systems and procedures is discussed. The new technologies which will make it possible to overcome the limitations of the present communication, navigation and surveillance systems by providing higher quality and improved efficiency, are briefly discussed. Because terminal area management certainly is one of the most critical aspects of overall air traffic management, the main focus in this article is on this issue. Finally, current research efforts toward improved trajectory optimization and control for flight operations in an extended terminal area are described in some detail. Author

A92-50207
PREDICTIVE CONTROL FOR OPTIMAL PATH TERRAIN FOLLOWING SYSTEM
SHUNDA XIAO (Northwestern Polytechnical University, Xian, People's Republic of China) and BENGANG CHEN (Leihua Electronic Technology Research Institute, People's Republic of China) Chinese Journal of Aeronautics (ISSN 1000-9361), vol. 4, no. 3, Aug. 1991, p. 305-311. Previously cited in issue 07, p. 987, Accession no. A91-22371. refs
Copyright

A92-50214
A STUDY ON MECHANICAL MODEL OF THE HELICOPTER 'GROUND RESONANCE'
ZHONG-QUAN GU (Nanjing Aeronautical Institute, People's Republic of China) Chinese Journal of Aeronautics (ISSN 1000-9361), vol. 4, no. 4, Nov. 1991, p. 354-360. Previously cited in issue 15, p. 2293, Accession no. A90-36423. refs
Copyright

A92-51006
JTIDS RELATIVE NAVIGATION AND DATA REGISTRATION
WAYNE W. ALTRICHTER (GEC-Marconi Electronic Systems Corp., Wayne, NJ) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 7, no. 6, June 1992, p. 42-50. refs
Copyright

The fundamental relationships of the Joint Tactical Information Distribution System (JTIDS) navigation and the error analysis for target registration and target hand-off in both geodetic and relative grid coordinates are presented. Particular attention is given to two scenarios which demonstrate the level of improvement that JTIDS navigation can have on situation awareness, target acquisition, and weapon delivery. It is shown that accurate data registration can be achieved by as few as two JTIDS members, with or without accurate knowledge of geodetic position. O.G.

A92-51007
CAPACITY AS A CONSIDERATION FOR PROVIDING AERONAUTICAL MOBILE SATELLITE AIR TRAFFIC SERVICES IN THE U.S. DOMESTIC AIRSPACE
CURTIS A. SHIVELY (Mitre Corp., McLean, VA) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 7, no. 6, June 1992, p. 51-58. refs
Copyright

A preliminary analysis is performed of the capacity of American Mobile Satellite Corporation (AMSC) system to provide aeronautical mobile-satellite service (AMSS). The analysis is based on assumptions for the service demand, the aeronautical telecommunications network (ATN), the communications scheme, the satellite channel, and the aircraft earth station. Data obtained indicate that the first generation AMSC system based on power from a single satellite would likely meet the demand for AMSS services early in the 21st century. If the demand grows to levels projected in the end-state scenario, greater use of spectrum efficient A-QPSK modulation or satellite enhancements providing more frequency reuse are likely to be needed even if ATN upper layer overhead could be excluded. O.G.

A92-51009* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DIFFERENTIAL GPS/INERTIAL NAVIGATION APPROACH/LANDING FLIGHT TEST RESULTS
SCOTT SNYDER, BRIAN SCHIPPER, LARRY VALLOT (Honeywell Systems and Research Center, Minneapolis, MN), NIGEL PARKER (Honeywell, Inc., Clearwater, FL), and CARY SPITZER (NASA, Langley Research Center, Hampton, VA) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 7, no. 5, May 1992, p. 3-11. refs
Copyright

Results of a joint Honeywell/NASA-Langley differential GPS/inertial flight test conducted in November 1990 are discussed focusing on postflight data analysis. The test was aimed at acquiring a system performance database and demonstrating automatic landing based on an integrated differential GPS/INS with barometric and radar altimeters. Particular attention is given to characteristics of DGPS/inertial error and the magnitude of the differential corrections and vertical channel performance with and without altimeter augmentation. It is shown that DGPS/inertial integrated with a radar altimeter is capable of providing a precision approach and autoland guidance of manned return space vehicles within the Space Shuttle accuracy requirements. O.G.

A92-51012
RECEIVER AUTONOMOUS INTEGRITY MONITORING (RAIM) CAPABILITY FOR SOLE-MEANS GPS NAVIGATION IN THE OCEANIC PHASE OF FLIGHT
YOUNG C. LEE (Mitre Corp., McLean, VA) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 7, no. 5, May 1992, p. 29-36. refs
Copyright

A GPS integrity monitoring scheme, RAIM, is based on redundant ranging signals to detect a satellite malfunction that causes a large range error. GPS RAIM capability for sole-means navigation in the oceanic phase of flight is analyzed, where the position protection limit requirement for the integrity function is not as stringent as for nonprecision approaches, and yet both detection and identification functions may be required if GPS is to be used as a sole-means system. A new detection and identification algorithm is presented which takes advantage of the fact that for the oceanic phase of flight, a much larger position error is acceptable than for the nonprecision approach phase of flight. Recommendations are made on how RAIM may be used if GPS is to be coupled with an inertial system to provide a sole-means capability in the oceanic phase of flight. O.G.

A92-52650
WORLD ADMINISTRATIVE RADIO CONFERENCE ENDS FAVOURABLY FOR AIR TRANSPORT SECTOR
C. B. GOITIA (Communications Directorate, Radio Aids Div., Argentina) ICAO Journal (ISSN 0018-8778), vol. 47, no. 6, June 1992, p. 21-24.
Copyright

An overview is presented of the recent WARC where ICAO's efforts helped prevent further erosion of the aeronautical frequency spectrum during a review of frequency allocations. Attention is focused on the problems and recommendations relating to the frequency allocations to aeronautical services in the 1 to 3 GHz range. R.E.P.

A92-53102
THE B-2 RADAR
COLIN A. SMITH (Hughes Aircraft Co., Strategic Systems Div., Los Angeles, CA) IN: AUTOTESTCON '91; IEEE Systems Readiness Technology Conference, Anaheim, CA, Sept. 24-26, 1991, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 17-33.
Copyright

The B-2 radar's on-platform contribution to system effectiveness is described. Information is provided which can be released about the B-2 radar including derivation of its design requirements, description of the radar hardware and software, and some of the radar's development history and transition to production. An illustration of how early development of the built-in test can significantly improve hardware and thus enhance system effectiveness is given. I.E.

A92-53239
MONOPULSE SECONDARY SURVEILLANCE RADAR AND THE MODE-S SURVEILLANCE SYSTEM [LE RADAR SECONDAIRE DE SURVEILLANCE A MONO-IMPULSION ET LE SYSTEME DE SURVEILLANCE MODE S]
FRANCIS BRANGIER (Centre d'Etudes de la Navigation Aerienne, Orly Aerogare, France) Navigation (Paris) (ISSN 0028-1530), vol. 40, no. 159, July 1992, p. 350-361. In French. refs
Copyright

It is indicated that the present SSR system experiences a certain number of limitations including garbling, low accuracy, and overinterrogation. By employing new techniques such as monopulse SSR and mode-S SSR, many of these problems can be solved. The implementation of these techniques in various countries is discussed. R.E.P.

A92-53240
GPS TESTS DURING APPROACH AT SINGAPORE AND ROISSY [ESSAIS GPS EN APPROCHE A SINGAPOUR ET ROISSY]
JEAN FOURNIER (Institut Francais de Navigation, Paris, France) Navigation (Paris) (ISSN 0028-1530), vol. 40, no. 159, July 1992, p. 378-387. In French.
Copyright

A review is presented of a flight between Paris Roissy and Singapore in which a portable GPS receiver attached to an airline passenger window is satisfactorily employed, whereas similar instrumentation attached to the cockpit windshield produced unsatisfactory results. Data obtained during approach and landing at both airfields were recorded, and the true positions were compared with the GPS positions. It is demonstrated flight safety could be enhanced by using this supplementary system for navigation accuracy, once the integrity problem is resolved. R.E.P.

N92-30978*# Douglas Aircraft Co., Inc., Long Beach, CA.
EVALUATION OF MICROWAVE LANDING SYSTEM APPROACHES IN A WIDE-BODY TRANSPORT SIMULATOR Final Report
L. G. SUMMERS and J. B. FEATHER Washington NASA. Langley Research Center Jun. 1992 153 p
(Contract NAS1-18028; RTOP 505-66-41-66)
(NASA-CR-4450; NAS 1.26:4450; MDC-91K0792) Avail: CASI HC A08/MF A02

The objective of this study was to determine the suitability of flying complex curved approaches using the microwave landing system (MLS) with a wide-body transport aircraft. Fifty pilots in crews of two participated in the evaluation using a fixed-base simulator that emulated an MD-11 aircraft. Five approaches, consisting of one straight-in approach and four curved approaches, were flown by the pilots using a flight director. The test variables include the following: (1) manual and autothrottles; (2) wind direction; and (3) type of navigation display. The navigation display was either a map or a horizontal situation indicator (HSI). A complex wind that changed direction and speed with altitude, and included moderate turbulence, was used. Visibility conditions were Cat 1 or better. Subjective test data included pilot responses to questionnaires and pilot comments. Objective performance data included tracking accuracy, position error at decision height, and control activity. Results of the evaluation indicate that flying curved MLS approaches with a wide-body transport aircraft is operationally acceptable, depending upon the length of the final straight segment and the complexity of the approach. Author

N92-31746# Sandia National Labs., Albuquerque, NM.
TECHNIQUES FOR AUTONOMOUS NAVIGATION
R. H. BYRNE, P. R. KLARER, and J. B. PLETTA Mar. 1992 83 p
(Contract DE-AC04-76DP-00789)
(DE92-013458; SAND-92-0457) Avail: CASI HC A05/MF A01

Based on the growing need to develop physical security systems which are more flexible and less manpower intensive, the US Army has defined the Required Operational Capability (ROC) for a Mobile Detection Assessment Response System (MDARS). This report evaluates potential technical approaches for implementing the portion of the MDARS robotic path-following system. To address the wide range of available technologies, the report is broken into two main sections, path sensing and position location. Path sensing techniques discussed include: vision, ultrasonic ranging, scanning lasers, inductive wire-following, and stripe-following. Position location systems covered include: CPS, Loran-C, Omega, transit, RF beacons, and laser reflectors. A cost-risk trade-off analysis of the systems described is provided along with recommendations on the best technical approach to meet the MDARS path-following requirements using proven technology. DOE

N92-31838# Federal Aviation Administration, Atlantic City, NJ.
GLOBAL POSITIONING SYSTEM RUNWAY INCURSION PROGRAM STATIC GROUND TESTS Technical Report, Feb. - Mar. 1991
CARL CARUSO May 1992 25 p
(Contract FAA-T0704-E)
(DOT/FAA/CT-TN91/44) Avail: CASI HC A03/MF A01

Described here are the ground tests of the Global Positioning System (GPS) in the terminal area at the Atlantic City International Airport. The purpose of the Runway Incursion Program is to investigate the application of GPS as a navigation aid to allow the pilot to safely transverse airport taxiways and runways under poor visibility conditions. The primary objective of the tests was to resolve the critical issue of differential GPS accuracy as a function of the differential update rate. Author

N92-32054# Naval Postgraduate School, Monterey, CA.
DECISION-MAKING GUIDE FOR THE PROPOSED COAST GUARD DIFFERENTIAL GLOBAL POSITIONING SYSTEM M.S. Thesis
ROBERT J. WILSON Jun. 1991 168 p
(AD-A246046) Avail: CASI HC A08/MF A02

The Coast Guard has begun an initiative to deploy a nationwide Differential Global Positioning System (DGPS) to support Coast Guard missions and to enhance maritime safety in harbor navigation. DGPS service is expected to provide accuracy to within ten meters (95 percent of the time) to suitably equip vessels. It would do this by broadcasting corrections to GPS navigation satellite signals, thereby, improving accuracy by a factor of ten over standard GPS. The primary emphasis is on showing how decision making and planning for the DGPS project may be aided by comparing technological alternatives using Cost Effectiveness Analysis (CEA). This method is essentially a means of quantifying effectiveness per dollar of cost. The author consolidates the discussion of key issues within one document, identifies the technical decision criteria, estimates alternative system life-cycle costs, and makes a preliminary finding as to the merits of radiobeacon transmission over a dedicated satellite channel. In order to quantify effectiveness, many performance criteria are consolidated under five figures of merit: accuracy, availability, coverage, integrity, and adaptability. The inclusion of user equipment prices in life-cycle costs proves to be critical to the preliminary finding in favor of the radiobeacon-based alternative. This CEA model is especially suited to decision making in an environment of technological and policy change, since it can be easily refined and updated. Author (GRA)

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A92-49333
INTEGRATING A RADAR/ESM ANTENNA SUITE WITH THE S-70 HELICOPTER
RICHARD J. PANKOW (Sikorsky Aircraft, Stratford, CT) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 539-543.
Copyright

The underside of the helicopter below the crew cabin was used for the installation of a combination antenna system. Very little clearance is available between the helicopter underside and the ground when accounting for hard landings. A combination of technical approaches were required to install broadband, rotating antennas along with a radar narrowband antenna in these small volumes. All antennas in the suite, which cover 5.2 octaves, share a common rotating scan axis. Single method attacks on the problem did not produce desired results. Reported is the successful compromise solution giving acceptable levels of performance for all systems served by the suite. I.E.

A92-50009
BRITISH AEROSPACE HAWK INTO THE 1990S
G. CHISNALL (British Aerospace /Military Aircraft/, Ltd., North Humberside, England) Institution of Mechanical Engineers, Proceedings, Part G - Journal of Aerospace Engineering (ISSN 0954-4100), vol. 206, no. G1, 1992, p. 27-36.
Copyright

The paper covers a review of the British Aerospace Hawk aircraft program. An overview of the main development events and entry into RAF service is included, which emphasizes the versatility of the basic concept. This was deliberately designed in by the original team in order to maximize the subsequent export potential of the aircraft. That this was an outstanding success is shown in the outline of the main export variants to date. This background gives context to the main body of the paper, in which the new Hawk aircraft developments, the 100 and 200 series, respectively, are described. These advanced versions are intended to maintain the market dominance of Hawk throughout the 1990s

and beyond. A final, brief review of the broader environment within which BAe is carrying out its private venture development of Hawk is included as a conclusion to the paper. Author

A92-50203
RESEARCH ON SONIC FATIGUE CALCULATION AND TEST FOR AIRCRAFT PANEL
SEN GE and ZHILUN ZHOU (Aircraft Strength Research Institute, Yaoxian, People's Republic of China) Chinese Journal of Aeronautics (ISSN 1000-9361), vol. 4, no. 3, Aug. 1991, p. 274-278. Previously cited in issue 16, p. 2670, Accession no. A91-40162. refs
Copyright

A92-50236
BIRD IMPACT ANALYSIS OF AIRCRAFT WINDSHIELD TRANSPARENCY
YAO-NAN GONG and SU-QIANG XU (Beijing University of Aeronautics and Astronautics, People's Republic of China) Chinese Journal of Aeronautics (ISSN 1000-9361), vol. 5, no. 2, May 1992, p. 106-112. Research supported by Science Foundation of the National Education Committee. refs
Copyright

The modeling and analytic methods for the response of windshield transparency to bird impact are studied. The interaction between the impact load and the transparency response as well as the nonlinearity effect is considered. To employ conveniently the existing general-purpose nonlinear finite element analysis programs and to dispel the oscillatory phenomenon arising in numerical solution, the momentum equilibrium method is used, other than the conventional Lagrangian and penalty methods. Meanwhile, instead of the incompressible irrotational fluid, a rubber-like hyper-elastic Mooney-Rivlin material is suggested for the first time to simulate the bird body behavior in impact; thus the difficulty of continuously updating the contact point pairs and adjusting the discretized FE-mesh during the analysis process can be avoided. Remarks similar to those given in other published papers are included. In addition, a solution method for the dynamic response under the derivative dynamic load is studied and compared with the coupling solution, and the consequent comments are given. Author

A92-50315
HELICOPTER ROTOR BLADE AEROELASTICITY IN FORWARD FLIGHT WITH AN IMPLICIT STRUCTURAL FORMULATION
ROBERTO CELI (Maryland, University, College Park) AIAA Journal (ISSN 0001-1452), vol. 30, no. 9, Sept. 1992, p. 2274-2282. Research supported by University of Maryland. Previously cited in issue 12, p. 1913, Accession no. A91-32033. refs
(Contract DAAL03-88-C-0002)
Copyright

A92-51506
IMPACT DAMAGE TOLERANCE OF HELICOPTER SANDWICH STRUCTURES
JEAN-PAUL CHARLES (Aerospatiale, Marignane, France) and DIDIER GUEDRA-DEGEORGES (Aerospatiale, Suresnes France) IN: International SAMPE Technical Conference, 23rd, Kiamesha Lake, NY, Oct. 21-24, 1991, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 51-61. refs
Copyright

The damage caused by low velocity impacts on thin-skin composite sandwich test coupons and structures having a honeycomb core and graphite/epoxy or aramid/epoxy skins is presently examined, using a fully instrumented falling weight with a special impact tester geometry to generate a wide variety of impact energies and damage areas. Attention is given to the influence of boundary limits, as well as to postimpact residual performance in both tensile and compressive loading. An acceptable level of damage-tolerance performance is obtained. Prospects for damage resistance and repairability are discussed. O.C.

A92-51527
MOLDLESS COMPOSITE AIRCRAFT WING STRUCTURAL DESIGN MODIFICATIONS
KENNETH E. BLACKBURN, PAUL F. EASTMAN, and MATTHEW G. MARKSTALLER (Brigham Young University, Provo, UT) IN: International SAMPE Technical Conference, 23rd, Kiamesha Lake, NY, Oct. 21-24, 1991, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 364-372. refs
Copyright

Moldless composite construction methods, utilizing shaped foam cores with composite skins and other built-in structural components, are used extensively by homebuilders in the construction of experimental aircraft using commercially available designs. Analyses of these designs are not readily available to the homebuilders. Finite element models of the canard and main wing were used to analyze a design for a homebuilt aircraft. Wings were built using both the fiberglass 'plans' design and an optimized design which utilized carbon fiber composites in high stress areas to minimize weight and increase stiffness. Associated costs and performance of the standard and redesigned wing structures are discussed. Author

A92-51538
COST EFFECTIVE CLOSE TOLERANCE PLASTIC MASTER MODELS
DAVE BARNEY (Cessna Aircraft Co., Wichita, KS) IN: International SAMPE Technical Conference, 23rd, Kiamesha Lake, NY, Oct. 21-24, 1991, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 609-615.
Copyright

To meet the goals of more efficiently operating aircraft, turning to the use of NC machining equipment for controlling contours on master model tooling has been very successful. Not only has the accuracy been very attractive, a considerable reduction in manhours expended has also been enjoyed, in many cases as much as a 75-percent savings over conventional methods. Attention is given to a very cost-effective, detailed method of building a complete master model, including materials, base construction, understructure, applying the machinable surface, machining, adding trim lines, sealing, repairing, handling, and usage. Models of various sizes up to 96 x 200 in are presented. Advantages, disadvantages, what to do and what not to do in the construction and usage of these models are also discussed. Author

A92-51569
INTEGRAL WING/FUEL BOX
PAUL V. OLIVA (ITN, Inc., Hauppauge, NY) IN: International SAMPE Technical Conference, 23rd, Kiamesha Lake, NY, Oct. 21-24, 1991, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 1047-1059.
Copyright

This method of fabrication reduces to provide an approach to fabricate graphite composite parts which includes the entire part of any assembly. For example, an aircraft wing can be fabricated by combining the spar, stiffeners, ribs, top to bottom skins, all preassembled and cured at one time. The fuselage and other sections of an aircraft could also be done in the same manner. The essential ingredient of the process is the use of an elastomeric bag for internal and external pressure during the cure of the composite. Author

A92-51580
BA'S 777
J. M. RAMSDEN Aerospace (UK) (ISSN 0305-0831), vol. 19, no. 7, July 1992, p. 12-18.
Copyright

An overview is presented of the Boeing-British Airways

coordinated design, development and operational aspects of the newly ordered 777 aircraft. Attention is given to the performance summary of the initial 777 and its stretch version based on typical mission rules. Consideration is given to the engineering team structure and function, which organization is based both in London and Seattle. R.E.P.

A92-51942
ESTIMATION OF LIFT AND DRAG CHARACTERISTICS OF AN AIRCRAFT FROM FLIGHT DATA
G. GIRIJA, V. PARAMESWARAN, J. R. RAOL, and S. SRINATHKUMAR (National Aeronautical Laboratory, Bangalore, India) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 43, no. 4, Nov. 1991, p. 285-292. Research supported by Aeronautical Development Agency of India. refs

A methodology is presented in which a combination of dynamic maneuvers is used within a model to estimate the performance characteristics of an aircraft. Maneuvers such as 'roller coaster', windup turn, and slowdown are conducted, and the flight data are studied by means of the maximum likelihood method. Drag-polar results are generated over the complete range of angles of attack, and the performance data are found to agree with reference data. C.C.S.

A92-51947
EFFECT OF A DEICING DEVICE ON THE INDUCED DRAG OF A LIFTING AIRFOIL [VLIV PORUCHY ODMRAZOVACIHO ZARIZENI NA INDUKOVANY ODPOR NOSNE PLOCHY]
ZDENEK SKODA Zpravodaj VZLU (ISSN 0044-5355), no. 1, 1992, p. 5-7. In Czech. refs
Copyright

In the reliability analysis of an aircraft deicing system, it is essential that consideration be given to the possible consequences of the partial failure of the deicing system on aircraft maneuverability and controllability. Here, a method for evaluating the effect of deicing failures on the induced drag is presented. V.L.

A92-51948
SHIMMY OF NOSE UNDERCARRIAGE WHEELS [BOCNI KMITANI KOL PRIDOVEHO PODVOZKU]
LADISLAV BOUCHAL Zpravodaj VZLU (ISSN 0044-5355), no. 1, 1992, p. 9-15. In Czech. refs
Copyright

In the article there is explained a method of analyzing the resistance of nose undercarriage wheels against shimmy in the regime of swiveling wheel and in the regime of controllable wheel. The peculiarities of resistance limits are expounded and evaluation of the safety margin of wheels against shimmy is given. A copy of input data, printout and graphic representation of computation results are included. Author

A92-52300
777 SHAPING UP
GUY NORRIS and GRAHAM WARWICK Flight International (ISSN 0015-3710), vol. 142, no. 4325, July 1, 1992, p. 27, 28, 30-32.
Copyright

An overview is presented of the assembly of the 777 transport with parts from more than a dozen countries, over 40 major suppliers, subcontractors, and hundreds of smaller suppliers as product definition takes place. Attention is given to the systems integration laboratory that will house a dedicated 777 flight-control test rig now being built, complete with control surfaces, full electronics, electrical power system and some parts of the hydraulics. Consideration is given to the powerplants, computer design system, the advanced air conditioning system, avionics and landing gear wheels, brakes and tires. R.E.P.

A92-52427#
SHIPBOARD MISSION TRAINING EFFECTIVENESS OF THE NAVAL AIR WARFARE CENTER'S V-22 GOVERNMENT TEST PILOT TRAINER
C. MILLER and G. VANDERVLIET (U.S. Navy, Naval Air Warfare Center, Patuxent River, MD) IN: AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers. Washington, American Institute of Aeronautics and Astronautics, 1992, p. 1-7.
(AIAA PAPER 92-4130)

Initial shipboard compatibility tests of the V-22 Osprey VSTOL tilt-rotor aircraft were conducted aboard the USS Wasp (LHD-1) on 4-8 December 1990. Pilot training and engineering analysis for the first shipboard launches and recoveries of the V-22 Osprey aircraft were conducted in the V-22 simulator at the Naval Air Test Center. Workload data was recorded and the pilots made comments regarding the quality of the training during these sessions. Quantitative comparisons of time history data were made using power spectral densities, averages and maximum attained values. Qualitative comments recorded during training were compared to the remarks made after the actual at-sea tests. The data help conclude that the training was effective, and point to possible improvements in the system for future sessions. Author

A92-52434#
USE OF HIGH-FIDELITY SIMULATION IN THE DEVELOPMENT OF AN F/A-18 ACTIVE GROUND COLLISION AVOIDANCE SYSTEM
TIMOTHY R. FITZGERALD and MICHAEL T. BRUNNER (U.S. Navy, Naval Air Warfare Center, Patuxent River, MD) IN: AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers. Washington, American Institute of Aeronautics and Astronautics, 1992, p. 68-78. refs
(AIAA PAPER 92-4140)

An active ground collision avoidance system (GCAS) is developed for the F/A-18 using F/A-18 simulation. The simulation is used for the development of all three components of GCAS: (1) the algorithms used to determine the recovery initiation altitude; (2) the additional flight control laws necessary to perform the recovery maneuver; and (3) the visual and audio cues used to provide recovery status information to the pilot. The use of a simulation allows the rapid development of a viable F/A-18 GCAS that incorporates technology from the F/A-18 Integrated Fire and Flight Control simulation and the Advanced Fighter Technology Integration F-16 program. Author

A92-52441*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ANALYSIS OF PROPULSION SYSTEM DYNAMICS IN THE VALIDATION OF A HIGH-ORDER STATE SPACE MODEL OF THE UH-60
FREDERICK D. KIM (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers. Washington, American Institute of Aeronautics and Astronautics, 1992, p. 138-153. refs
(AIAA PAPER 92-4150) Copyright

Frequency responses generated from a high-order linear model of the UH-60 Black Hawk have shown that the propulsion system influences significantly the vertical and yaw dynamics of the aircraft at frequencies important to high-bandwidth control law designs. The inclusion of the propulsion system comprises the latest step in the development of a high-order linear model of the UH-60 that models additionally the dynamics of the fuselage, rotor, and inflow. A complete validation study of the linear model is presented in the frequency domain for both on-axis and off-axis coupled responses in the hoverflight condition, and on-axis responses for forward speeds of 80 and 120 knots. Author

A92-52442#
GENERIC HELICOPTER FOR MULTISHIP SIMULATIONS
LARRY A. MOODY (McDonnell Aircraft Co., Saint Louis, MO) IN: AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers. Washington, American Institute of Aeronautics and Astronautics, 1992, p. 154-158.
(AIAA PAPER 92-4151) Copyright

A software model was created to fill the need for a generic

helicopter to be used for enhanced environment realism in multiship combat simulations. The main objective of the model was to execute with a minimum of computational processing while maintaining acceptable performance and handling characteristics. This objective was met by using a set of high fidelity control laws with a minimal aerodynamics reaction model. This approach yielded a helicopter model that not only achieved the objectives of low processing demand and acceptable performance and handling characteristics, but also retained all of the control system's pilot relief modes such as altitude and heading hold modes. Author

A92-52459*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

PILOTED EVALUATION OF AN INTEGRATED PROPULSION AND FLIGHT CONTROL SIMULATOR

MICHELLE M. BRIGHT (NASA, Lewis Research Center, Cleveland, OH) and DONALD L. SIMON (U.S. Army, Propulsion Directorate; NASA, Lewis Research Center, Cleveland, OH) IN: AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers. Washington, American Institute of Aeronautics and Astronautics, 1992, p. 302-312. refs (AIAA PAPER 92-4178) Copyright

This paper describes a piloted evaluation of the integrated flight and propulsion control simulator at NASA Lewis Research Center. The purpose of this evaluation is to demonstrate the suitability and effectiveness of this fixed based simulator for advanced integrated propulsion and airframe control design. The evaluation will cover control effector gains and deadbands, control effectiveness and control authority, and heads up display functionality. For this evaluation the flight simulator is configured for transition flight using an advanced Short Take-Off and vertical Landing fighter aircraft model, a simplified high-bypass turbofan engine model, fighter cockpit, displays, and pilot effectors. The paper describes the piloted tasks used for rating displays and control effector gains. Pilot comments and simulation results confirm that the display symbology and control gains are very adequate for the transition flight task. Additionally, it is demonstrated that this small-scale, fixed base flight simulator facility can adequately perform a real time, piloted control evaluation. Author

A92-52849

THE APPLICATION OF A THEORETICAL BLADE SAILING MODEL TO PREDICT THE BEHAVIOUR OF ARTICULATED HELICOPTER ROTORS

S. J. NEWMAN (Southampton, University, United Kingdom) Aeronautical Journal (ISSN 0001-9240), vol. 96, no. 956, June-July 1992, p. 233-239. Research supported by Ministry of Defence Procurement Executive.

Copyright

A theoretical model had been previously developed to predict the behavior of a semi-rigid helicopter rotor blade during rotor engagement and disengagement under high wind conditions. This has now been extended to cater for an articulated rotor by modeling the droop and anti-flap stop mechanisms by high rate linear springs. Much increased blade deflections are predicted, as anticipated, along with the possibility of blade tip/tail boom contact at a high enough wind speed. The importance of the higher modes in the description of the phenomenon is demonstrated. A comparison of the theoretical model with an experiment using a full size Puma aircraft is presented. Author

A92-53007

ESTIMATION OF AERODYNAMIC CHARACTERISTICS FROM FLIGHT-TEST DATA. I - MULTICOLLINEARITY IN THE EQUATION ERROR METHOD

OSAMU KOBAYASHI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 40, no. 463, 1992, p. 443-452. In Japanese. . refs

The multicollinearity problem in the equation error method is discussed. This problem occurs not only when strong correlations between the explanatory variables are generated by the aircraft's maneuver, but also when the number of explanatory variables is greater than the maximum number of variables which can be essentially independent in the equation of motion. The physical meaning of the partial regression coefficients and the multicollinearity is explained. L.M.

A92-53012

A STUDY ON ROTOR INDUCED SAND AND DUST ENVIRONMENT AND ITS HARMFULNESS TO HELICOPTER

SHOUSHEN LIU, ZHENG GAO (Nanjing Aeronautical Institute, China), JIHUAI LU, and MING XU (Naval Research Center, Shanghai, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 11, Nov. 1991, p. A575-A578. In Chinese.

An experimental study and theoretical analysis on rotor-induced sand and dust environment and its harmfulness to a helicopter are briefly described in this paper. The experimental study has been made by using a helicopter model which consists of rotor and fuselage models. The induced sand and dust environment is established around the helicopter model hovering at different heights near the ground and having different rotor disk loading. The real harm of sand and dust generated by rotor downwash to the helicopter was observed and studied. The sand and dust concentration, forces and particle size distribution are measured at some designated locations on (or near) the helicopter. The flow field of the rotor downwash around the helicopter is theoretically analyzed and its velocity is calculated and tested. The law of induced sand and dust concentration, particle size distribution, and the method of estimating the forces are given from the research results. Author

A92-53056

STRUCTURAL OPTIMIZATION AND VIBRATION CONTROL OF COMPOSITE ROTOR BLADES

GUANGHUA FAN, RULIANG HOU (Chinese Helicopter Research and Development Institute, China), GENGDONG CHENG, and YUANXIAN GU (Dalian University of Technology, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 12, Dec. 1991, p. B554-B559. In Chinese. refs

A research for structural dynamic optimization design of composite rotor blades is summarized. After basic type of rotor hub and blade are determined, the frequencies are adjusted by varying the blade's mass and stiffness distribution. The designability of composite rotor blade and the changeability of cross section structure offer effective methods to frequency designs. The finite element methods and numerical optimization are used to optimize the mass and stiffness distributions of blades, in order to adjust frequencies, to improve blade's natural frequency and dynamic properties for structures, to reduce vibration, and to lower the mass. The computer-aid design of the rotor blades has partly been achieved. Two examples of composite rotor blades, BO-105 and Douphin have been calculated. Author

A92-53090

MECHANICAL MODEL OF LANDING IMPACT OF THREE DIMENSIONAL FUSELAGE LANDING GEAR

ZHEJUN GAO (Chengdu Aircraft Corp., China) and RIXIN ZHANG (Chengdu University of Science and Technology, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 8, Aug. 1991, p. B349-B357. In Chinese. refs

Based on the geometry, dynamics, and kinematic characteristics of landing gear systems, a landing impact mechanical model and its initial condition of a 3D fuselage landing gear with flexural shock strut is presented. Kinematic equations and the equations of motion under various landing conditions, including symmetric and asymmetric impact are given. The proposed computational model includes four displacements and deformations for the shock system and current mechanical knowledge of tires. R.E.P.

A92-53092

A FULL-SCALE FATIGUE TEST AND FAILURE ANALYSES RESEARCH OF F-X FIGHTERS

GUORONG JIA, YUWEN MA, and XIZHEN ZHANG (Shengyang

Aircraft Research Institute, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 8, Aug. 1991, p. B364-B368. In Chinese.

To verify the structural integrity of the F-X aircraft, a full-scale structural fatigue testing in suspending state is conducted with a 42 point automated loading rig to indicate the critical fatigue items of the structure and the service. The flight by flight load spectrum, including 22 load conditions and the integral tank pressure is adopted. The test procedures, the aircraft support method, the direct digital control automated loading system, and the failure analyses are presented. R.E.P.

A92-53121
REGIONAL CHALLENGE
HARRY HOPKINS Flight International (ISSN 0015-3710), vol. 142, no. 4333, Aug. 26-Sept. 1, 1992, p. 39-42.
Copyright

The Regional Jet developed in Canada is described and discussed in terms of unique design features, flying issues for pilots, and the its performance in a test flight. Specific details are given regarding the aircraft's ability to hold high power, and the wing design is shown to afford compensation for the relatively heavy aircraft. The Regional Jet is shown to have high system redundancy and good fuel burn, and the maneuverable aircraft is expected to be an effective carrier for short flights. C.C.S.

N92-30304*# California Univ., Davis. Dept. of Mechanical, Aeronautical and Materials Engineering.
MODELING AND ANALYSIS METHODOLOGY FOR AEROELASTICALLY TAILORED CHORDWISE DEFORMABLE WINGS Final Report
LAWRENCE W. REHFIELD, STEPHEN CHANG, and PETER J. ZISCHKA Jul. 1992 80 p
(Contract NAS1-18754; RTOP 510-02-12-08)
(NASA-CR-189620; NAS 1.26:189620) Avail: CASI HC A05/MF A01

Structural concepts have been created which produce chordwise camber deformation that results in enhanced lift. A wing box can be tailored to utilize each of these with composites. In attempting to optimize the aerodynamic benefits, we have found there are two optimal designs that are of interest. There is a weight optimum which corresponds to the maximum lift per unit structural weight. There is also a lift optimum that corresponds to maximum absolute lift. New structural models, the basic deformation mechanisms that are utilized and typical analytical results are presented. It appears that lift enhancements of sufficient magnitude can be produced to render this type of wing tailoring of practical interest. Experiments and finite element correlations are performed which confirm the validity of the theoretical models utilized. Author

N92-30424# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany). Aircraft Div.
MULTIDISCIPLINARY OPTIMIZATION OF FIBER COMPOSITE AIRCRAFT STRUCTURES
H. A. ESCHENAUER (Siegen Univ.,, Germany, F.R.), G. SCHUHMACHER (Siegen Univ.,, Germany, F.R.), and W. HARTZHEIM 12 Dec. 1991 15 p Presented at the NATO/DFG Advanced Study Institute on Optimization of Large Structural Systems, Berchtesgaden, Fed. Republic of Germany, 23 Sep. - 4 Oct. 1991
(MBB/FW321/S/PUB/476; ETN-92-91902) Copyright Avail: CASI HC A03/MF A01

The application of a method of structural optimization to find optimal layouts of fiber composite structures in aircraft contruction is addressed. The goal of the optimization process is to minimize the structural weight and, simultaneously, to fulfill multidisciplinary constraints concerning failure criteria, stability requirements, dynamic responses, areroelastic efficiencies and flutter speeds. Considering these requirements, the optimal values for the layer thickness and the fiber orientations of composite structures must be determined. This problem can efficiently be solved by structural optimization methods. The model formulation in structural optimization is described in general as well as the special optimization model and the structural and sensitivity analysis for fiber composite structures. An application example demonstrated the performance of the whole procedure. This example shows that the structural optimization method is very useful to increase the efficiency of the design process as well as the quality and performance of aircraft structures. ESA

N92-30752*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ON-LINE ANALYSIS CAPABILITIES DEVELOPED TO SUPPORT THE AFW WIND-TUNNEL TESTS
CAROL D. WIESEMAN, SHERWOOD T. HOADLEY, and SANDRA M. MCGRAW (Lockheed Engineering and Sciences Co., Hampton, VA.) Jul. 1992 11 p Presented at the AIAA Dynamic Specialists' Conference, Dallas, TX, 16-17 Apr. 1992 Previously announced in IAA as A92-35656
(Contract RTOP 505-63-50-15)
(NASA-TM-107651; NAS 1.15:107651) Avail: CASI HC A03/MF A01

A variety of on-line analysis tools were developed to support two active flexible wing (AFW) wind-tunnel tests. These tools were developed to verify control law execution, to satisfy analysis requirements of the control law designers, to provide measures of system stability in a real-time environment, and to provide project managers with a quantitative measure of controller performance. Descriptions and purposes of the developed capabilities are presented along with examples. Procedures for saving and transferring data for near real-time analysis, and descriptions of the corresponding data interface programs are also presented. The on-line analysis tools worked well before, during, and after the wind tunnel test and proved to be a vital and important part of the entire test effort. Author

N92-30878# Goldsworthy Engineering, Inc., Springville, UT.
ORGANIC MATRIX COMPOSITE HELICOPTER INTERNAL/EXTERNAL CARGO PALLET SYSTEM (OMC INTEX) Final Report, Jul. 1986 - Jun. 1990
ROB J. SJOSTEDT and DONNA K. DAWSON Apr. 1992 95 p
(Contract DAAJ02-86-C-0009)
(AD-A251127; PC-86-08; USAAVSCOM-TR-92-D-2) Avail: CASI HC A05/MF A01

This report describes the development of an OMC INTEX Cargo Pallet System relative to the Army's changing cargo handling requirements. Design, fabrication, and testing of three prototype pallets are discussed. The end result was a full-scale OMC pallet that passed all specified tests, including ultimate hoist and flight testing. The pallet was designed for automated pultrusion processing, which will offer cost effective fabrication of OMC pallets in production quantities. GRA

N92-31165# Federal Aviation Administration, Atlantic City, NJ.
HELICOPTER NIGHTTIME PARKING TEST RESULTS - UH-1 Technical Report, Jan. - Aug. 1989
ROSANNE M. WEISS May 1992 67 p
(DOT/FAA/CT-TN92/1; AD-A253798) Avail: CASI HC A04/MF A01

Flight tests were previously conducted at the Federal Aviation Administration (FAA) Technical Center to examine issues regarding rotortip separation in ground maneuver areas at heliports. Technical Note DOT/FAA/CT-TN88/30, 'Heliport Surface Maneuvering Test Results', details the results of those tests. However, those tests were conducted under visual flight conditions (VFR) daylight conditions. Given the limitations of scoptic vision, it was determined that nighttime testing was needed to determine whether pilot parking separation performance and perception deteriorates under night, low ambient light conditions. This report documents the results of nighttime parking tests conducted at the Technical Center between Jan. - Aug. 1989. Over 100 parking maneuvers were conducted using a UH-1H helicopter. All were conducted under head, tail, and crosswind conditions, with an unlit and a lit obstacle and without an obstacle in place. Pilot subjective data in reference to these maneuvers were collected via post-maneuver ratings and

post-flight questionnaire. Data collection and analysis methodology and objective as well as subjective issues are discussed. Statistical and graphical analysis of pilot performance and perception data and subjective input are provided. Conclusions are drawn about the considerations that must be given to parking space size at heliports permitting nighttime operations. Author

N92-31174*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AN ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF FLUTTER SUPPRESSION VIA PIEZOELECTRIC ACTUATION
JENNIFER HEEG Jul. 1992 13 p Presented at the AIAA 33rd Structures, Structural Dynamics, and Materials Conference, Dallas, TX, 13-15 Apr. 1992
(Contract RTOP 505-63-50-15)
(NASA-TM-107653; NAS 1.15:107653) Avail: CASI HC A03/MF A01

The objective of this research was to analytically and experimentally study the capabilities of adaptive material plate actuators for suppressing flutter. Piezoelectrics are materials which are characterized by their ability to produce voltage when subjected to a mechanical strain. The converse piezoelectric effect can be utilized to actuate a structure by applying a voltage. For this investigation, a two degree of freedom wind-tunnel model was designed, analyzed, and tested. The model consisted of a rigid wing and a flexible mount system which permitted translational and rotational degrees of freedom. Actuators, made of piezoelectric material were affixed to leaf springs on the mount system. Command signals, applied to the piezoelectric actuators, exerted control over the closed-loop damping and stiffness properties. A mathematical aeroservoelastic model was constructed using finite element and stiffness properties. A mathematical aeroservoelastic model was constructed using finite element methods, laminated plate theory, and aeroelastic analysis tools. A flutter suppression control law was designed, implemented on a digital control computer, and tested to conditions 20 percent above the passive flutter speed of the model. The experimental results represent the first time that adaptive materials have been used to actively suppress flutter. It demonstrates that small, carefully-placed actuating plates can be used effectively to control aeroelastic response. Author

N92-31208*# G and C Systems, Inc., San Juan Capistrano, CA.
HIGH-SPEED CIVIL TRANSPORT ISSUES AND TECHNOLOGY PROGRAM Final Report
MARLE D. HEWETT Washington NASA May 1992 118 p Prepared in cooperation with PRC Kentron, Inc., Edwards, CA
(Contract NAS2-12722; ATD-91-GNC-7102; RTOP 505-64-20)
(NASA-CR-186020; H-1795; NAS 1.26:186020) Avail: CASI HC A06/MF A02

A strawman program plan is presented, consisting of technology developments and demonstrations required to support the construction of a high-speed civil transport. The plan includes a compilation of technology issues related to the development of a transport. The issues represent technical areas in which research and development are required to allow airframe manufacturers to pursue an HSCT development. The vast majority of technical issues presented require flight demonstrated and validated solutions before a transport development will be undertaken by the industry. The author believes that NASA is the agency best suited to address flight demonstration issues in a concentrated effort. The new Integrated Test Facility at NASA Dryden Flight Research Facility is considered ideally suited to the task of supporting ground validations of proof-of-concept and prototype system demonstrations before night demonstrations. An elaborate ground hardware-in-the-loop (iron bird) simulation supported in this facility provides a viable alternative to developing an expensive fill-scale prototype transport technology demonstrator. Drygen's SR-71 assets, modified appropriately, are a suitable test-bed for supporting flight demonstrations and validations of certain transport technology solutions. A subscale, manned or unmanned flight demonstrator is suitable for flight validation of transport technology solutions, if appropriate structural similarity relationships can be established. The author contends that developing a full-scale prototype transport technology demonstrator is the best alternative to ensuring that a positive decision to develop a transport is reached by the United States aerospace industry. Author

N92-31261*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
OVERVIEW OF THE NASA DRYDEN FLIGHT RESEARCH FACILITY AERONAUTICAL FLIGHT PROJECTS
ROBERT R. MEYER, JR. Aug. 1992 20 p Presented at the AGARD Flight Mechanics Panel, Chania, Crete, Greece, 11 May 1992
(Contract RTOP 505-68-50)
(NASA-TM-104254; H-1847; NAS 1.15:104254; AGARD-16)
Avail: CASI HC A03/MF A01

Several principal aerodynamics flight projects of the NASA Dryden Flight Research Facility are discussed. Key vehicle technology areas from a wide range of flight vehicles are highlighted. These areas include flight research data obtained for ground facility and computation correlation, applied research in areas not well suited to ground facilities (wind tunnels), and concept demonstration. Author

N92-31264*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A SUMMARY OF THE ACTIVE FLEXIBLE WING PROGRAM
BOYD PERRY, III, STANLEY R. COLE, and GERALD D. MILLER (Rockwell International Corp., Los Angeles, CA.) Jul. 1992 12 p Presented at the AIAA Dynamic Specialists' Conference, Dallas, TX, 16-17 Apr. 1992 Previously announced in IAA as A92-35652
(Contract RTOP 505-63-50-15)
(NASA-TM-107655; NAS 1.15:107655) Avail: CASI HC A03/MF A01

A summary of the NASA/Rockwell Active Flexible Wing Program is presented. Major elements of the program are presented. Key program accomplishments included single- and multiple-mode flutter suppression, load alleviation and load control during rapid roll maneuvers, and multi-input/multi-output multiple-function active controls tests above the open-loop flutter boundary. Author

N92-31350*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FLUTTER SUPPRESSION DIGITAL CONTROL LAW DESIGN AND TESTING FOR THE AFW WIND-TUNNEL MODEL
VIVEK MUKHOPADHYAY Jul. 1992 8 p Presented at the AIAA Dynamics Specialists' Conference, Dallas, TX, 16-17 Apr. 1992 Previously announced in IAA as A92-35668
(Contract RTOP 505-63-50-15)
(NASA-TM-107652; NAS 1.15:107652; AIAA PAPER 92-2095-CP)
Avail: CASI HC A02/MF A01

Design of a control law for simultaneously suppressing the symmetric and antisymmetric flutter modes of a string mounted fixed-in-roll aeroelastic wind tunnel model is described. The flutter suppression control law was designed using linear quadratic Gaussian theory and involved control law order reduction, a gain root-locus study, and the use of previous experimental results. A 23 percent increase in open-loop flutter dynamic pressure was demonstrated during the wind tunnel test. Rapid roll maneuvers at 11 percent above the symmetric flutter boundary were also performed when the model was in a free-to-roll configuration. Author

N92-31351*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ROLLING MANEUVER LOAD ALLEVIATION USING ACTIVE CONTROLS
JESSICA A. WOODS-VEDELER and ANTHONY S. POTOTZKY (Lockheed Engineering and Sciences Co., Hampton, VA.) Jul. 1992 11 p Presented at the AIAA Dynamics Specialists' Conference, Dallas, TX, 16-17 Apr. 1992 Previously announced in IAA as A92-35670

(Contract RTOP 505-63-50-15)
(NASA-TM-107654; NAS 1.15:107654) Avail: CASI HC A03/MF A01

Rolling Maneuver Load Alleviation (RMLA) was demonstrated on the Active Flexible Wing (AFW) wind tunnel model in the LaRC Transonic Dynamics Tunnel. The design objective was to develop a systematic approach for developing active control laws to alleviate wing incremental loads during roll maneuvers. Using linear load models for the AFW wind-tunnel model which were based on experimental measurements, two RMLA control laws were developed based on a single-degree-of-freedom roll model. The RMLA control laws utilized actuation of outboard control surface pairs to counteract incremental loads generated during rolling maneuvers and roll performance. To evaluate the RMLA control laws, roll maneuvers were performed in the wind tunnel at dynamic pressures of 150, 200, and 250 psf and Mach numbers of .33, .38, and .44, respectively. Loads obtained during these maneuvers were compared to baseline maneuver loads. For both RMLA controllers, the incremental torsion moments were reduced by up to 60 percent at all dynamic pressures and performance times. Results for bending moment load reductions during roll maneuvers varied. In addition, in a multiple function test, RMLA and flutter suppression system control laws were operated simultaneously during roll maneuvers at dynamic pressures 11 percent above the open-loop flutter dynamic pressure. Author

N92-31515# Cranfield Inst. of Tech., Bedford (England). College of Aeronautics.
ASTOVL COMBAT AIRCRAFT DESIGN SYNTHESIS AND OPTIMIZATION
N. KEHAYAS Jan. 1992 279 p Sponsored by RAE
(CRANFIELD-AERO-9201; ISBN-1-871564-360; ETN-92-91728)
Avail: CASI HC A13/MF A03

The development of a baseline configuration for an Advanced Short Take Off and Vertical Landing (ASTOVL) combat aircraft is presented. The design synthesis and coding of these baseline configuration (code VERTI), the interfacing of the design synthesis code VERTI with the optimizer code RQPMIN, and the optimization of the baseline configuration, are presented. ESA

N92-31793# Wright Lab., Wright-Patterson AFB, OH.
AN ASSESSMENT OF THE B-747'S CAPABILITY TO OPERATE ON ROUGH SURFACES
ELIJAH W. TURNER and JOHN T. RIECHERS May 1992 98 p
(AD-A250134; WL-TM-92-313-FIBE) Avail: CASI HC A05/MF A02

A study has been conducted to determine the capability of the Boeing 747 to operate on rough runways; specifically, runways that have been damaged by bombing and repaired rapidly using current Air Force procedures. The quality of the repairs has been determined that will allow the aircraft to operate from the repaired surface without being subjected to loads on the landing gears that exceed design limit load. This study indicates that the B-747 is capable of taking off on a repaired runway at 836,000 lbs gross weight provided that repairs in the first 500 feet of the takeoff roll are at least class B. Repairs further down the runway only need to be class E. If the aircraft will traverse two repairs, tables are provided that give the minimum spacing between repairs. Consideration is not given to traversing more than two repairs. Analysis indicates that the ability of the nose gear to withstand loads produced by traversing repair profiles can be significantly improved by increasing the precharge pressure in the shock strut. A nose gear precharge of 185 psi will reduce the peak loads sufficiently to permit a class C repair to be at any position on the runway, including the first 500 feet. Increasing the precharge pressure to 272 psi will permit class E repairs to be located anywhere. At the maximum landing gross weight of 666,000 lbs, none of the repairs A through E produced loads that exceeded design limit load during taxi at any speed. GRA

N92-31880# Israel Military Industries, Ramat-Hasharon (Israel). Systems Div.
OPTIMAL TRAJECTORIES FOR AN UNMANNED AIR VEHICLE
JOSEPH Z. BEN-ASHER *In* Israel Society of Aeronautics and Astronautics, 31st Israel Annual Conference on Aviation and Astronautics p 132-140 22 Feb. 1990 Previously announced in IAA as A91-43094
Avail: CASI HC A02/MF A03

Time-optimal trajectories for the Delilah Unmanned Air Vehicle (UAV) were studied. Delilah is a 400-lb, turbojet-powered decoy carrying active and passive radio-frequency (RF) payloads; its dash speed is 770 kt and its flight ceiling is 30,000 ft. The Pontryagin Minimum Principle was applied to the minimum-time point-to-point maneuvering problem and a new technique was demonstrated, to perform the Jacobi test. The technique is based on a singular value decomposition of the transition matrix and is simpler and more reliable than the old technique of evaluating sub-determinants. Two approximations to the problem, the energy model and the intermediate model, were shown to agree well with the exact solution. ISA

N92-31881# Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
ESTIMATION OF AIRCRAFT ATTITUDE BY ANGULAR RATE MEASUREMENTS
M. KOIFMAN and S. J. MERHAV *In* Israel Society of Aeronautics and Astronautics, 31st Israel Annual Conference on Aviation and Astronautics p 141-152 22 Feb. 1990 Previously announced in IAA as A91-43095 Sponsored by Ministry of Defence and Precision Instrument Industries
Avail: CASI HC A03/MF A03

A method for on-board aircraft attitude estimation based on the measurements of an orthogonal triad of strapdown low-cost gyros, airspeed, barometric attitude, and magnetic heading sensors is presented. A reduced-order, computationally simplified, Extended Kalman Filter is shown to provide on-line attitude estimates with bounded errors not exceeding 0.5 degree at output rates of the order of 20 Hz. Considerations for order reduction and computational simplifications which facilitate on-line operation are presented. Off-line computer simulations including uncertain atmospheric turbulence and time-varying gyro drift demonstrate precision and robustness. Actual on-line simulations including real rate gyros are described. The results validate the feasibility of the concept. ISA

N92-32111*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TIME SIMULATION OF FLUTTER WITH LARGE STIFFNESS CHANGES
MORDECHAY KARPEL (Israel Inst. of Tech., Haifa.) and CAROL D. WIESEMAN Jul. 1992 11 p Presented at the AIAA Structures, Structural Dynamics, and Materials Conference, Dallas, TX, 13-15 Apr. 1992 Previously announced in IAA as A92-34467
(Contract NAS1-18605; NAGW-1708; RTOP 505-63-50-15)
(NASA-TM-107650; NAS 1.15:107650) Avail: CASI HC A03/MF A01

Time simulation of flutter, involving large local structural changes, is formulated with a state-space model that is based on a relatively small number of generalized coordinates. Free-free vibration modes are first calculated for a nominal finite-element model with relatively large fictitious masses located at the area of structural changes. A low-frequency subset of these modes is then transformed into a set of structural modal coordinates with which the entire simulation is performed. These generalized coordinates and the associated oscillatory aerodynamic force coefficient matrices are used to construct an efficient time-domain, state-space model for a basic aeroelastic case. The time simulation can then be performed by simply changing the mass, stiffness, and damping coupling terms when structural changes occur. It is shown that the size of the aeroelastic model required for time simulation with large structural changes at a few apriori known locations is similar to that required for direct analysis of a single structural case. The method is applied to the simulation of an

aeroelastic wind-tunnel model. The diverging oscillations are followed by the activation of a tip-ballast decoupling mechanism that stabilizes the system but may cause significant transient overshoots. Author

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A92-49251
IEEE/AIAA DIGITAL AVIONICS SYSTEMS CONFERENCE, 10TH, LOS ANGELES, CA, OCT. 14-17, 1991, PROCEEDINGS
New York, Institute of Electrical and Electronics Engineers, Inc., 1991, 602 p. For individual items see A92-49252 to A92-49340.
(ISBN 0-7803-0115-3) Copyright

The papers presented in this volume focus on recent developments in digital avionics, with emphasis on spacecraft and launch systems and on commercial aviation issues. Topics discussed include vehicle management systems; communications, navigation, identification systems; launch vehicle and spacecraft avionics; Ada applications and methods; and special function avionics and techniques. The discussion also covers systems engineering methods and tools, rotorcraft avionics, modular avionics packaging, fault tolerant avionics, crew station technology, and artificial intelligence and expert systems. V.L.

A92-49252
UTILITY MANAGEMENT SYSTEM FOR HYPERSONIC VEHICLES
RICHARD K. WALDO (McDonnell Douglas Electronics Systems Co., Saint Charles, MO) and STEPHEN F. FOLEY (USAF, Wright-Patterson AFB, OH) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 1-5. refs
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The authors discuss the issues involved in developing a utility management system (UMS) for hypersonic vehicles. Hypersonic vehicles require that the vehicle subsystems be highly integrated to minimize weight. This integration of the subsystems also makes the most efficient use of consumables. Consequently, a highly integrated, yet distributed, set of controls is required to manage these subsystems efficiently. A UMS integrated into a vehicle management system (VMS) allows for such control of fuel, active vehicle cooling, secondary power (including electrical power and hydraulic power), environmental control, life support systems, etc. UMSs use nontraditional concepts for the architecture, procurement, integration testing, and developmental approach to the hardware and software. I.E.

A92-49254
TESTING AND ANALYSIS OF A 'SMART' INTERFACE TO CONNECT TWO COMPLEX AVIONICS BUS SYSTEMS WITHOUT SIGNIFICANT MODIFICATION TO THE SOFTWARE OF EITHER SYSTEM
RICHARD R. PRUYN and TIMOTHY C. NICHOLS (Boeing Co., Helicopters Div., Philadelphia, PA) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 12-17.
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Laboratory proof-of-concept testing has been completed to show how a smart interface terminal (called the bus translator unit) can interface with and interconnect two complex data bus systems. The testing utilized an existing software integration laboratory of the core (flight management and navigation) avionics system of a digital fly-by-wire rotorcraft. The coupled system and the smart interface were simulated to the level required to exchange data and control commands. Translations and formatting of the data were required to match those needed by the aircraft and the unique mission avionics suite. Two-way exchanges of data and control commands are demonstrated. I.E.

A92-49271
ARTIFICIAL INTELLIGENCE IN THE HELICOPTER COCKPIT OF THE FUTURE
DAN BALLARD (Reticular Systems, Inc., San Diego, CA) and LISA OWSLEY (U.S. Army, Aviation Systems Command, Fort Eustis, VA) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 125-130. refs
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The authors describe research in the development of a situation assessment (SA) system for use in next-generation US Army helicopters. They first describe the problems faced by attack and scout helicopter pilots when conducting missions at night or under adverse weather conditions. An overall artificial intelligence (AI) processing architecture for use in the Army helicopter domain is then described. This processing architecture is based on the technology developed by DARPA and the US Air Force for the Pilot's Associate (PA) program. This technology will support the Army's Rotorcraft Pilot's Associate (RPA) Advanced Technology Transition Demonstration (ATTD) program. I.E.

A92-49273* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AN ULTRARELIABLE INTEGRATED DIGITAL COMPUTER FOR HELICOPTERS
RICHARD E. HARPER (Charles Stark Draper Laboratory, Inc., Cambridge, MA) and GAYLE GRANT (U.S. Army, Avionics Research and Development Activity, Fort Monmouth, NJ) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 137-146. Research supported by U.S. Army. refs
(Contract NAS1-18565)
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The US Army Fault-Tolerant Architecture (AFTA) has been defined to meet real-time fault-tolerant processing requirements of future Army applications. AFTA is the enabling technology that will allow the Army to configure existing processors and other hardware to provide high throughput and ultrahigh reliability necessary for terrain-following/terrain-avoidance (TF/TA) and nap-of-the-earth (NOE) flight control and other advanced Army applications. A brief description of AFTA's relevant attributes and theory of operation is given. The systems engineering models which permit the configuration on an AFTA to meet mission requirements as they evolve are presented, along with an example of their use to engineer an AFTA configuration. The resulting AFTA configuration, its predicted throughput, reliability, availability, weight, power, volume, and life-cycle cost impact, and the effects of possible engineering tradeoffs are presented. I.E.

A92-49287
MANAGING SIMULATOR WIRING INFORMATION AND DERIVING SYSTEM CONTINUITY
MARSHALL C. HALL, III, ROBERT C. KIRCHER, JR., and SAMUEL T. MALLOS (Boeing Commercial Airplane Group, Seattle, WA) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 226-231.
Copyright

The authors provide an overview of the air transport engineering simulator electrical wiring design, maintenance and use processes and describe some of the information management challenges and problems inherent in that environment. They focus on the problem of maintaining conformity, throughout the simulator's service life, of the as-built or component-oriented documentation with the as-used or aircraft systems-oriented documentation of the simulator's wiring, at the wire/signal level. A detailed description

of a partial solution (the wiring information system at the Boeing Flight Systems Laboratory) for the as-built vs as-used problem is presented. The additional work needed to complete the solution is defined. Future directions are sketched. I.E.

A92-49297* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A FAULT-TOLERANT NETWORK ARCHITECTURE FOR INTEGRATED AVIONICS
BRYAN BUTLER and STUART ADAMS (Charles Stark Draper Laboratory, Inc., Cambridge, MA) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 281-286. Research supported by U.S. Army. refs
(Contract NAS1-18565)
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The Army Fault-Tolerant Architecture (AFTA) under construction at the Charles Stark Draper Laboratory is an example of a highly integrated critical avionics system. The AFTA system must connect to other redundant and nonredundant systems, as well as to input/output devices. A fault-tolerant data bus (FTDB) is being developed to provide highly reliable communication between the AFTA computer and other network stations. The FTDB is being designed for Byzantine resilience and is probably capable of tolerating any single arbitrary fault. The author describes a prototype architecture for the fault-tolerant data bus. I.E.

A92-49303
MLS/RNAV CONTROL DISPLAY UNIT DEVELOPMENT
BARRY C. SCOTT (FAA, Washington, DC), TSUYOSHI GOKA (T. Goka Avionics, Sunnyvale, CA), DAVID GATES, III (Mantech International, Inc., Alexandria, VA), and JOSEPH QUINTAL (S. Levy, Inc., Campbell, CA) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 331-336. refs
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The authors describe the process of developing a microwave landing system (MLS)/RNAV control display unit and associated simulation capability for retrofit in older-generation electromechanical aircraft cockpits. Functional specifications, design, development, and fabrication of the control display unit, requirements of a retrofit kit, and installation and integration into a typical phase-II simulator are discussed. Operational evaluation in a full-mission simulation environment is also discussed. Recommendations are offered for applications and implementations in actual aircraft. I.E.

A92-49308
AN AIRBORNE MULTIMODE RADAR DISPLAY PROCESSOR
JOHN FELSMAN and JOSEPH W. IANNIELLO (Norden Systems, Inc., Norwalk, CT) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 367-374. refs
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The authors describe a display processor unit (DPU) that develops display images for a multimode airborne radar system. The DPU described has a unique feature that allows display updates for a period of time when the radar is not transmitting. Once the radar image is formed, the information provided by the avionics system can reposition the display image. In this mode this aircraft is less vulnerable to detection by electronic counter measures. This feature also provides a significant improvement in display clarity during normal operation. The multimode airborne radar display modes, the equipment that generates the displays, and the technology used are also described. I.E.

A92-49310
TESTABILITY OF THE PAALS AUTO-ALIGN SENSOR SYSTEM
DOUGLAS C. MACGUGAN (Sundstrand Data Control, Redmond, WA) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 381-386. refs
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The author addresses the testability design of the precision accelerometer alignment and leveling system (PAALS) auto-align sensor system. The PAALS module is a sensor system for measuring the alignment of avionic packages relative to the system reference axes. PAALS stores the measured alignment parameters in memory as updated by command from the main system computers, and is designed to be co-located on active targeting sub-systems. The PAALS auto-align sensor system is designed to provide accurate alignment data with a high degree of reliability and extremely low maintenance. To achieve these requirements, the PAALS design incorporated testability to verify the accuracy and insure reliability. The testability design consists of four parts: functional partitioning, enhanced reliability design, internal self-test design, and offline testing. I.E.

A92-49312
FAULT TOLERANT AVIONICS DISPLAY SYSTEM
ELLIS F. HITT (Battelle, Columbus, OH) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 393-398. refs
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The author discusses the fault-tolerant requirements of avionics display systems, and an open architecture which permits implementing these requirements. The fault tolerant requirements include the classes of hardware and software faults. Within each class, the requirements are broken down into fault types the system must tolerate. The designers of both hardware and software must develop an integrated approach to implementing fault detection, damage assessment, fault isolation, and recovery for the fault types. Active matrix (AM) liquid crystal displays (LCDs) used with high-performance graphics and video processors provide the capability needed to achieve these fault-tolerant designs. I.E.

A92-49313
EXTREME WIDE FIELD-OF-VIEW DISPLAYS AND THE ENCLOSED COCKPIT
JOHN A. WEBSTER (Concept Vision Systems, Inc., Conway, WA) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 399-404.
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Recent developments have shown that extreme wide field-of-view (EWFOV) displays are possible and will become the preferred display in future high performance aircraft. Visual perception and novel display option possibilities are discussed. EWFOV displays encompassing at 240 deg H x 120 deg V field of view are possible. These displays are able to replace the viewer's normal reality with a new reality acceptable to the viewer, thereby allowing the enclosed pilot to operate as if not enclosed. Research trends are outlined. I.E.

A92-49315
ARTIFICIAL INTELLIGENCE TECHNIQUES APPLIED TO VEHICLE MANAGEMENT SYSTEM DIAGNOSTICS
KEITH G. COCHRAN (McDonnell Aircraft Co., Saint Louis, MO) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 411-415.
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A vehicle management system (VMS) research and development project is underway at McDonnel Aircraft to integrate control of systems on combat aircraft and enhance diagnostics. A VMS demonstrator has been constructed to test VMS methodologies and architectures. Two real-time expert systems are under development to diagnose electrical and fuel system failures on the VMS demonstrator: an electrical expert system, located on a Sun Microsystems SPARCstation1 that acquires data from a centralized computer; and a fuel expert system, located in

the control computers using a shared memory allocation with the control software. Both expert systems used the CLIPS inference engine developed by NASA. Future enhancements to the two expert systems will include more use of probability in determining failures and testing other versions of the CLIPS inference engine. I.E.

A92-49318
VERIFICATION AND VALIDATION TESTING OF THE PILOT'S ASSOCIATE
NORMAN D. GEDDES (Applied Systems Intelligence, Inc., Gainesville, GA) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 426-431. Research supported by Lockheed Corp., USAF, and DARPA.
(Contract F33615-85-C-3804)
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The DARPA/USAF/Lockheed Pilot's Associate is a comprehensive and complex real-time artificial intelligence decision aid. The author discusses how the Lockheed team is conducting the verification and validation of the Pilot's Associate as an integrated methodology that brings design and test into a closer relationship. The issues of verification and validation have been addressed as an integral part of the design and development process over the course of the project. The methodology encompasses digital combat simulations, engineering development testing of individual software units and subsystems, prototype testing, manned functional testing, real-time performance testing, and a manned operational performance evaluation. I.E.

A92-49327
MAP PROJECTIONS AND AIRBORNE MOVING MAP DISPLAYS
HALL THOMAS (Honeywell, Inc., Air Transport Div., Phoenix, AZ) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 493-498. refs
Copyright

The author discusses advantages and disadvantages of several methods of map projection, and identifies two methods that work well at any latitude with any map orientation. Four methods of map projection are discussed: cylindrical equidistant projection, sinusoidal projection, oblique orthographic projection, and oblique azimuthal equidistant projection. There are two modes of map displays, plan mode and map mode. Most of the discussion applies to the plan mode. For most applications, the projection of choice is orthographic projection. For maps of small areas with many target points, however, the cylindrical projection may be preferred due to computational requirements. For airborne maps with very long flight segments, the increased distance accuracy may make the azimuthal projections desirable. When properly implemented, the computational requirements of the orthographic and azimuthal projections are not significantly different. I.E.

A92-49331
SYSTEMS COMMONALITY - INTEGRATED AVIONICS FOR THE MH-47E AND THE MH-60K
CAREY SMITH (IBM Corp., Federal Sector Div., Owego, NY) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 526-532. Research supported by U.S. Army.
Copyright

The program described involves two aircraft: the MH-47E, which is a special modification of the Boeing CH-47D Chinook, and its complement, the MH-60K version of the Sikorsky UH-60L Black Hawk. The author provides an overview of the IBM integrated avionics subsystem (IAS), which extends the communication and navigation capabilities of the Chinook and Black Hawk aircraft by integrating avionics processing and supplying cockpit management. The hardware and mission processor software functions that constitute the IAS are discussed, in addition to the redundant system architecture which is based on Mil-Std-1553B data bus. One-hundred percent hardware and software commonality has been achieved in the IAS design. Maximum aircraft availability is enhanced through the commonality of equipment and software while the number of spares and test equipment required to support both aircraft is reduced. I.E.

A92-49332
THE ARMY SPECIAL OPERATIONS AIRCRAFT INTEGRATED AVIONICS SUBSYSTEM - AN OPERATIONAL PERSPECTIVE
ROY S. SMITH and GATES S. MURCHIE (IBM Corp., Federal Sector Div., Owego, NY) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 533-538. Research supported by U.S. Army.
Copyright

The authors focus on integration techniques utilized to enhance an operator interface and contain pilot workload within acceptable levels. The US Army MH-47E and MH-60K special operations aircraft (SOA) provide the capability to perform the Army's clandestine, deep-penetration missions in adverse weather, at night, over any terrain which the aircraft can traverse. The inherent complexity of this mission required an extensive avionics subsystem (IAS). The ultimate success of any integrated system hinges on the ability of the operators to access system capabilities and interpret system data in a timely fashion. Through the use of workload-reducing integration techniques, the IAS design has allowed capabilities to be successfully managed by a two-operator aircrew. I.E.

A92-49336
OPERATING PRINCIPLES FOR INTEGRATED SENSOR PROCESSING
M. J. BEACKEN and M. J. GELLER (AT&T Bell Laboratories, Whippany, NJ) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 555-560.
Copyright

The authors address the operating principles applicable to integrated avionics processors. The techniques described have been successfully applied in avionics programs within an integrated standard electronic modules format E (SEM E) heterogeneous multiple processor system. Analysis of avionics applications is blended with ease-of-use, programmability and systems considerations to derive the system principles. Applications scheduling, initialization, termination and resource management techniques are considered. I.E.

A92-49340
GPS INTEGRATION IMPROVES MISSION CAPABILITIES OF CH-47D AIRCRAFT
RICHARD W. FLESNER (Collins Avionics & Communications Div., Cedar Rapids, IA) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 577-582.
Copyright

Rockwell International fielded an integrated avionics system (IAS) on the CH-47D Chinook helicopter aircraft in 1985. The most recent modification to the IAS is the integration of the NAVSTAR global positioning system (GPS) as the precise navigation/time reference. The author begins with an overview of the CH-47D integrated avionics system prior to the GPS integration. A detailed description is given for the integration design of the GPS, including a discussion on how the capabilities of the GPS enhance the performance of the integrated avionics system and improve the mission capabilities of the aircraft under the most demanding conditions, including mission-peculiar flight profiles and four-dimensional maneuvers using GPS as the precise navigational/time reference. I.E.

A92-51003
ARCHITECTURES AND GPS/INS INTEGRATION - IMPACT ON MISSION ACCOMPLISHMENT
ZDZISLAW H. LEWANTOWICZ (USAF, Wright Laboratory, Wright-Patterson AFB, OH) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 7, no. 6, June 1992, p. 16-20. refs
Copyright

Various factors affecting the difference in utilization of the GPS by the military services, especially when compared to that of the commercial and civil sectors are considered. These factors which include the more demanding military operating environment and mission requirements, and avionics integration architectures are discussed from a broad perspective of system level avionics integration. Avionics architecture options are analyzed in terms of the cost of integration, cost of ownership, and mission capability. O.G.

A92-51011
A FAULT-TOLERANT AIR DATA/INERTIAL REFERENCE SYSTEM
CHARLES R. MCCLARY (Honeywell, Inc., Air Transport Systems Div., Minneapolis, MN) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 7, no. 5, May 1992, p. 19-23. refs
Copyright

A fault-tolerant Air Data Inertial Reference System (ADIRS) is described herein. The system consists of a fault-tolerant Air Data Inertial Reference Unit (ADIRU), A Secondary Air Data Attitude Reference Unit (SAARU) and six Air Data Modules (ADM). The ADIRS replaces the conventional inertial reference and air data systems on today's aircraft and uses ARINC 629 bi-directional serial digital data bus interfaces. The ADIRS is designed to be the inertial and air data reference for the ARINC 651 Integrated Modular Avionics (IMA) distributed architecture and provides low life cycle cost and high availability through high reliability, simple high integrity monitoring and deferred maintenance. Author

A92-52018
CONTROLLING RADAR SIGNATURE
KENNETH W. FOULKE (U.S. Navy, Naval Air Warfare Center, China Lake, CA) Aerospace America (ISSN 0740-722X), vol. 30, no. 8, Aug. 1992, p. 44-46.
Copyright

Low observable technologies for military and tactical aircraft are reviewed including signature-reduction techniques and signal detection/jamming. Among the applications considered are low-signature sensors and the reduction of radar cross section in conjunction with radar-absorbing structures and materials. Technologies for reducing radar cross section are shown to present significant technological challenges, although they afford enhanced aircraft survivability. C.C.S.

A92-52433*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TAKEOFF PERFORMANCE MONITORING SYSTEM DISPLAY OPTIONS
DAVID B. MIDDLETON (NASA, Langley Research Center, Hampton, VA), RAGHAVACHARI SRIVATSAN (Vigyan, Inc., Hampton, VA), and LEE H. PERSON, JR. (NASA, Langley Research Center, Hampton, VA) IN: AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers. Washington, American Institute of Aeronautics and Astronautics, 1992, p. 57-67. refs
(AIAA PAPER 92-4138) Copyright

The development of displays for the Takeoff Performance Monitoring System (TPMS) is described with attention given to the three concepts prepared for commercial applications. The TPMS algorithm is described and related to the display requirements for pilots of two-engine airplanes. Head-up and -down displays are considered for displaying the simple advisory data which indicate whether the takeoff is a 'Go' or 'No-go' based on engine failure, acceleration error, and runway length. Six pilots are shown the three display options which include: (1) basic information; (2) basic data with 'Go/No-go' advisory flags; and (3) basic data, advisory flags, and an abort-warning symbol. The pilots tended to select the option with the most advisory data available, but the inconclusive preference study led to the concept of presenting all three configurations as possible display options for the TPMS. C.C.S.

A92-52465* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
VISION-BASED OBSTACLE DETECTION FOR ROTORCRAFT FLIGHT
BANAVAR SRIDHAR, RAY SUORSA, PHILLIP SMITH, and BASSAM HUSSIEN (NASA, Ames Research Center, Moffett Field, CA) (IEEE, Special Workshop on Passive Ranging, Princeton, NJ, Oct. 10, 1991) Journal of Robotic Systems (ISSN 0741-2223), vol. 9, no. 6, Sept. 1992, p. 709-727. refs

An obstacle detection approach to rotorcraft flight is described which is based on feature tracking and recursive range estimation. Flight characteristics are taken into account. A range map derived on the basis of this approach provides an advisory display to the pilot and can serve as input to an automatic obstacle-avoidance guidance system. A NASA CH-47 Chinook helicopter was used to develop an image and rotorcraft flight data base for verification of obstacle detection concepts. The performance of the passive range estimation algorithms is demonstrated using both laboratory image and flight image data. O.G.

N92-30524# TRW, Inc., Beavercreek, OH. Military Electronics and Avionics Div.
A MODEL OF THE ADA AVIONICS REAL-TIME SYSTEM: AN EXAMPLE OF THE BENEFITS OF THE HARDWARE/SOFTWARE CODESIGN APPROACH IN DEVELOPMENT OF REAL-TIME SYSTEMS Final Report
B. E. CLARK, F. G. GRAY, J. T. MORRISON, and T. S. WHITE Mar. 1992 174 p Prepared in cooperation with EPA, Research Triangle Park, NC; and Virginia Polytechnic Inst., Blacksburg, VA (Contract F33615-87-D-1452)
(AD-A248893; WL-TR-92-1022) Avail: CASI HC A08/MF A02

The Ada Avionics Real-Time System (AARTS) Operating System (AOS) is the OS and management system under development for the PAVE PILLAR architecture. The AOS, in its current version, was modeled in the Architectural Design and Assessment Systems (ADAS) along with the hardware and applications being exercised in the Avionics Directorate's Integrated test bed. The report describes the model, the results of simulation executions, and methods for expansion of the model to architectures larger than that of the integrated test bed. GRA

N92-30965*# Douglas Aircraft Co., Inc., Long Beach, CA.
HIGH SPEED RESEARCH SYSTEM STUDY. ADVANCED FLIGHT DECK CONFIGURATION EFFECTS
JAY R. SWINK and RICHARD T. GOINS Jun. 1992 85 p
(Contract NAS1-19345)
(NASA-CR-189650; NAS 1.26:189650) Avail: CASI HC A05/MF A01

In mid-1991 NASA contracted with industry to study the high-speed civil transport (HSCT) flight deck challenges and assess the benefits, prior to initiating their High Speed Research Program (HSRP) Phase 2 efforts, then scheduled for FY-93. The results of this nine-month effort are presented, and a number of the most significant findings for the specified advanced concepts are highlighted: (1) a no nose-droop configuration; (2) a far forward cockpit location; and (3) advanced crew monitoring and control of complex systems. The results indicate that the no nose-droop configuration is critically dependent upon the design and development of a safe, reliable, and certifiable Synthetic Vision System (SVS). The droop-nose configuration would cause significant weight, performance, and cost penalties. The far forward cockpit location, with the conventional side-by-side seating provides little economic advantage; however, a configuration with a tandem seating arrangement provides a substantial increase in either additional payload (i.e., passengers) or potential downsizing of the

vehicle with resulting increases in performance efficiencies and associated reductions in emissions. Without a droop nose, forward external visibility is negated and takeoff/landing guidance and control must rely on the use of the SVS. The technologies enabling such capabilities, which de facto provides for Category 3 all-weather operations on every flight independent of weather, represent a dramatic benefits multiplier in a 2005 global ATM network: both in terms of enhanced economic viability and environmental acceptability. Author

N92-31868# Israel Aircraft Industries Ltd., Lod. Flight Control Dept.

FCS SKEWED SENSORS ARRAY: PRACTICAL CONSIDERATIONS

D. AGAMI and H. YAHIA *In* Israel Society of Aeronautics and Astronautics, 31st Israel Annual Conference on Aviation and Astronautics p 44-50 22 Feb. 1990 Previously announced in IAA as A91-43082

Avail: CASI HC A02/MF A03

Several papers published in this area during the past years describe computational methods which solve the basic problem of the Skewed Sensors Array (SSA), i.e., how to resolve the orthogonal inputs based on the skewed sensor data, and how to detect and isolate a failed sensor. In general, various transformation methods from the sensor vector space to the orthogonal input space are described, and failed sensor isolation techniques are offered - based on consistency tests. In this paper, a further step was made to analyze the inaccuracies in the context of the effects on an aircraft which employs an SSA. The results point out the main deficiencies of the SSA in practice. Given flight control grade sensors with reasonable static error bands, it is foreseen that considerable effort will be required during the design and test phases of a project, in order to satisfy the flight control accuracy requirements, through the use of sophisticated and time-consuming voter/monitor algorithms. The choice of an SSA for flight control is, therefore, a serious matter of risk and cost trade-off for any specific application. ISA

N92-32051# Naval Postgraduate School, Monterey, CA.

A CONTINUING STUDY OF ALTITUDE DETERMINATION DEFICIENCIES OF THE SERVICE AIRCRAFT INSTRUMENTATION PACKAGE (SAIP) M.S. Thesis

ROBERT J. RUSSELL Sep. 1991 79 p

(AD-A245952) Avail: CASI HC A05/MF A01

After correcting test equipment used in a previous study of the SAIP for an ambiguous grounding requirement, research was continued on aerodynamic factors affecting SAIP altitude measurement. Existing equations for incompressible flow over a cylinder and a sphere were used to model the static-pressure probe located on the front of the SAID pod and an algorithm was derived for the computation of the pressure coefficient, Cp. Our low-speed wind tunnel data show an overpressure at the static pressure ports when the angle of attack (phi) is less than 14 deg. The five-inch diameter body of the SAIP, located aft of the static pressure probe, is responsible for creating a stagnation-like region at the front of the SAIP probe which envelops the static-port location. Calculation of the altitude error (delta zeta) using the model for Cp, corrected for compressibility, is within + or - 15 percent of the error observed in flight at Mach 0.60. Improvements in the compressibility correction as well as analyses using an aero-panel method are suggested before sufficiently reliable fixes to the SAIP can be proposed. GRA

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.

A92-49827

ENGINE FLIGHT LOAD RELIABILITY ANALYSIS

DEJIN CHENG and JINGYANG HE (Chinese Flight Test Establishment, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 3, July 1992, p. 205-209. In Chinese.

Engine flight load reliability analysis is a special reliability research on the subject of the engine integral load chart based on JX/TJ tubojet X engine flight load measurement. This paper makes full scale statistics and analysis on a great number of data obtained from the actual measurements of flight testing and quite a number of data collected from flight-line service. A theoretical research has been made on application of double design works to engine low cycle fatigue life calculation and testing. The results of this research have been proved by the statistics and analysis of JX/TJX engine flying testing measurements. Author

A92-49830

LIMIT POINT FLOW MODE ANALYSIS OF EXHAUST DIFFUSER AND OPERATION CHARACTERISTICS OF INJECTOR

GUOZHENG ZHANG (Gas Turbine Establishment of China, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 3, July 1992, p. 219-222. In Chinese. refs

This paper analyzes the great effect of injection transfer characteristics on limit point operation parameters in an injector and flow character of injected flow according to injector limit point data measured in tests of Science Foundation Subject No. 24001. The actual flow mode at injector limit point is presented. The paper also analyzes the impassability of limit expansion ratio for the injector and the reason why the limit expansion ratio calculated from the injector engineering method is much less than its value obtained from the tests. The existing conclusion that the injector limit expansion ratio is the highest possible ratio is refuted by the theoretical demonstration and injector operation characteristics measured in tests. It is proved that the operational expansion ratio can be increased much beyond the limit expansion ratio when the injector absorbs injection transfer mass. The operation test characteristics of injector from low expansion ratio to high expansion ratio beyond the limit expansion ratio is first accomplished. Author

A92-49833

TURBOFAN WITH A SMALL BYPASS RATIO FOR FIRST STAGE OF A TWO-STAGE TO-ORBIT VEHICLE

KAITIAN YANG (Shenyang Aeroengine Research Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 3, July 1992, p. 229-231. In Chinese. refs

As turbomachinery is superior to rocket and ramjet at lower flight speed, a computational analysis of five sorts of hydrogen-fueled turbomachinery, i.e., ATR engine, rocket fan, tip turbine fan, two-spool hydrogen expander engine and turbofan has been accomplished. The results show that the turbofan with small bypass ratio is superior to the others in the performance at flight Mach number below 3.5. After choice of better cycle parameters, further performance calculation of the turbofan has been carried out. The total residual thrust of six engines is shown to be more than 411.88 kN at flight Mach number below 3.5. It is indicated that the specific impulse of the engine is more than 31.63 kN - s/kg at flight Mach number below 3.5 and 73.55 kN - s/kg at flight Mach number below 0.9, respectively. This type of

turbofan combined with a ramjet is proved to be suitable for a powerplant in the first stage of a two-stage to-orbit vehicle.
Author

A92-49834
EFFECT OF THERMODYNAMIC PARAMETERS ON PERFORMANCE AND COST OF TURBINE ENGINES
RUGEN WANG (Air Force College of Engineering, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 3, July 1992, p. 232-234. In Chinese. refs

A method for estimating life cycle cost of aircraft turbine engines manufactured in China is provided on the basis of a statistical technology and a definition of life cycle cost ratio has been used. Changes in thrust, specific fuel consumption and life cycle cost have been calculated when thermodynamic parameters and mean time between overhauls of the engine increase. It was found that there was a marked growth of the engine thrust when T3 increased, but life cycle cost ratio of the engine should, too, quickly grow. In order to make the growth of life cycle cost ratio acceptable for the air force, mean time between overhauls and total operation time of the engine must be lengthened. An overhigh pressure ratio of the compressor often makes the thrust drop down and life cycle cost ratio grow up. Author

A92-49836
RESEARCH ON ALTITUDE SIMULATION OF STARTING FOR A SINGLE-SPOOL SMALL TURBOJET
QING ZHU (Aerospace Ministry, Beijing, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 3, July 1992, p. 238-240. In Chinese. refs

Altitude simulation ignition tests of a single-spool small turbojet starting were completed at an altitude test rig. Some conclusions from the test data analysis have been drawn. It is very useful to supply secondary oxygen jet for high-altitude ignition and starting. The use of high energy igniter improves ignition and starting performance and reduces starting time. Fuel flow must be matched with air flow during high-altitude starting. The fuel flow must be controlled by the rotational velocity of the rotor to limit temperature at T4 and to avoid hang-up during starting. Author

A92-49841
THE MECHANISM OF LIQUID-COOLING OF VANE IN HIGH-TEMPERATURE TURBINE
DEZHANG LIU, MINHOU LIU, and WEIDONG WU (Nanjing Aeronautical Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 3, July 1992, p. 261-265. In Chinese. refs

In this research kerosene is used as a coolant instead of water in respect of identical and distinct properties. The heat transfer coefficient along full flow path was obtained with the kerosene coolant through an even-heated straight tube, and relation between the heat transfer cooling of kerosene and water has been determined in the case of the vapor-liquid two-phase boiling flow. The key problem of the kerosene used as coolant is 'coking property' and instability of wall temperature. However, it does happen in some particular working conditions, but the working conditions can be regulated with an empirical formula for the initial point annular flow to eliminate the coking zones. Several useful conclusions have been drawn for the cooling passage of turbine vanes. Author

A92-50252
COMPUTATIONAL STUDY OF A SUPERSONIC MIXER-EJECTOR EXHAUST SYSTEM
T. J. BARBER and O. L. ANDERSON (United Technologies Research Center, East Hartford, CT) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, no. 5, Sept.-Oct. 1992, p. 927-934. Previously cited in issue 07, p. 985, Accession no. A91-21372. refs
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A92-50278
SOME READILY QUANTIFIABLE ASPECTS OF SCRAMJET ENGINE PERFORMANCE
JACK L. KERREBROCK (MIT, Cambridge, MA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, no. 5, Sept.-Oct. 1992, p. 1116-1122. refs
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The quantitative treatment of the operation of scramjet engines is examined emphasizing the operational parameters that can be modeled and used to assess engine performance. The thermofluid dynamics of the scramjet are analyzed with consideration given to the effects of real-gas chemistry, combustion, and expansion kinetics. Modeling assumptions are described for the inlet, mixer, combustor, and nozzle flow, and results are given for different flight trajectories and Mach numbers. A combustor inlet Mach number is derived for the condition of insufficient recombination in the nozzle which maximizes Isp for flight Mach numbers over 10. The inlet Mach number is related to other operational parameters which demonstrate that the upper limit of the ratio of mass fraction to orbital speed is about 0.25. The analysis is shown to give the upper limits for performance - defined as mass ratio delivered to orbital speed - of scramjet operation. C.C.S.

A92-50311
EXPERIMENTS ON THE STRUCTURE OF AN ANNULAR COMPRESSIBLE REACTING SHEAR LAYER
R. S. BARLOW (Sandia National Laboratories, Livermore, CA), D. C. FOURGUETTE (California Institute of Technology, Pasadena), M. G. MUNGAL (Stanford University, CA), and R. W. DIBBLE (California, University, Berkeley) AIAA Journal (ISSN 0001-1452), vol. 30, no. 9, Sept. 1992, p. 2244-2251. Research supported by DOE. Previously cited in issue 07, p. 986, Accession no. A91-21475. refs

A92-50478
ON THE EFFECT OF EXTERNAL FLOW AND SHEAR-LAYER THICKNESS ON THE EXPANSION CELLS OF UNDER-EXPANDED SUPERSONIC CIRCULAR JETS
A. MICHALKE (Berlin, Technische Universitaet, Federal Republic of Germany) European Journal of Mechanics, B/Fluids (ISSN 0997-7546), vol. 11, no. 3, 1992, p. 363-381. refs
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The influence of an external subsonic flow on the expansion cells of under-expanded supersonic jets of circular cross-section is investigated on the basis of locally parallel, inviscid flow. This effect is important for the noise generated by jet engines in flight. For small over-pressure ratios the linearized inviscid equations are solved for a vortex sheet model of the perfectly-expanded jet. It is found that the expansion cell length is increased, but the pressure distribution within the cells is smoothed by the external flow. An approximate formula for the eigenvalues of the problem is given. Using a parallel-flow approximation, the effect of nonzero shear layer thickness of the jet is also investigated. It is found that the cell length is reduced for increasing shear-layer thickness and small external flow Mach numbers. For higher jet Mach numbers and high subsonic external flow the expansion cell length is almost unaffected by nonzero jet shear-layer thickness. While for low external flow Mach numbers the sensitivity of the expansion cell length to shear-layer thickness is slightly reduced by an increase of jet temperature, the cell length dependence on shear-layer thickness is almost unaffected by jet temperature for high subsonic external flow. Author

A92-50504
DETECTION AND IDENTIFICATION OF AXIAL FLOW COMPRESSOR INSTABILITIES
G. VACHTSEVANOS, H. KANG, J. CHENG, and I. KIM (Georgia Institute of Technology, Atlanta) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 5, Sept.-Oct. 1992, p. 1216-1223. Research supported by U.S. Navy. refs
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A new approach to failure detection and identification is proposed that combines an analytic estimation method and an

intelligent identification scheme in such a way that sensitivity to true failure modes is enhanced while the possibility of false alarms is reduced. A real-time recursive parameter estimation algorithm with covariance resetting that triggers the fault detection and identification routine only when potential failure modes are anticipated is employed. A possibilistic scheme based on fuzzy set theory is applied to the identification part of the algorithm with computational efficiency. At the final stage of the algorithm, an index is computed - the degree of certainty - based on Dempster-Shafer theory, which measures the reliability of the decision. The proposed algorithm has been applied successfully to the detection of rotating stall and surge instabilities in axial flow compressors. Author

A92-50528
A NEW RESONANT LINK AIRCRAFT POWER GENERATING SYSTEM
T. M. JAHNS (General Electric Co., Schenectady, NY) and M. A. MALDONADO (USAF, Wright Laboratory, Wright-Patterson AFB, OH) IN: IECEC '91; Proceedings of the 26th Intersociety Energy Conversion Engineering Conference, Boston, MA, Aug. 4-9, 1991. Vol. 1. La Grange Park, IL, American Nuclear Society, 1991, p. 13-19. refs
(Contract F33615-87-C-2806)
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A novel 400-Hz aircraft power generating system is introduced which has been designed to achieve significant improvements in power density and reliability compared to conventional systems now in use. Design targets for this exploratory development program include system (generator plus converter) power density of 1 kVA/lb and mean-time-between-failure of 5000 hours. At the heart of the novel variable-speed, constant-frequency configuration is a high-frequency resonant link inverter designed so that all inverter switching occurs under zero-voltage conditions. Advantages include minimization of switching stresses and EMI generation. Inverter losses are further reduced by using MOS-controlled thyristors (MCTs) as the power switches in order to take advantage of the MCT's low forward voltage drop. A 60-kVA breadboard version of the generating system has been constructed, and test results are presented which confirm its key performance characteristics. I.E.

A92-52890
SIMULATION ANALYSIS OF THE INFLUENCE OF VARIATION IN SOME SELECTED DESIGN AND CONTROL PARAMETERS ON THE ACCELERATION TIME OF A TURBOJET ENGINE
M. ORKISZ (Air Force Academy, Deblin, Poland) Polish Academy of Sciences, Institute of Fundamental Technological Research, Engineering Transactions (ISSN 0035-9408), vol. 39, no. 3-4, 1991, p. 351-367. refs
Copyright

The equation governing the acceleration time of a turbojet engine is presented in an implicit form; the expansion into power series contains first-order partial derivatives. The derivatives represent the 'sensitivity measure' of the acceleration time due to the variation of (1) the design parameters of the compressor (stability margin, moment of inertia, efficiency, compression ratio), (2) technical conditions (deformation of blade profiles, due to erosion, turbine blade clearance), and (3) service conditions due to flight speed and altitude. The relations derived enable the wide range simulation analysis of the problem. Author

A92-53120
SILENT SOLUTIONS
GRAHAM WARWICK Flight International (ISSN 0015-3710), vol. 142, no. 4333, Aug. 26-Sept. 1, 1992, p. 23, 26, 27, 30.
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The noise requirements for corporate aircraft fleets are analyzed in terms of solutions providing methodologies for hushkitting and alternative engine technologies. Attention is given to the regulatory distinctions between British aircraft that are qualified as stage-1, -2, and -3 and the associated implications for hushkitting. Engine modifications are set forth which were used by aircraft manufacturers to eliminate extreme noises, and several hushkits are shown to be available for the 727. A 'heavyweight' hushkit is described for the 727-200, and an ejector suppressor is described for the F28 engines of the 1-11 series aircraft. Five hushkits for DC-9s and the hushkits designed for the 737-200 and the F28 are shown to provide the highest level (stage-3) of noise reductions, although a fuel-burn penalty is predicted for all of the techniques. C.C.S.

A92-53181
NEW-TYPE OF ULTRALIGHT FLEXIBLE A-SI SOLAR CELL AND ITS APPLICATION ON AN AIRPLANE
Y. KISHI, H. INOUE, H. TANAKA, S. KOUZUMA, K. MURATA, S. SAKAI, M. NISHIKUNI, K. WAKISAKA, H. SHIBUYA, H. NISHIWAKI (Sanyo Electric Co., Ltd., Hirakata, Japan) et al. IN: IEEE Photovoltaic Specialists Conference, 22nd, Las Vegas, NV, Oct. 7-11, 1991, Conference Record. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 1213-1218. refs
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An ultralight flexible a-Si solar cell fabricated on a transparent film substrate has been developed. High photoconductivity of 2 x 10 exp -5/Ohm/cm and high photosensitivity of 1 x 10 exp 6 were obtained with a-Si films deposited by H2-dilution of SiH4 on a transparent film substrate at 180 C. Prebaking the transparent film substrate effectively reduced the impurity content of the a-Si film. A maximum output power of 550 mW and a power-to-weight ratio of 275 mW/g were obtained for an integrated-type a-Si solar cell with a size of 110 x 115 mm. As a the first application of this flexible a-Si solar cell, a solar-powered airplane has been developed, and it completed a transcontinental flight across the United States. I.E.

A92-53258
A NUMERICAL STUDY OF THE RADIATION CHARACTERISTIC OF AN ELLIPTICAL EXHAUST JET
JIAXING ZHAO and LIGUO LI (Nanjing Aeronautical Institute, China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956), vol. 24, no. 3, June 1992, p. 274-282. In Chinese. refs

A numerical study is conducted to investigate radiation characteristics for the design of a helicopter infrared suppressor. A computational method for the 3D turbulent free flame jet exhausted from a helicopter's elliptical jet pipe is described. The method comprises a numerical solution technique for the time-averaged governing particle differential equation and physical models for the turbulence and thermal radiation. Analytical results of the exhaust gas temperature, velocity, composition, and radiation flux are compared with experimental findings and show that the method is generally feasible. C.D.

A92-53276
NUMERICAL SIMULATION OF THREE-DIMENSIONAL TURBULENT FLOWS IN COMBUSTION CHAMBERS
GENWANG MAO, JINXIAN LI, and XINPIN WU (Northwestern Polytechnical University, Xian, China) Journal of Propulsion Technology (ISSN 1001-4055), no. 4, Aug. 1992, p. 1-8. In Chinese. refs

Based on the SIMPLE method, a numerical method and a computer program are developed to simulate flows in combustion chambers. The flows in combustion chambers with film cooling slots and secondary air holes are numerically simulated under different conditions. The results are in good accordance with experimental results. Author

A92-53336
AIRCRAFT ENGINES AND GAS TURBINES (2ND REVISED AND ENLARGED EDITION)
JACK L. KERREBROCK Research supported by California Institute of Technology. Cambridge, MA, MIT Press, 1992, 491 p. refs
(ISBN 0-262-11162-4) Copyright

The present volume provides an introduction to the engineering of aircraft propulsion systems with emphasis on the engine rather than on the disciplines involved in engine design. A

phenomenological discussion of the processes by which energy is converted from heat to mechanical energy to thrust is presented. Several types of engines are discussed within the framework of ideal cycle analysis, where the components of an actual engine are represented parametrically without quantitative reference to the engine structure. The mechanical characteristics required of each major engine component to achieve the parametric behavior assumed in the cycle analysis are examined. A complete gas generator and a complete propulsion system are discussed, with emphasis on the problems of engine control, inlet-to-engine and engine-to-nozzle matching, and inlet distortion. The mechanisms by which aircraft engines produce noise are addressed, and some of the simpler techniques of propulsion systems analysis to determine which engine should be developed are examined.

P.D.

A92-53389
SIMULATION RESEARCH ON THE DYNAMIC CHARACTERISTICS OF STEAM-INJECTED GAS TURBINE
KEJIU MAO, XIAOWEN DAI, and KELING GAO (Beijing University of Aeronautics and Astronautics, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 4, April 1991, p. B133-B139. In Chinese. refs

Nonlinear mathematical models for a steam-injected gas turbine are derived in this paper. In the formulating process of models, variable specific heat, intermediate plenum efficiency and heat transfer in the gas path are considered to make the mathematical models more accurate. With the computer programs on the basis of these models, static and dynamic characteristics of the gas turbine are analyzed in detail. Author

N92-30303# Galaxy Scientific Corp., Mays Landing, NJ.
STATISTICS ON AIRCRAFT GAS TURBINE ENGINE ROTOR FAILURES THAT OCCURRED IN US COMMERCIAL AVIATION DURING 1989 Final Report
E. R. CHAPDELAINE (Federal Aviation Administration, Atlantic City, NJ.), B. C. FENTON (Federal Aviation Administration, Atlantic City, NJ.), R. A. DELUCIA (Naval Air Propulsion Test Center, Trenton, NJ.), and M. MULLER Jun. 1992 26 p
(Contract DTFA03-89-C-0043)
(DOT/FAA/CT-92/5) Avail: CASI HC A03/MF A01

Presented here is statistical information relating to gas turbine engine rotor failures which occurred during 1989 in U.S. commercial aviation service use. Four hundred and thirty-five failures occurred in 1989. Rotor fragments were generated in 156 of the failures, and of these 24 were uncontained. The predominant failure involved blade fragments, 87 percent of which were contained. Eight disk failures occurred and six were uncontained. Thirty-six percent of the 435 failures occurred during the takeoff and climb stages of flight. This service data analysis is prepared on a calendar-year basis and published yearly. The data are useful in support of flight safety analyses, proposed regulatory actions, certification standards, and cost benefit analyses. Author

N92-30518*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
THRUST STAND EVALUATION OF ENGINE PERFORMANCE IMPROVEMENT ALGORITHMS IN AN F-15 AIRPLANE
TIMOTHY R. CONNERS Jul. 1992 23 p Presented at the 28th AIAA-SAE-ASME-ASEE Joint Propulsion Conference, Nashville, TN, 6-8 Jul. 1992
(Contract RTOP 533-02-36)
(NASA-TM-104252; H-1842; NAS 1.15:104252; AIAA PAPER 92-3747) Avail: CASI HC A03/MF A01

An investigation is underway to determine the benefits of a new propulsion system optimization algorithm in an F-15 airplane. The performance seeking control (PSC) algorithm optimizes the quasi-steady-state performance of an F100 derivative turbofan engine for several modes of operation. The PSC algorithm uses an onboard software engine model that calculates thrust, stall margin, and other unmeasured variables for use in the optimization. As part of the PSC test program, the F-15 aircraft was operated on a horizontal thrust stand. Thrust was measured with highly accurate load cells. The measured thrust was compared to onboard model estimates and to results from posttest performance programs. Thrust changes using the various PSC modes were recorded. Those results were compared to benefits using the less complex highly integrated digital electronic control (HIDEC) algorithm. The PSC maximum thrust mode increased intermediate power thrust by 10 percent. The PSC engine model did very well at estimating measured thrust and closely followed the transients during optimization. Quantitative results from the evaluation of the algorithms and performance calculation models are included with emphasis on measured thrust results. The report presents a description of the PSC system and a discussion of factors affecting the accuracy of the thrust stand load measurements. Author

N92-30569*# Quest Integrated, Inc., Kent, WA.
A NEW UNSTEADY MIXING MODEL TO PREDICT NO(X) PRODUCTION DURING RAPID MIXING IN A DUAL-STAGE COMBUSTOR
SURESH MENON Apr. 1992 59 p
(Contract NAS3-26242; RTOP 324-02-00)
(NASA-CR-189155; NAS 1.26:189155; QUEST-TR-534) Avail: CASI HC A04/MF A01

An advanced gas turbine engine to power supersonic transport aircraft is currently under study. In addition to high combustion efficiency requirements, environmental concerns have placed stringent restrictions on the pollutant emissions from these engines. A combustor design with the potential for minimizing pollutants such as NO(x) emissions is undergoing experimental evaluation. A major technical issue in the design of this combustor is how to rapidly mix the hot, fuel-rich primary zone product with the secondary diluent air to obtain a fuel-lean mixture for combustion in the second stage. Numerical predictions using steady-state methods cannot account for the unsteady phenomena in the mixing region. Therefore, to evaluate the effect of unsteady mixing and combustion processes, a novel unsteady mixing model is demonstrated here. This model has been used to study multispecies mixing as well as propane-air and hydrogen-air jet nonpremixed flames, and has been used to predict NO(x) production in the mixing region. Comparison with available experimental data show good agreement, thereby providing validation of the mixing model. With this demonstration, this mixing model is ready to be implemented in conjunction with steady-state prediction methods and provide an improved engineering design analysis tool.

Author

N92-30753*# Pennsylvania State Univ., University Park. Dept. of Electrical and Computer Engineering.
FINITE DIFFERENCE TIME DOMAIN MODELING OF STEADY STATE SCATTERING FROM JET ENGINES WITH MOVING TURBINE BLADES Progress Report, 25 Sep. 1991 - 25 Mar. 1992
DEIRDRE A. RYAN, H. SCOTT LANGDON, JOHN H. BEGGS, DAVID J. STEICH, RAYMOND J. LUEBBERS, and KARL S. KUNZ 4 May 1992 35 p
(Contract NAG1-1350)
(NASA-CR-190290; NAS 1.26:190290) Avail: CASI HC A03/MF A01

The approach chosen to model steady state scattering from jet engines with moving turbine blades is based upon the Finite Difference Time Domain (FDTD) method. The FDTD method is a numerical electromagnetic program based upon the direct solution in the time domain of Maxwell's time dependent curl equations throughout a volume. One of the strengths of this method is the ability to model objects with complicated shape and/or material composition. General time domain functions may be used as source excitations. For example, a plane wave excitation may be specified as a pulse containing many frequencies and at any incidence angle to the scatterer. A best fit to the scatterer is accomplished using cubical cells in the standard cartesian implementation of the FDTD method. The material composition of the scatterer is determined by specifying its electrical properties at each cell on the scatterer. Thus, the FDTD method is a suitable choice for

problems with complex geometries evaluated at multiple frequencies. It is assumed that the reader is familiar with the FDTD method. Author

N92-30972*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NAVIER-STOKES ANALYSIS AND EXPERIMENTAL DATA COMPARISON OF COMPRESSIBLE FLOW WITHIN DUCTS

G. J. HARLOFF (Sverdrup Technology, Inc., Brook Park, OH.), B. A. REICHERT, J. R. SIRBAUGH (Sverdrup Technology, Inc., Brook Park, OH.), and S. R. WELLBORN (Iowa State Univ. of Science and Technology, Ames.) Jul. 1992 7 p Presented at the 13th International Conference on Numerical Methods in Fluid Dynamics, Rome (Italy), 6-10 Jul. 1992

(Contract NAS3-25266; RTOP 505-62-52)

(NASA-TM-105796; E-7226; NAS 1.15:105796) Avail: CASI HC A02/MF A01

Many aircraft employ ducts with centerline curvature or changing cross-sectional shape to join the engine with inlet and exhaust components. S-ducts convey air to the engine compressor from the intake and often decelerate the flow to achieve an acceptable Mach number at the engine compressor by increasing the cross-sectional area downstream. Circular-to-rectangular transition ducts are used on aircraft with rectangular exhaust nozzles to connect the engine and nozzle. To achieve maximum engine performance, the ducts should minimize flow total pressure loss and total pressure distortion at the duct exit. Changes in the curvature of the duct centerline or the duct cross-sectional shape give rise to streamline curvature which causes cross stream pressure gradients. Secondary flows can be caused by deflection of the transverse vorticity component of the boundary layer. This vortex tilting results in counter-rotating vortices. Additionally, the adverse streamwise pressure gradient caused by increasing cross-sectional area can lead to flow separation. Vortex pairs have been observed in the exit planes of both duct types. These vortices are due to secondary flows induced by pressure gradients resulting from streamline curvature. Regions of low total pressure are produced when the vortices convect boundary layer fluid into the main flow. The purpose of the present study is to predict the measured flow field in a diffusing S-duct and a circular-to-rectangular transition duct with a full Navier-Stokes computer program, PARC3D, and to compare the numerical predictions with new detailed experimental measurements. The work was undertaken to extend previous studies and to provide additional CFD validation data needed to help model flows with strong secondary flow and boundary layer separation. The S-duct computation extends the study of Smith et al, and Harloff et al, which concluded that the computation might be improved by using a finer grid and more advanced turbulence models. The present study compares results for both the Baldwin-Lomas and k-epsilon turbulence models and is conducted with a refined grid. For the transition duct, two inlet conditions were considered, the first with straight flow and the second with swirling flow. The first case permits examination of the effects of the geometric transition on the flow field, while the second case includes the rotational flow effect characteristic of a gas turbine engine. Author

N92-30998*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

PRELIMINARY DYNAMIC TESTS OF A FLIGHT-TYPE EJECTOR

COLIN K. DRUMMOND Jul. 1992 22 p Presented at the 28th Joint Propulsion Conference, Nashville, TN, 6-9 Jul. 1992; sponsored by AIAA, SAE, ASME, and ASEE

(Contract RTOP 505-62-30)

(NASA-TM-105814; E-7245; NAS 1.15:105814) Copyright Avail: CASI HC A03/MF A01

A thrust augmenting ejector was tested to provide experimental data to assist in the assessment of theoretical models to predict duct and ejector fluid-dynamic characteristics. Eleven full-scale thrust augmenting ejector tests were conducted in which a rapid increase in the ejector nozzle pressure ratio was effected through a unique facility, bypass/burst-disk subsystem. The present work examines two cases representative of the test performance window. In the first case, the primary nozzle pressure ration (NPR) increased 36 percent from one unchoked (NPR = 1.29) primary flow condition to another (NPR = 1.75) over a 0.15 second interval. The second case involves choked primary flow conditions, where a 17 percent increase in primary nozzle flowrate (from NPR = 2.35 to NPR = 2.77) occurred over approximately 0.1 seconds. Although the real-time signal measurements support qualitative remarks on ejector performance, extracting quantitative ejector dynamic response was impeded by excessive aerodynamic noise and thrust stand dynamic (resonance) characteristics. It does appear, however, that a quasi-steady performance assumption is valid for this model with primary nozzle pressure increased on the order of 50 lb(sub f)/s. Transient signal treatment of the present dataset is discussed and initial interpretations of the results are compared with theoretical predictions for a similar Short Takeoff and Vertical Landing (STOVL) ejector model. Author

N92-31172*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

TRENDS IN AEROPROPULSION RESEARCH AND THEIR IMPACT ON ENGINEERING EDUCATION

LOUIS A. POVINELLI, BRUCE A. REICHERT, and ARTHUR J. GLASSMAN (Toledo Univ., OH.) Jun. 1992 7 p Presented at the ASEE 1992 Annual Conference, Toledo, OH, 21-25 Jun. 1992

(Contract RTOP 505-62-52)

(NASA-TM-105682; E-7061; NAS 1.15:105682) Avail: CASI HC A02/MF A01

This presentation is concerned with the trends in aeropropulsion both in the U.S. and abroad and the impact of these trends on the educational process in our universities. In this paper, we shall outline the new directions for research which may be of interest to educators in the aeropropulsion field. Awareness of new emphases, such as emission reductions, noise control, maneuverability, speed, etc., will have a great impact on engineering educators responsible for restructuring courses in propulsion. The information presented herein will also provide some background material for possible consideration in the future development of propulsion courses. In describing aeropropulsion, we are concerned primarily with air-breathing propulsion; however many observations apply equally as well to rocket engine systems. Aeropropulsion research needs are primarily motivated by technologies required for advanced vehicle systems and frequently driven by external requirements such as economic competitiveness, environmental concern and national security. In this presentation, vehicle based research is first described, followed by a discussion of discipline and multidiscipline research necessary to implement the vehicle-focused programs. The importance of collaboration in research and the training of future researchers concludes this presentation. Author

N92-31250*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NASA. LEWIS RESEARCH CENTER SUPERSONIC THROUGHFLOW FAN PROGRAM

ROYCE D. MOORE, DANIEL L. TWEEDT, and RODRICK V. CHIMA 1990 17 p Presented at the 1990 JANNAF Propulsion Meeting, Anaheim, CA, 3-5 Oct. 1990

(Contract RTOP 505-62-61)

(NASA-TM-103248; E-5675; NAS 1.15:103248) Avail: CASI HC A03/MF A01

Recent studies have indicated the need for a commercial supersonic transport which can cruise at Mach 2 to 3. Various propulsion systems to power this new generation transport were examined and include supersonic throughflow fan engines which show the largest potential payoff. This concept also shows advantages for other types of aircraft including fighters. Another potential application of the supersonic throughflow fan is its use in conjunction with an air turboramjet engine. A fan that can operate with supersonic inlet Mach numbers would reduce the inlet losses incurred in diffusing the flow from supersonic to subsonic velocities at the fan face. In addition, the size and weight of an all-supersonic inlet will be substantially lower than that of a conventional inlet.

In order to furnish the required information for assessing the potential for this type of fan, NASA-Lewis began a program to design, analyze, build, and test a fan stage that is capable of operation with supersonic axial velocities from inlet to exit. The objectives of this program are to demonstrate the feasibility and potential of supersonic throughflow fans, to gain a fundamental understanding of the flow physics associated with such systems, and to develop an experimental data base for design and analysis code validation. An overview is presented of the NASA-Lewis supersonic throughflow fan program. The fan's aerodynamic design is summarized and some results from initial testing of a proof-of-concept supersonic throughflow fan are discussed. Finally, the experimental results are compared with those calculated from two viscous codes. Author

N92-31275*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
SUBSONIC FLIGHT TEST EVALUATION OF A PERFORMANCE SEEKING CONTROL ALGORITHM ON AN F-15 AIRPLANE
GLENN B. GILYARD and JOHN S. ORME Aug. 1992 20 p Presented at the 28th AIAA/SAE/ASME/ASEE Joint Propulsion Conference, Nashville, TN, 6-8 Jul. 1992
(Contract RTOP 533-02-36)
(NASA-TM-4400; H-1808; NAS 1.15:4400) Avail: CASI HC A03/MF A01

The subsonic flight test evaluation phase of the NASA F-15 (powered by F 100 engines) performance seeking control program was completed for single-engine operation at part- and military-power settings. The subsonic performance seeking control algorithm optimizes the quasi-steady-state performance of the propulsion system for three modes of operation. The minimum fuel flow mode minimizes fuel consumption. The minimum thrust mode maximizes thrust at military power. Decreases in thrust-specific fuel consumption of 1 to 2 percent were measured in the minimum fuel flow mode; these fuel savings are significant, especially for supersonic cruise aircraft. Decreases of up to approximately 100 degree R in fan turbine inlet temperature were measured in the minimum temperature mode. Temperature reductions of this magnitude would more than double turbine life if inlet temperature was the only life factor. Measured thrust increases of up to approximately 15 percent in the maximum thrust mode cause substantial increases in aircraft acceleration. The system dynamics of the closed-loop algorithm operation were good. The subsonic flight phase has validated the performance seeking control technology, which can significantly benefit the next generation of fighter and transport aircraft. Author

N92-31439# Aeronautical Research Labs., Melbourne (Australia).
RESEARCH INTO IMPROVING THE DURABILITY OF THE HOT SECTION IN THE AIRCRAFT TURBINE ENGINE
N. S. SWANSSON Dec. 1991 24 p
(AD-A250342; ARL-PROP-TM-473; DODA-AR-006-651) Avail: CASI HC A03/MF A01

Propulsion Branch at ARL is reviewing the direction of its research activities into the integrity, durability, and life extension of aircraft turbine engine components. Hot section repairs dominate the costs of engine overhaul, so resources are being redeployed from other programs on life of engine components toward this area of high potential benefit. Engine hot section life is an area of great complexity and wide scope. Despite the technical difficulties and limits in resources, the branch can make a useful contribution with carefully selected research. New proposed areas or extensions are structural analysis of high temperature components under cycles of thermal loading, and thermal analysis of components to determine temperature distribution which characterizes the thermomechanical loading. While structural analysis can build upon existing related expertise, little experience exists in thermal analysis and its core discipline of heat transfer, so a program to build up this technology base is proposed and options are examined. GRA

N92-31534*# United Technologies Corp., East Hartford, CT.
LIFE PREDICTION AND CONSTITUTIVE MODELS FOR ENGINE HOT SECTION ANISOTROPIC MATERIALS PROGRAM Interim Report
D. M. NISSLEY and T. G. MEYER Aug. 1992 177 p
(Contract NAS3-23939)
(NASA-CR-189222; NAS 1.26:189222; PWA-5968-80) Avail: CASI HC A09/MF A02

This report presents the results from a 35 month period of a program designed to develop generic constitutive and life prediction approaches and models for nickel-based single crystal gas turbine airfoils. The program is composed of a base program and an optional program. The base program addresses the high temperature coated single crystal regime above the airfoil root platform. The optional program investigates the low temperature uncoated single crystal regime below the airfoil root platform including the notched conditions of the airfoil attachment. Both base and option programs involve experimental and analytical efforts. Results from uniaxial constitutive and fatigue life experiments of coated and uncoated PWA 1480 single crystal material form the basis for the analytical modeling effort. Four single crystal primary orientations were used in the experiments: (001), (011), (111), and (213). Specific secondary orientations were also selected for the notched experiments in the optional program. Constitutive models for an overlay coating and PWA 1480 single crystal material were developed based on isothermal hysteresis loop data and verified using thermomechanical (TMF) hysteresis loop data. A fatigue life approach and life models were selected for TMF crack initiation of coated PWA 1480. An initial life model used to correlate smooth and notched fatigue data obtained in the option program shows promise. Computer software incorporating the overlay coating and PWA 1480 constitutive models was developed. Author

N92-31817# Los Alamos National Lab., NM.
ANALYTICAL AND EXPERIMENTAL STUDIES OF HEAT PIPE RADIATION COOLING OF HYPERSONIC PROPULSION SYSTEMS
R. A. MARTIN, M. A. MERRIGAN, M. G. ELDER, J. T. SENA, E. S. KEDDY, and C. C. SILVERSTEIN (CCS Associates, Bethel Park, PA.) 1992 7 p Presented at the 28th Joint Propulsion Conference, Nashville, TN, 6-8 Jul. 1992
(Contract W-7405-ENG-36)
(DE92-013428; LA-UR-92-1390; CONF-920747-2) Avail: CASI HC A02/MF A01

Preliminary, research-oriented, analytical and experimental studies were completed to assess the feasibility of using high-temperature heat pipes to cool hypersonic engine components. This new approach involves using heat pipes to transport heat away from the combustor, nozzle, or inlet regions, and to reject it to the environment by thermal radiation from an external heat pipe nacelle. For propulsion systems using heat pipe radiation cooling (HPRC), it is possible to continue to use hydrocarbon fuels into the Mach 4 to Mach 6 speed range, thereby enhancing the economic attractiveness of commercial or military hypersonic flight. In the second-phase feasibility program recently completed, we found that heat loads produced by considering both convection and radiation heat transfer from the combustion gas can be handled with HPRC design modifications. The application of thermal insulation to ramburner and nozzle walls was also found to reduce the heat load by about one-half and to reduce peak HPRC system temperatures to below 2700 F. In addition, the operation of HPRC at cruise conditions of around Mach 4.5 and at an altitude of 90,000 ft lowers peak hot section temperatures to around 2800 F. An HPRC heat pipe was successfully fabricated and tested at Mach 5 conditions of heat flux, heat load, and temperature. DOE

N92-31910*# Massachusetts Inst. of Tech., Cambridge. Gas Turbine Lab.
TURBINE BLADE TIP AND SEAL CLEARANCE EXCITATION FORCES
M. MARTINEZ-SANCHEZ and B. JAROUX 27 May 1992

372 p
(Contract NAS8-35018)
(NASA-CR-184341; NAS 1.26:184341) Avail: CASI HC A16/MF A03

Experimental and theoretical work done as Phase 3 of a program sponsored by MSFC to investigate the magnitude, origin, and parametric variations of destabilizing forces which arise in high power turbines due to blade-tip leakage effects are described. The two facilities which were built for this purpose are first described. The larger one is a closed, 2 atm pressurized Freon-12 flow loop in which is installed a 1:1 replica of the SSME first stage hydrogen turbine, which can be driven by the flow, and which generates about 14 KW of power into a load-absorbing DC generator. The smaller facility is used to measure the forces on labyrinth seals of the same type as those used in our turbine tests with a shrouded turbine. The seals can be kinematically whirled and spun (independently), and the inlet swirl can be set to a variety of values. Air is the working fluid (with atmospheric discharge) and the data are real-time pressure distributions in the seal glands. The five different unshrouded turbine configurations were tested with static offsets, plus one with a shroud band and a two-ridge seal. Theoretical models of various degrees of complexity were developed to help interpreting and extrapolating the data. The notion of partial work done by the fluid leaking through the tip gaps was put on a quantitative basis by examining the leakage vortex roll-up dynamics. This was used to obtain a theory of the work loss due to a uniform gap. Perturbation and multiple scale arguments were then used to extend this to the case of an eccentric turbine. This yields an unsteady, 3-D theory which can predict the distribution of the approach flow, and its effect on work defect, cross-forces, pressure patterns, and dynamic damping. The predictions agree qualitatively with the data and exhibit the correct trends, but the cross-forces are generally under-predicted. Author

N92-32059# Purdue Univ., West Lafayette, IN. School of Mechanical Engineering.
RESEARCH ON AERO-THERMODYNAMIC DISTORTION INDUCED STRUCTURAL DYNAMIC RESPONSE OF MULTISTAGE COMPRESSOR BLADING Final Report, Nov. 1987 - May 1991
SANFORD FLEETER Mar. 1992 220 p
(Contract F49620-88-C-0022)
(AD-A250865; TSPC-TR-92-10; AFOSR-92-0403TR) Avail: CASI HC A10/MF A03

The overall objective of this basic research program was the quantitative investigation of the fundamental phenomena relevant to aerothermodynamic distortion-induced structural dynamic blade responses in multistage gas turbine engines. The technical approach involved unique benchmark experiments and analyses. In particular, the flow physics of multistage blade row interactions were investigated, with unique unsteady aerodynamic data obtained and analyses developed to understand, quantify, and discriminate the fundamental flow phenomena as well as to direct the modeling of advanced analyses. Data obtained define the flow interactions and the effects on both the aerodynamic forcing function and the resulting unsteady aerodynamics of compressor rotor blades and stator vanes in a multistage environment over a wide range of realistic reduced frequency values for the first time. GRA

08

AIRCRAFT STABILITY AND CONTROL

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

A92-49264
DIGITAL FLIGHT CONTROL SYSTEMS - SOME NEW COMMERCIAL TWISTS
JOHN R. TODD (Douglas Aircraft Co., Long Beach, CA) and LARRY J. YOUNT (Honeywell, Inc., Air Transport Systems Div., Phoenix, AZ) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 79-84.
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The exponential increase in the number and complexity of aircraft digital electronic systems over the last decade has brought to light a number of fault and failure mechanisms not encountered with traditional mechanical and analog systems. One approach to handling these problems on future commercials aircraft is through the use of integrated modular avionics (IMAs). The issues and concepts associated with commercial IMAs are discussed. Some integration concepts for future fly-by-wire/fly-by-light commercial aircraft are considered. It is likely that highly integrated commercial modular avionics systems will be in service by the late 1990s or early twenty first century. It is expected that the extent and rapidity of modular avionics applications on commercial transport will depend largely on the flexibility and fault tolerance achievable at a reasonable cost as well as on the need for incorporation of new highly integrated systems. I.E.

A92-49294
IMPLEMENTATION OF NON-DEDICATED REDUNDANCY IN A FAULT TOLERANT MULTIPROCESSOR TESTBED
MICHAEL S. ROTTMAN and DANIEL B. THOMPSON (USAF, Wright Laboratory, Wright-Patterson AFB, OH) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 263-268. refs
Copyright

The advanced multiprocessor control architecture development (AMCAD) program has focused on the application of nondedicated redundancy to flight control and vehicle management systems. Aspects are examined of the AMCAD architecture and operating system concepts supporting nondedicated redundancy in the AMCAD testbed, and the lower-level operating system mechanisms for providing redundant communications and voting on redundant data are described. Future research under consideration for this testbed is addressed. I.E.

A92-49296
ACHIEVING FAULT TOLERANCE IN MULTICHANNEL CONTROL SYSTEMS
BHAL R. TULPULE and STEVEN A. AVRITCH (Hamilton Standard, Windsor Locks, CT) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 275-280. refs
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The authors present a review of three patented techniques for achieving a very high degree of fault tolerance in multichannel control systems. The first technique involves the synchronization of the redundant channels using a fault tolerant hardware synchronizer. The symmetrization technique involves a unique architecture and algorithms for maintaining identical signals and configurations at the voting planes in the presence of transient, asymmetrical or Byzantine failures. Finally, equalization is a systematic procedure for the chronological and hierarchical update of the appropriate historical databases of the channel(s) being restored, using the corresponding databases of the unaffected channels. Use of these proven techniques leads to a highly fault tolerant, reliable system in which all redundant channels operate identically, computing bit-for-bit identical outputs. I.E.

A92-49324
CRITICAL DIGITAL SYSTEMS - A FLY-BY-LIGHT CONSIDERATION
J. R. TODD (Douglas Aircraft Co., Long Beach, CA) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and

Electronics Engineers, Inc., 1991, p. 471-476.
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The author addresses the benefits and issues associated with fly-by-light technology and discusses the status of ongoing work. The rapid increase and evolution of digital electronic aircraft systems has evidenced some new and potentially troublesome failure modes heretofore not encountered with commercial aircraft. One potential cause of some of these faults or failures is the external electromagnetic environment (EME) in which aircraft must operate. In many systems fiber optics could provide cost effective EME protection. Douglas Aircraft has conducted or been directly involved in six flight test programs dealing with the fiber optics aspects of fly-by-light and associated with a number of others. The baseline Douglas Aircraft fly-by-light architecture shown was developed in 1984 from an internal study chartered to design a highly reliable digital flight control system for future transport aircraft. As an adjunct to the fly-by-wire/fly-by-light test integration facility work, Douglas Aircraft is also integrating a fly-by-light cockpit simulator, which is discussed. I.E.

A92-49325* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A LOW MAINTENANCE AND HIGHLY RELIABLE FLY-BY-LIGHT ARCHITECTURE
DAN PALUMBO (NASA, Langley Research Center, Hampton, VA) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 477-481. refs
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The author proposes a highly reliable distributed architecture for use in a commercial transport. Fly-by-light characteristics of the architecture are a serial fiber optic backplane and redundant fiber optic data bus. The fiber optic bus is fault tolerant and Byzantine resilient. A distributed architecture (both physically and logically) can be realized by utilizing several processing clusters on the data bus. A processing cluster is composed of one or more processing units. The processing units consist of several modules. The modules of the processing unit are connected via a serial fiber optic backplane. Fault tolerance is implemented at the backplane to increase reliability and availability. I.E.

A92-49326
FLIGHT MANAGEMENT SYSTEM BACK-UP NAVIGATION FOR THE A330/A340 AIRCRAFT
HENRI GRIGUERE (Honeywell, Inc., Air Transport Div., Blagnac, France) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 482-486.
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The author presents the architecture and functional operation of the multi-purpose control display unit (MCDU) back-up navigation used on the A330/A340 MCDU aircraft. Its purpose and capability in playing a key role on the A330/A340 for providing navigational back-up and equipment redundancy are explored. The A330/A340 flight management system is embedded in two flight management and guidance and envelope computers (FMGECs) and the triple redundant MCDU. At any one time two of the MCDUs are used to interface with the two FMGECs. The third MCDU can be switched into either position in case of an MCDU failure. In addition, two of the MCDUs have the capability to provide back-up navigation in case of loss of the FM function from the FMGECs. I.E.

A92-49330
AN ADVANCED FLIGHT PATH MANAGEMENT SYSTEM FOR LOW-ALTITUDE HELICOPTER FLIGHT
HERB MALE and CHRIS BODENHORN (IBM Corp., Federal Sector Div., Owego, NY) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 510-515.
Copyright

The authors address results obtained from development and piloted evaluations of an advanced flight path management (FPM) system prototype and an architecture for its incorporation into the US Army special operations aircraft (ASOA) integrated avionics system (IAS). Prototype implementation, for piloted evaluation in the Flight Simulation Laboratory, made use of IBM PS/2 Model 80 processors with i860 accelerator cards, token rings, and MIL-STD-1553B data buses. The software environment included the IBM C language and the AIX operating system. Results presented include replanning response times, path tracking, data bus requirements, and required processor throughput. I.E.

A92-50008
DEVELOPMENT OF ACTIVE CONTROL TECHNOLOGY FOR THE NEXT GENERATION OF COMBAT AIRCRAFT
R. N. LEE (British Aerospace /Military Aircraft/, Ltd., Preston, England) Institution of Mechanical Engineers, Proceedings, Part G - Journal of Aerospace Engineering (ISSN 0954-4100), vol. 206, no. G1, 1992, p. 15-25.
Copyright

In the mid 1970s British Aerospace recognized that active control technology offered considerable benefits in terms of improved performance and combat effectiveness for future combat aircraft. However, the introduction of such technology carried with it a significant development risk. In order to minimize that risk, a series of flight demonstrator programs were initiated. This paper describes the principles of active control and the very successful fly-by-wire Jaguar and experimental aircraft demonstrator flight test programs which progressively demonstrated the viability and benefits of active controls to the extent that this technology is being fully utilized on the new European fighter aircraft. Author

A92-50010
CAREFREE HANDLING SYSTEMS FOR HELICOPTERS
C. P. MASSEY (Westland Helicopters, Ltd., Yeovil, England) (Seminar on Man-Machine Interface in Civil and Military Aircraft, London, England, Oct. 10, 1991) Institution of Mechanical Engineers, Proceedings, Part G - Journal of Aerospace Engineering (ISSN 0954-4100), vol. 206, no. G1, 1992, p. 37-46. refs
Copyright

A program of work is being undertaken with the aim of defining features to help the pilot respect the helicopter's numerous flight limitations, reducing the workload and enhancing mission performance. Carefree handling features that have been studied include visual, audible and tactile cues and direct intervention methods. These features have been evaluated in a series of piloted simulation trials at DRA Bedford. Most of the work to date has been based around helicopters with active control technology (ACT) flight control systems, but conventionally controlled helicopters have also been considered. Results from the program suggest some benefits for head-up visual displays, tactile and audible cues, with more significant benefits for the direct intervention methods. A combination of these features allows the pilot to use the full performance of the vehicle without exceeding limits and at low pilot workload. Author

A92-50212
A CALCULATING METHOD OF THE KILL PROBABILITY ATTACK AREA FOR AAM
TING-JIE LI, RUN-QUAN LIU, CHAO-ZHI WANG (Beijing University of Aeronautics and Astronautics, People's Republic of China), GU-XIANG ZHU, and LI-ZHEN WANG (Ministry of Aeronautics and Astronautics, 014 Center, People's Republic of China) Chinese Journal of Aeronautics (ISSN 1000-9361), vol. 4, no. 4, Nov. 1991, p. 338-346. Previously cited in issue 07, p. 987, Accession no. A91-22352. refs
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A92-50235
SOME PROBLEMS ON ATMOSPHERIC TURBULENCE SPECTRUM AND AIRCRAFT RESPONSE
KE XU (Xian Aircraft Industry Co., People's Republic of China), YE-LUN XIAO, and GUI-LIAN ZHANG (Beijing University of

Aeronautics and Astronautics, People's Republic of China) Chinese Journal of Aeronautics (ISSN 1000-9361), vol. 5, no. 2, May 1992, p. 95-105. Previously cited in issue 22, p. 3821, Accession no. A91-52190. refs
Copyright

A92-50237
THE DESIGN AND SIMULATION OF AN INTELLIGENCE FLIGHT CONTROL SYSTEM
CHANG-SHENG JIANG, CHUN-LIN SHEN, and ZHON-HAN HU (Nanjing Aeronautical Institute, People's Republic of China) Chinese Journal of Aeronautics (ISSN 1000-9361), vol. 5, no. 2, May 1992, p. 113-120. Research supported by Science Foundation of the Aeronautical and Astronautical Department of China. refs
Copyright

In this paper, the design of an intelligence automatic flight control system is discussed. The basic structure of the system, the basic rules of intelligence control for simulating the human behavior, the division of characteristic models and the construction of intelligence control laws are suggested. Based on the principles mentioned above, the knowledge base, the data base, the rule base and the inference mechanism of the system for some kind of aircraft are designed. In the meanwhile, it is demonstrated by digital simulation that this system has excellent control performance, strong robustness and adaptability, and good decoupling function. Author

A92-50497
IDEAL PROPORTIONAL NAVIGATION
PIN-JAR YUAN and JENG-SHING CHERN (Chung Shan Institute of Science and Technology, Lungtan, Republic of China) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 5, Sept.-Oct. 1992, p. 1161-1165. refs
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Proportional navigation has been proved to be a useful guidance technique in several surface-to-air and air-to-air homing systems for interception of airborne targets. Besides the familiar pure, true, and generalized proportional navigation guidance laws, a new guidance scheme, called ideal proportional navigation, with commanded acceleration applied in the direction normal to the relative velocity between interceptor and target, is presented. In this study the closed-form solutions of ideal proportional navigation are completely derived for maneuvering and nonmaneuvering targets, and some important characteristics related to the system performance are introduced. Under this scheme the capture criterion is related to the effective proportional navigation constant only, no matter where the initial condition and target maneuver are. With some more energy consumption, this new guidance scheme has a larger capture area and is much more effective than the other schemes. Author

A92-50503
ROBUST FLIGHT CONTROL SYSTEMS - A PARAMETER SPACE DESIGN
ALBERTO CAVALLO, GIUSEPPE DE MARIA (Napoli, Universita, Naples, Italy), and LEOPOLDO VERDE (Centro Italiano Ricerche Aerospaziali, Capua, Italy) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 5, Sept.-Oct. 1992, p. 1207-1215. Previously announced in STAR as N91-15718. refs
Copyright

Generally, high performance requirements in terms of better efficiency (reduction in fuel consumption) and maneuverability, impose intrinsic instability on the aircraft. Then a Stability Augmentation System is required for its stabilization. Moreover, the aircraft must be safely controllable without any exceptional piloting skill. The requirements of stability and control are referred in literature as handling qualities. According to handling quality specifications, a feedback controller must be designed with robustness criteria with respect to flight conditions and sensor failure. A new design procedure of feedback controllers which allows the achievement of simultaneous stabilization, and provides some kind of fault tolerance with respect to sensor failure, are proposed. An application to the F4-E military aircraft is also presented. Author

A92-50508
DYNAMICS AND CONTROL OF MANEUVERABLE TOWED FLIGHT VEHICLES
J. E. COCHRAN, JR., M. INNOCENTI, T. S. NO, and A. THUKRAL (Auburn University, AL) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 5, Sept.-Oct. 1992, p. 1245-1252. Research supported by Hayes Targets. Previously cited in issue 20, p. 3156, Accession no. A90-45161. refs
Copyright

A92-50520
ROLL METRICS FOR HANDLING QUALITIES - THE LANDING APPROACH
AJAY THUKRAL and MARIO INNOCENTI (Auburn University, AL) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 5, Sept.-Oct. 1992, p. 1297, 1298. refs
Copyright

A validation is presented of Gibson's (1982) method when applied to the analysis of highly augmented aircraft lateral handling qualities, and new boundaries for satisfactory dynamic behavior are developed for the landing task. The phase rate boundary and control sensitivy boundary for level 1 are presented in tabular form. The results confirm the validity of the methodology as a general design tool for good handling qualities when the aircraft behavior possesses considerable high-order effects. P.D.

A92-51004
DISTRIBUTED FLIGHT CONTROL SYSTEM USING FIBER DISTRIBUTED DATA INTERFACE (FDDI)
OLIVER K. HALL (McDonnell Douglas Aircraft Co., Saint Louis, MO) and PAUL D. STIGALL (Missouri-Rolla, University, Rolla) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 7, no. 6, June 1992, p. 21-33. refs
Copyright

This paper discusses the design of fault-tolerant distributed control systems. The application described is a generic flight control system for a fighter aircraft. The proposed system is designed for high redundancy and expandability to meet various requirements. The communication network is based on the Fiber Distributed Data Interface (FDDI) to provide a high level of electro magnetic interference resistance and reliability. The choice of fiber optic media also provides an extremely high bandwidth and tremendous growth capability for future communications needs. While the example given is for a flight control system using FDDI as the communications network, the methods and configurations presented should be applicable to many real-time control implementations. In general this paper is a study of generic counter rotating ring architectures, and is not specific to FDDI or flight control systems. Author

A92-51940
STABILITY OF AN ADAPTIVE CONTROLLER FOR AIRCRAFT. I - ANALYSIS VIA LIAPUNOV THEORY
F. GAJENDRAN (Calicut Regional Engineering College, India) and TOM X. PANATTIL (Hindustan Aeronautics, Ltd., Bangalore, India) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 43, no. 4, Nov. 1991, p. 265-277. Research supported by Calicut Regional Engineering College. refs

The MRAC scheme by Chandrasekhar and Rao (1987) is analyzed and extended by using a more general Liapunov function so that the controller optimizes performance in spite of parameter variations. The MRAC scheme is reduced to a simple equivalent system that resembles a servo with a nonlinar operator in the feedback path and a stable error model in the forward path. A distinction is drawn between parameter-adaptive laws which depend on an adjustable parameter, and parameter-error-adaptive laws which depend on parameter error. The global asymptotic stability of the system in this approach is obtained even if the plant is unstable and unknown. The integral term in the adaptive law is found to play a role in determining the degree of stability, and the

term can be used to filter low frequency noise. The approach to adaptive control is of interest for applications to high-performance aircraft that have wide parameter variations within its flight envelope. C.C.S.

A92-51945
FLIGHT CONTROL SYSTEM DESIGN USING EIGENSTRUCTURE ASSIGNMENT FOR ROLLING THE AIRCRAFT AROUND THE VELOCITY VECTOR
R. SOMAKUMAR (Design Bureau, Bangalore, India) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 43, no. 4, Nov. 1991, p. 319-330. refs

Rolling aircraft about the near-body-axis leads to large amount of sideslip at high angles of attack. For decoupling the sideslip developed during roll rate excitation, it is relevant to identify the condition of minimum interaction between the responses. If the aircraft rolls around the velocity vector the sideslip developed due to the kinematic coupling is very small. The eigenvalues of the system are placed for the desired bandwidth based on the handling quality specifications, and the eigenvectors are assigned to achieve the desired command response characteristics. In the lateral-directional system assigning the eigenvalues are not unique, and the additional degrees of freedom available can be used for selecting suitable eigenvectors. Two-degree-of-freedom design which incorporates the control crossfeed and the feedbacks helps the aircraft to roll around the velocity vector. Author

A92-51946
AIRCRAFT LONGITUDINAL DYNAMICS EQUATIONS INCLUDING WIND SHEAR EFFECTS
AJIT R. SHENOY, N. ANANTHKRISHNAN, and K. SUDHAKAR (Indian Institute of Technology, Bombay, India) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 43, no. 4, Nov. 1991, p. 331-335. refs

Linearized equations are developed by means of a body-fixed axis system that describe the longitudinal motion of an aircraft experiencing wind shear. The resulting equations are applied to the case of an aircraft experiencing wind gradients in the form of vertical wind shear. The analytical results give the eigenvalues, frequencies, and damping modes associated with the short-period and phugoid modes, and phugoid stability is shown to be highly sensitive to wind gradient. C.C.S.

A92-52041
NONLINEAR DYNAMIC STABILITY CHARACTERISTICS OF RECOVERY BODIES
KEIICHI KARASHIMA and KIYOSHI SATO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 40, no. 462, 1992, p. 384-395. In Japanese. refs

This paper is concerned with detailed results of an experimental study on nonlinear dynamic stability of pitching motions of the various recovery bodies at a low subsonic speed. The experiment is conducted in an induction type transonic wind tunnel at Mach number of 0.2, and measurement of angular variation with time of the models is made for pitching oscillation with a finite amplitude. An approximate oscillation equation, that is formulated by use of an unsteady aerodynamic pitching-moment coefficient and, in general, is capable of predicting fairly accurately the experimental data having various nonlinear oscillatory modes, is proposed on the basis of the concept of a curve-fitting method. It is shown that the aerodynamic pitching moment and the associated nonlinear dynamic stability can be determined from the numerical simulation to the experimental data with sufficient accuracy. Author

A92-52043
STATIC AND DYNAMIC FLIGHT-PATH STABILITY OF AIRPLANES
OSAMU KOBAYASHI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 40, no. 462, 1992, p. 403-411. In Japanese. refs

The concept of flight-path stability, which is today in use, is based on the characteristics of steady unaccelerated flight conditions, and so can be called 'static flight-path stability'. After the description about the static flight-path stability, this paper introduces the 'dynamic flight-path stability' concept for accelerated/decelerated flight conditions, and discusses the necessary elevator-compensation to provide an airplane with the designated dynamic flight-path stability. Furthermore, it is demonstrated that the airplane with the compensation can stably control the flight-path by the elevator in the backside flight region, through the study on the airplane's response and phugoid-mode characteristics. Author

A92-52457#
THE VISTA/F-16 PROGRAMMABLE FEEL SYSTEM
R. J. SIRACUSE and K. S. GOVINDARAJ (Arvin/Calspan Corp., Buffalo, NY) IN: AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers. Washington, American Institute of Aeronautics and Astronautics, 1992, p. 285-295.
(AIAA PAPER 92-4172) Copyright

The programmable Force Feel System (FFS) is described which can be used with Variable Stability In-flight Simulator Test Aircraft (VISTA) for simulating the control, feel, and dynamic characteristics of aircraft. The computer algorithms for the digital feel system and the servoconfiguration and feel-system implementation are set forth. The FFS utilizes a two-axis electrohydraulic servo assembly and a digital model-following system based on a microcomputer. The net servo command is illustrated to describe the servo stability compensation, and variable nonlinear feel characteristics are provided independently. The VISTA system with the variable FFS was demonstrated during proof of concept tests for aircraft, and the system can be successfully employed to provide a wide range of flying characteristics. C.C.S.

A92-53088
THE RESEARCH ON PILOT INDUCED OSCILLATION
TINGNAN CHEN and HAOJUN XU (Air Force College of Engineering, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 8, Aug. 1991, p. B339-B344. In Chinese. refs

According to the essence of Pilot Induced Oscillation (PIO) and the theory of closed-loop control, the mathematical model of pilot-plane system is set up. Take a fighter trainer as an example, its PIOs are calculated in time-domain, and their results are compared with those obtained from the frequency-domain method. The results show that the time-domain method is not only visualized but also is very clear in physical meaning. Moreover a lot of nonlinear elements are also easy to be considered. Its result may be more reliable. Author

A92-53089
EXPERIMENTAL INVESTIGATION OF IN-FLIGHT OSCILLATION ON HELICOPTERS AND ITS PREVENTION
ZHIMING XIN (Air Force Research Institute No.1, Beijing, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 8, Aug. 1991, p. B345-B348. In Chinese. refs

In this paper, the main phenomena and features of in-flight oscillation failure on helicopters are summarized. Then, the experimental investigation of the failure is described. The investigation consists of the research approaches and the flight dynamic model of the helicopter. The experimental investigation on the control system-autopilot loop oscillation and pilot-induced helicopter oscillation, and the results are also presented. Some failure prevention principles and measures for design and operation are proposed. Author

A92-53094
OPTIMAL IMPLICIT MODEL-FOLLOWING APPROACH WITH FREQUENCY-SHAPED WEIGHTING AND ITS APPLICATION TO DESIGN OF FLIGHT CONTROL SYSTEM
JINZHONG WEI and JINYUAN GAO (Beijing University of Aeronautics and Astronautics, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 8, Aug. 1991, p. B377-B387. In Chinese. refs

The synthesis of frequency-shaped weighting matrices in the

quadratic cost function and the theory of implicit model-following are presented. The approach to select frequency-shaped weighting matrices is studied and the procedure using this method to design flight control law is given. The results are obtained by digital simulation and real-time microprocessor realization. R.E.P.

A92-53095
A FUEL-OPTIMAL 4D GUIDANCE ALGORITHM
QIHUA XU and SHUNDA XIAO (Northwestern Polytechnical University, Xian, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 8, Aug. 1991, p. B388-B395. In Chinese. refs

A fuel-optimal 4D guidance algorithm is presented. With the aid of the proposed algorithm, an optimal flight trajectory can be calculated on line. Such an optimal flight path can meet both the fuel savings and arrival time requirements. Simulation results also show that the algorithm mentioned above is really satisfactory from the engineering point of view. Since not only the computation time is reduced in comparison with other algorithms, but the precision is also high. The work done in this paper is a necessary step for the implementation of an onboard 4D flight management system. Author

A92-53388
AN IMPROVED WALL CORRECTION METHOD FOR THE LONGITUDINAL STABILITY
GUIQING JIANG (China Aerodynamic Research and Development Center, Mianyang) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 4, April 1991, p. B127-B132. In Chinese. refs

The variation of horizontal tail position due to the angle of attack should be taken into account when wall-interference corrections on the longitudinal stability are performed. The interference factor at tail, tau, is determined by the actual position of the tail. In addition, in the ordinary wall correction method, the effectiveness of the tail panel delta-m(z)/delta-alpha(t) which is contributed to the pitching moment coefficient is usually substituted by delta-m(z)/theta(t). A correction is made to account for the wall interference by using the improved method, and favorable results are obtained. Author

A92-53394
A STUDY ON THE STABILITY OF AIRCRAFT AT HIGH ANGLES-OF-ATTACK AND STATE VECTOR PROPAGATION SENSITIVITY
JILU LI and ZHIDAI HE (Northwestern Polytechnical University, Xian, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 4, April 1991, p. B166-B170. In Chinese. refs

N92-30323# Oklahoma Univ., Norman. School of Aerospace Mechanical and Nuclear Engineering.
INFLUENCE OF STRUCTURAL AND AERODYNAMIC MODELING ON FLUTTER ANALYSIS AND STRUCTURAL OPTIMIZATION Interim Report, Jun. - Dec. 1990
ALFRED G. STRIZ Jun. 1991 77 p
(Contract F33615-87-C-3228)
(AD-A248487; ASIAC-1090.10; WL-TR-91-3064) Avail: CASI HC A05/MF A01

The influences of structural and aerodynamic modeling on the flutter analysis and multidisciplinary optimization of fully built-up finite element wing models in an aeroelastic environment are not yet well understood. Therefore, the dynamic aeroelastic and optimization capabilities in the Automated STRuctural Optimization System (ASTROS) were used to evaluate the flutter behavior and the behavior of structural optimization with flutter constraints of various representative fully built-up finite element wing models in subsonic and supersonic flow. ASTROS was used as a tool to calculate flutter speeds and frequencies and to minimize the weight of these wing models in subsonic and supersonic flow under given flutter and frequency constraints to determine the effect that these modeling factors have. GRA

N92-30439# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany). Helicopter Div.
RESONANCE AND CONTROL RESPONSE TESTS USING A CONTROL SIMULATION DEVICE
HUBERT MUELLER 1991 11 p Presented at the 17th European Rotorcraft Forum, Berlin, Fed. Republic of Germany, 24-27 Sep. 1991
(MBB-UD-0608-91-PUB; ETN-92-91888) Avail: CASI HC A03/MF A01

Prototypes of the light twin helicopter, the BO 108, are addressed. Both aircrafts are equipped with a stimulation device for main rotor control inputs. Many kinds of collective or cyclic inputs can be chosen in a computer menu. It is possible to select the longitudinal and lateral signals separately or in combination. Each input is of an accuracy which no pilot can offer. Thus, a better response analysis can be done if the helicopter's motion is also measured. The different components of the stimulation system and their functions and performance are described. Examples of ground and flight testing are presented for various subjects like ground and air resonance, flight mechanical control response and engine characteristics. For comparison, diagrams of former helicopter testing with manual control inputs are shown and discussed. ESA

N92-30922*# Oregon State Univ., Corvallis. Dept. of Electrical and Computer Engineering.
NONLINEAR STABILITY AND CONTROL STUDY OF HIGHLY MANEUVERABLE HIGH PERFORMANCE AIRCRAFT, PHASE 2 Annual Report
R. R. MOHLER 20 Aug. 1992 68 p
(Contract NAG1-1081)
(NASA-CR-190667; NAS 1.26:190667; OSU-ECE-NASA-92-02)
Avail: CASI HC A04/MF A01

This research should lead to the development of new nonlinear methodologies for the adaptive control and stability analysis of high angle-of-attack aircraft such as the F18 (HARV). The emphasis has been on nonlinear adaptive control, but associated model development, system identification, stability analysis and simulation is performed in some detail as well. Various models under investigation for different purposes are summarized in tabular form. Models and simulation for the longitudinal dynamics have been developed for all types except the nonlinear ordinary differential equation model. Briefly, studies completed indicate that nonlinear adaptive control can outperform linear adaptive control for rapid maneuvers with large changes in alpha. The transient responses are compared where the desired alpha varies from 5 degrees to 60 degrees to 30 degrees and back to 5 degrees in all about 16 sec. Here, the horizontal stabilator is the only control used with an assumed first-order linear actuator with a 1/30 sec time constant. Author

N92-31175*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PRELIMINARY SUBSONIC AERODYNAMIC MODEL FOR SIMULATION STUDIES OF THE HL-20 LIFTING BODY
E. BRUCE JACKSON and CHRISTOPHER I. CRUZ Aug. 1992 68 p
(Contract RTOP 505-64-40-01)
(NASA-TM-4302; L-16956; NAS 1.15:4302) Avail: CASI HC A04/MF A01

A nonlinear, six-degree-of-freedom aerodynamic model for an early version of the HL-20 lifting body is described and compared with wind tunnel data upon which it is based. Polynomial functions describing most of the aerodynamic parameters are given and tables of these functions are presented. Techniques used to arrive at these functions are described. Basic aerodynamic coefficients were modeled as functions of angles of attack and sideslip. Vehicle lateral symmetry was assumed. Compressibility (Mach) effects were ignored. Control-surface effectiveness was assumed to vary linearly with angle of deflection and was assumed to be invariant with the angle of sideslip. Dynamic derivatives were obtained from predictive aerodynamic codes. Landing-gear and ground effects were scaled from Space Shuttle data. The model described is provided to

support pilot-in-the-loop simulation studies of the HL-20. By providing the data in tabular format, the model is suitable for the data interpolation architecture of many existing engineering simulation facilities. Because of the preliminary nature of the data, however, this model is not recommended for study of the absolute performance of the HL-20. Author

N92-31240*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DESIGN AND EXPERIMENTAL VALIDATION OF A FLUTTER SUPPRESSION CONTROLLER FOR THE ACTIVE FLEXIBLE WING
MARTIN R. WASZAK and S. SRINATHKUMAR (National Aeronautical Lab., Bangalore, India) Aug. 1992 19 p
(Contract RTOP 505-64-20-01)
(NASA-TM-4381; L-16977; NAS 1.15:4381) Avail: CASI HC A03/MF A01

The synthesis and experimental validation of an active flutter suppression controller for the Active Flexible Wing wind tunnel model is presented. The design is accomplished with traditional root locus and Nyquist methods using interactive computer graphics tools and extensive simulation based analysis. The design approach uses a fundamental understanding of the flutter mechanism to formulate a simple controller structure to meet stringent design specifications. Experimentally, the flutter suppression controller succeeded in simultaneous suppression of two flutter modes, significantly increasing the flutter dynamic pressure despite modeling errors in predicted flutter dynamic pressure and flutter frequency. The flutter suppression controller was also successfully operated in combination with another controller to perform flutter suppression during rapid rolling maneuvers. Author

N92-31656*# Douglas Aircraft Co., Inc., Long Beach, CA.
DESIGN AND ANALYSIS ISSUES OF INTEGRATED CONTROL SYSTEMS FOR HIGH-SPEED CIVIL TRANSPORTS Final Report
CRAIG A. MCCARTY, JOHN B. FEATHER, JOHN R. DYKMAN, MARK A. PAGE, and JOHN HODGKINSON Washington NASA May 1992 73 p Prepared for PRC Kentron, Inc., Edwards, CA
(Contract NAS2-12722; ATD-91-DAC-7103)
(NASA-CR-186022; H-1787; NAS 1.26:186022) Avail: CASI HC A04/MF A01

A study was conducted to identify, rank, and define development plans for the critical guidance and control design and analysis issues as related to economically viable and environmentally acceptable high-speed civil transport. The issues were identified in a multistep process. First, pertinent literature on supersonic cruise aircraft was reviewed, and experts were consulted to establish the fundamental characteristics and problems inherent to supersonic cruise aircraft. Next, the advanced technologies and strategies being pursued for the high-speed civil transport were considered to determine any additional unique control problems the transport may have. Finally, existing technologies and methods were examined to determine their capabilities for the design and analysis of high-speed civil transport control systems and to identify the shortcomings and issues. Three priority levels - mandatory, highly beneficial, and desirable - were established. Within each of these levels, the issues were further ranked. Technology development plans for each issue were defined. Each plan contains a task breakdown and schedule. Author

N92-31865# Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.
A SIMULATION MODEL OF A SINGLE ROTOR HELICOPTER
Z. BEIGELMAN and A. ROSEN *In* Israel Society of Aeronautics and Astronautics, 31st Israel Annual Conference on Aviation and Astronautics p 27-37 22 Feb. 1990 Previously announced in IAA as A91-43080
Avail: CASI HC A03/MF A03

The paper presents a model suitable for helicopter flight mechanics purposes. The different components of the vehicle are treated separately, and thus a modular model is obtained. The complete dynamic model is highly nonlinear and is used for trim calculations and calculations of the dynamic response to arbitrary pilot's input, or different external disturbances. Linearization of the model leads to an eigenvalue problem for analyzing the stability of different trim positions. For validation purposes the results of the new model are compared to flight test results and results of other numerical models of the AH-1G Cobra helicopter. Fair agreement is presented, while deviations are discussed and explained. ISA

N92-31967# Stanford Univ., CA. Dept. of Mechanical Engineering.
MATHEMATICAL MODELING AND NUMERICAL SIMULATION OF THE DYNAMICS OF FLEXIBLE STRUCTURES UNDERGOING LARGE OVERALL MOTIONS Final Report, 15 Feb. 1989 - 14 May 1991
J. C. SIMO 14 May 1991 11 p
(Contract AF-AFOSR-0294-89)
(AD-A250202; AFOSR-92-0287TR) Avail: CASI HC A03/MF A01

A multidisciplinary effort aimed at the development of analytical and computational tools for the modeling and simulation of very flexible structures is reported. This research is concerned with three main areas: (1) mathematical aspects with special emphasis on nonlinear stability analysis; (2) modeling aspects with emphasis in very flexible slender structures; and (3) numerical analysis aspects with emphasis on methodologies suitable for large scale and accurate simulation. The present research effort has resulted in 36 publications, two conferences, and a strong collaboration (in a related research effort also sponsored by AFOSR) with groups at UC Berkeley and University of Maryland. GRA

N92-32175*# Boeing Commercial Airplane Co., Seattle, WA.
ENGINE MONITORING DISPLAY STUDY Final Report
MARY E. HORNSBY Washington NASA. Langley Research Center Aug. 1992 96 p
(Contract NAS1-18027; RTOP 505-66-41-04)
(NASA-CR-4463; NAS 1.26:4463) Avail: CASI HC A05/MF A01

The current study is part of a larger NASA effort to develop displays for an engine-monitoring system to enable the crew to monitor engine parameter trends more effectively. The objective was to evaluate the operational utility of adding three types of information to the basic Boeing Engine Indicating and Crew Alerting System (EICAS) display formats: alphanumeric alerting messages for engine parameters whose values exceed caution or warning limits; alphanumeric messages to monitor engine parameters that deviate from expected values; and a graphic depiction of the range of expected values for current conditions. Ten training and line pilots each flew 15 simulated flight scenarios with five variants of the basic EICAS format; these variants included different combinations of the added information. The pilots detected engine problems more quickly when engine alerting messages were included in the display; adding a graphic depiction of the range of expected values did not affect detection speed. The pilots rated both types of alphanumeric messages (alert and monitor parameter) as more useful and easier to interpret than the graphic depiction. Integrating engine parameter messages into the EICAS alerting system appears to be both useful and preferred. Author

N92-32241*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A PARAMETER OPTIMIZATION APPROACH TO CONTROLLER PARTITIONING FOR INTEGRATED FLIGHT/PROPULSION CONTROL APPLICATION
PHILLIP SCHMIDT (Akron Univ., OH.), SANJAY GARG, and BRIAN HOLOWECKY (Akron Univ., OH.) Aug. 1992 30 p
(Contract RTOP 505-62-50)
(NASA-TM-105826; E-7260; NAS 1.15:105826) Avail: CASI HC A03/MF A01

A parameter optimization framework is presented to solve the problem of partitioning a centralized controller into a decentralized hierarchical structure suitable for integrated flight/propulsion control implementation. The controller partitioning problem is briefly discussed and a cost function to be minimized is formulated, such that the resulting 'optimal' partitioned subsystem controllers will

closely match the performance (including robustness) properties of the closed-loop system with the centralized controller while maintaining the desired controller partitioning structure. The cost function is written in terms of parameters in a state-space representation of the partitioned sub-controllers. Analytical expressions are obtained for the gradient of this cost function with respect to parameters, and an optimization algorithm is developed using modern computer-aided control design and analysis software. The capabilities of the algorithm are demonstrated by application to partitioned integrated flight/propulsion control design for a modern fighter aircraft in the short approach to landing task. The partitioning optimization is shown to lead to reduced-order subcontrollers that match the closed-loop command tracking and decoupling performance achieved by a high-order centralized controller. 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.

A92-50270* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LEAST-SQUARES/PARABOLIZED NAVIER-STOKES PROCEDURE FOR OPTIMIZING HYPERSONIC WIND-TUNNEL NOZZLES
JOHN J. KORTE, AJAY KUMAR (NASA, Langley Research Center, Hampton, VA), D. J. SINGH (Analytical Services and Materials, Inc., Hampton, VA), and B. GROSSMAN (Virginia Polytechnic Institute and State University, Blacksburg) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, no. 5, Sept.-Oct. 1992, p. 1057-1063. Previously cited in issue 17, p. 2868, Accession no. A91-41741. refs
Copyright

A92-51348
TECHNICAL TOOLS OF TEST AUTOMATION FOR GAS-TURBINE ENGINES BASED ON CLUSTER CAMAC MODULES WITH AN INCREASED NUMBER OF CHANNELS [TEKHNICHESKIE SREDSTVA SISTEMY AVTOMATIZATSII ISPYTANII GAZOTURBINNYKH DVIGATELEI NA OSNOVE KLASTERNYKH KAMAK-MODULEI S RASSHIRENNYM CHISLOM KANALOV]
V. K. KOMPANETS, V. N. PINES, and O. P. SKOBELEV Avtometriia (ISSN 0320-7102), no. 2, Mar.-Apr. 1992, p. 87-92. In Russian. refs
Copyright
A measurement data collection structure for a test automation system for modern turboprop gas-turbine engines is proposed which is based on cluster CAMAC modules with an expanded number of channels. The transducer sampling time is estimated. A version of a structure with sampling synchronization in cluster modules is considered which improves the conversion accuracy. V.L.

A92-51398
FLAP CONTROL SIMULATION
Aerospace Engineering (ISSN 0736-2536), vol. 12, no. 7, July 1992, p. 13-19.
Copyright
A simulation study has been initiated at NASA Ames Research Center to investigate alternative flap and wing controls for various aircraft applications. The simulation of flap control configurations for tilt-wing aircraft has provided valuable information on handling qualities and control characteristics, and reduced actual test time required. Based on the simulation study, it was possible to obtain data on the flying qualities of a conventional programmed flap and two geared flap configurations. R.E.P.

A92-51401
STRUCTURAL TESTING TECHNOLOGY AT HIGH TEMPERATURE; PROCEEDINGS OF THE CONFERENCE, DAYTON, OH, NOV. 4-6, 1991
Conference sponsored by SEM. Bethel, CT, Society for Experimental Mechanics, Inc., 1991, 55 p. For individual items see A92-51402 to A92-51411.
(ISBN 0-912053-34-8) Copyright
Papers are presented in the fields of elevated-temperature-structures testing technology and high-temperature structural testing. Particular consideration is given to flight vehicle thermal testing with IR lamps, the simulation of high heat-flux levels with graphite heating and arc lamps, research capabilities of the NASA Langley 8-Foot High-Temperature Tunnel, high-temperature ground vibration test techniques, and acoustic testing at elevated temperatures. Attention is also given to the history of high-temperature testing at WPAFB, a historical overview of high-temperature structural testing at the NASA Dryden Flight Research Facility, hypervelocity technology carbon/carbon testing, thermal-structural panel buckling tests, thermal life-cycle testing of a titanium matrix composite, and titanium honeycomb panel testing. I.S.

A92-51402
SIMULATION OF HIGH HEAT FLUX LEVELS WITH GRAPHITE HEATING AND ARC LAMPS
TIMOTHY P. SIKORA and KENNETH B. LEGER (USAF, Wright Laboratory, Wright-Patterson AFB, OH) IN: Structural testing technology at high temperature; Proceedings of the Conference, Dayton, OH, Nov. 4-6, 1991. Bethel, CT, Society for Experimental Mechanics, Inc., 1991, p. 3-8.
Copyright
To meet the structural test needs of current hypersonic development programs, new heating technologies have been developed to supplement the established quartz lamp heaters. Graphite heaters for moderate heat flux rates are available for small to large specimens. Arc lamp heaters can provide high heat fluxes, but over small areas. Both devices are in use and have been used successfully in structural tests. Principles of operation as well as advantages and disadvantages of each device are discussed. Author

A92-51403* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RESEARCH CAPABILITIES OF THE NASA LANGLEY 8-FOOT HIGH TEMPERATURE TUNNEL
RICHARD L. PUSTER (NASA, Langley Research Center, Hampton, VA) IN: Structural testing technology at high temperature; Proceedings of the Conference, Dayton, OH, Nov. 4-6, 1991. Bethel, CT, Society for Experimental Mechanics, Inc., 1991, p. 9-16. refs
Copyright
The NASA Langley Research Center's 8-Foot High Temperature Tunnel (8' HTT) has been modified to facilitate the testing of hypersonic airbreathing propulsion systems in addition to aerothermal load definition and structural concept verification at Mach 4, 5, and 7. The 8' HTT simulates flight from 60 to 125 kft with run times of 1 to 2 min. The 8-ft diameter and 12-ft-long free jet length enables the testing of large engines or multiple subscale engines. Methane and air combustion products provide the true temperature environment; an oxygen system enriches the combustion products to the same volume fraction of oxygen as air to enable the testing of airbreathing engines. A hydrogen system provides model fuel for cooling and combustion. High use tunnel components have been upgraded or replaced. Author

A92-51404* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
HIGH TEMPERATURE GROUND VIBRATION TEST TECHNIQUES
MICHAEL W. KEHOE and H. T. SNYDER (NASA, Flight Research Center, Edwards, CA) IN: Structural testing technology at high temperature; Proceedings of the Conference, Dayton, OH, Nov.

4-6, 1991. Bethel, CT, Society for Experimental Mechanics, Inc., 1991, p. 17-26. refs
Copyright

This paper describes the experimental modal test techniques and procedures used to conduct uniform, nonuniform, and transient thermoelastic vibration tests. Experimental setup and elevated temperature instrumentation considerations are also discussed. Modal data for a 30.48- by 127-cm aluminum plate heated to a temperature of 371.1 C are presented. These data show the effect of heat on the plate's modal characteristics. Author

A92-51405
ACOUSTIC TESTING AT ELEVATED TEMPERATURES
KENNETH R. WENTZ, KEVIN HARRIS, and ARNEL PACIA (USAF, Flight Dynamics Directorate, Wright-Patterson AFB, OH) IN: Structural testing technology at high temperature; Proceedings of the Conference, Dayton, OH, Nov. 4-6, 1991. Bethel, CT, Society for Experimental Mechanics, Inc., 1991, p. 27, 28. refs
Copyright

This paper describes the three facilities under development at Wright Laboratory which will perform acoustic testing at elevated temperatures. The first is the High Temperature Acoustic Subelement Test Facility, capable of testing .25 m by .40 m specimens at 180 dB overall sound pressure level and 1370 C. The second is the Random Fatigue In-situ Test Facility, consisting of a large electrodynamic shaker and an environmental chamber capable of performing vibration tests on small coupon specimens at a temperature range of -160 to 1430 C. The third is the Combined Environment Acoustic Test Facility, capable of testing 1.3 m by 1.3 m specimens at 180 dB overall sound pressure level and 1370 C. Author

A92-51406
A HISTORY OF HIGH-TEMPERATURE TESTING AT WPAFB
S. LUSTIG (USAF, Wright-Patterson AFB, OH) IN: Structural testing technology at high temperature; Proceedings of the Conference, Dayton, OH, Nov. 4-6, 1991. Bethel, CT, Society for Experimental Mechanics, Inc., 1991, p. 29-34. refs
Copyright

The history of high-temperature testing at the Wright-Patterson Air Force Base (WPAFB) started in 1952, when a pilot heating facility was designed; by 1961, the WPAFB had an operational full-scale heating facility. This paper describes the development of heating methods, the early heat tests (which included tests of the Thor intermediate-range-missile and Titan intercontinental-range-missile fuel tanks, the Hawk missile, the F-106 fighter, and the B-58 bomber), and tests on hypersonic aircraft (including X-20 Dynasoar) and for the Advanced Structural Concepts Experimental Program. I.S.

A92-51407* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
A HISTORICAL OVERVIEW OF HIGH-TEMPERATURE STRUCTURAL TESTING AT THE NASA DRYDEN FLIGHT RESEARCH FACILITY
V. M. DEANGELIS (NASA, Flight Research Center, Edwards, CA) IN: Structural testing technology at high temperature; Proceedings of the Conference, Dayton, OH, Nov. 4-6, 1991. Bethel, CT, Society for Experimental Mechanics, Inc., 1991, p. 35-37. refs
Copyright

Major hot structure test programs conducted at NASA Dryden Flight Research Facility from 1960s to the present are reviewed with emphasis placed on the YF-12A flight load program, which included extensive experimental and analytical tasks. Analytical models of the YF-12A aircraft were generated using NASTRAN and FLEXTAB codes. Experimental data were generated from wind tunnel model tests, laboratory tests performed on the flight vehicle (including Mach-3 thermal simulation that involved heating the entire aircraft's surface after which the aircraft was returned to flight status), and flight tests. I.S.

A92-52426
AIAA/AHS FLIGHT SIMULATION TECHNOLOGIES CONFERENCE, HILTON HEAD ISLAND, SC, AUG. 24-26, 1992, TECHNICAL PAPERS
Conference sponsored by AIAA and AHS. Washington, American Institute of Aeronautics and Astronautics, 1992, 340 p. For individual items see A92-52427 to A92-52461.
Copyright

The present conference on technologies for flight simulation encompasses rotorcraft applications, human response, crew-station design, simulation applications, simulator architecture, simulation networking, motion systems, pilot cuing, operations and management, simulation facilities, and in-flight simulations. Specific issues addressed include technology applications for helicopter crew training, simulator-induced alteration of head movements, takeoff performance monitoring-system display options, a generic helicopter for multiship simulations, algorithmic improvements for simulator motion drive, and aural/vibrational cuing in rotorcraft simulation. Also addressed are special rotation vectors, dead reackoning for aircraft in distributed interactive simulation, a man/vehicle systems research facility, the applicability of distributed simulation techniques to high performance aircraft, and a parallel architecture for flight-simulator visual systems. C.C.S.

A92-52428*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SIMULATION OF AUTOMATIC ROTORCRAFT NAP-OF-THE-EARTH FLIGHT IN GRAPHICS WORKSTATION ENVIRONMENT
T. LAM (Sterling Software, Inc., Palo Alto, CA) and VICTOR H. L. CHENG (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers. Washington, American Institute of Aeronautics and Astronautics, 1992, p. 8-15. refs
(AIAA PAPER 92-4131) Copyright

This paper describes a three-dimensional (3D) helicopter flight simulation system. The simulation is designed to be a readily available tool for concept verification and tuning of automatic obstacle-avoidance guidance algorithms. The system has been implemented on networked workstations capable of interactive 3D graphics simulation. The simulation uses realistic terrain and obstacle models. The dynamics of the rotorcraft and the functional capabilities of the range sensors are simulated to provide all the components required to evaluate the guidance function. Standard graphics hardware available on the workstation is utilized to accelerate the range-data calculations for sensor simulation at the guidance rate. An example is given to demonstrate the performance of the obstacle-avoidance capability. Author

A92-52446#
DESIGN AND PERFORMANCE OF THE CENTRIFUGE-BASED DYNAMIC FLIGHT SIMULATOR
JACOB EYTH, JR. and PEGGY L. HEFFNER (U.S. Navy, Naval Air Warfare Center, Warminster, PA) IN: AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers. Washington, American Institute of Aeronautics and Astronautics, 1992, p. 183-190. refs
(AIAA PAPER 92-4156)

An overview is given of the design and applications of the Dynamic Flight Simulator (DFS), a centrifuge-based system for the motion-based flight simulation. The DFS is based on a two-axis-gimbaled gondola mounted on a centrifuge 50-foot arm driven by a motor, and the device has a maximum G capability of 10 g with a G-onset of 4 g/s for a fully instrumented cockpit. The device can also be used with a lightweight cockpit and an advanced technology cockpit, and a simulation computer system is provided for an aircraft-like environment. The DFS is equipped with a flight deck and an experimental control station to replace the cockpit functions, and simulations can be conducted for the F-14D, A-6, and a fluidic version of an F-18. The DFS is shown to be effective for astronaut training and investigations of enhanced fighter

maneuverability, and it is expected to provide the basis for studying nap-of-the-earth flight and helicopter maneuvering. C.C.S.

A92-52447#
DEVELOPMENTAL EVALUATION OF A CENTRIFUGE FLIGHT SIMULATOR AS AN ENHANCED MANEUVERABILITY FLYING QUALITIES TOOL
DENNIS A. KIEFER and JEFFREY F. CALVERT (U.S. Navy, Naval Air Warfare Center, Warminster, PA) IN: AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers. Washington, American Institute of Aeronautics and Astronautics, 1992, p. 191-212. refs
(AIAA PAPER 92-4157)

The exploitation of the centrifuge-based Dynamic Flight Simulator (DFS) as a tool for enhanced maneuverability simulations is addressed by examining improvements to motion fidelity and technological limitations. Specific attention is give to the evaluation of pilot analyses of critical displays during high angle-of-attack enhanced maneuvering tasks. A generic tactical aircraft model is described that employs a propulsion model of the F110 engine with poststall maneuvering. The axes system for the simulations and a centrifuge control algorithm are set forth, and the system incorporates a G-bias function and compensation for bank-angle oscillation. The centrifuge control algorithm is shown to provide for good motion fidelity, and the DFS is capable of generating a pilot-perceived motion environment consistent with that of actual flight. The primary advantage is that the DFS can be used to simulate high angle-of-attack maneuvering and thereby study critical human-factors issues. C.C.S.

A92-52458*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
MAN-VEHICLE SYSTEMS RESEARCH FACILITY - DESIGN AND OPERATING CHARACTERISTICS
ROBERT J. SHINER and BARRY T. SULLIVAN (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers. Washington, American Institute of Aeronautics and Astronautics, 1992, p. 296-301. refs
(AIAA PAPER 92-4177) Copyright

This paper describes the full-mission flight simulation facility at the NASA Ames Research Center. The Man-Vehicle Systems Research Facility (MVSRF) supports aeronautical human factors research and consists of two full-mission flight simulators and an air-traffic-control simulator. The facility is used for a broad range of human factors research in both conventional and advanced aviation systems. The objectives of the research are to improve the understanding of the causes and effects of human errors in aviation operations, and to limit their occurrence. The facility is used to: (1) develop fundamental analytical expressions of the functional performance characteristics of aircraft flight crews; (2) formulate principles and design criteria for aviation environments; (3) evaluate the integration of subsystems in contemporary flight and air traffic control scenarios; and (4) develop training and simulation technologies. Author

A92-52460*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HIGH PERFORMANCE FLIGHT SIMULATION AT NASA LANGLEY
JEFF I. CLEVELAND, II, STEVEN J. SUDIK, and RANDALL D. GROVE (NASA, Langley Research Center, Hampton, VA) IN: AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers. Washington, American Institute of Aeronautics and Astronautics, 1992, p. 313-319. refs
(AIAA PAPER 92-4179) Copyright

The use of real-time simulation at the NASA facility is reviewed specifically with regard to hardware, software, and the use of a fiberoptic-based digital simulation network. The network hardware includes supercomputers that support 32- and 64-bit scalar, vector, and parallel processing technologies. The software include drivers, real-time supervisors, and routines for site-configuration management and scheduling. Performance specifications include: (1) benchmark solution at 165 sec for a single CPU; (2) a transfer rate of 24 million bits/s; and (3) time-critical system responsiveness of less than 35 msec. Simulation applications include the Differential Maneuvering Simulator, Transport Systems Research Vehicle simulations, and the Visual Motion Simulator. NASA is shown to be in the final stages of developing a high-performance computing system for the real-time simulation of complex high-performance aircraft. C.C.S.

N92-30329# Army Electronic Proving Ground, Fort Huachuca, AZ.
ANTENNA PATTERN MEASUREMENT FACILITIES Final Report
16 May 1991 96 p
(AD-A248964) Avail: CASI HC A05/MF A01

The test operations procedure (TOP) is an overview of procedures for testing antennas using the automated data acquisition and analysis system (ADAAS) at the Antenna Test Facility (ATF), US Army Electronic Proving Ground, Fort Huachuca, Arizona. The ATF has two test ranges: an outdoor compact range and an arc range. The Compact Range uses a parabolic reflector to collimate radio frequency energy in order to simulate far-field testing. A large hydraulic positioner moves the test antenna through azimuth and elevation arcs to allow testing of an entire hemisphere of coverage. The Arc Range operates in the near field using uncollimated RF. It uses a turntable to rotate the test item through the desired range of azimuth; a probe antenna moving along the vertical arc structure provides elevation coverage. The combination provides full hemispherical coverage. The TOP describes procedures for measuring antenna gain; locations of beams, lobes, and nulls; and other antenna characteristics. It contrasts the capabilities of the two ranges and provides guidelines to help the user select the right range for a particular test. GRA

N92-30508*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SMALL ENGINE COMPONENTS TEST FACILITY COMPRESSOR TESTING CELL AT NASA LEWIS RESEARCH CENTER
RICHARD A. BROKOPP and ROBERT S. GRONSKI (Sverdrup Technology, Inc., Brook Park, OH.) Jul. 1992 13 p Proposed for presentation at the 17th AIAA Aerospace Ground Testing Conference, Nashville, TN, 6-8 Jul. 1992
(Contract RTOP 505-62-84)
(NASA-TM-105685; E-7064; NAS 1.15:105685; AIAA PAPER 92-3980) Avail: CASI HC A03/MF A01

LeRC has designed and constructed a new test facility. This facility, called the Small Engine Components Tests Facility (SECTF), is used to test gas turbines and compressors at conditions similar to actual engine conditions. The SECTF is comprised of a compressor testing cell and a turbine testing cell. Only the compressor testing cell is described. The capability of the facility, the overall facility design, the instrumentation used in the facility, and the data acquisition system are discussed in detail. Author

N92-30547# IIT Research Inst., Lanham, MD.
DEVELOPMENT STATISTICS FOR THE UH-1 ADA FEASIBILITY STUDY
Jan. 1992 152 p
(AD-A252404) Avail: CASI HC A08/MF A01

This document describes data collection and analysis techniques that were applied to an Ada software redevelopment of the UH-1 Flight Simulator (FS). It presents results for the following subject areas: the application of function point analysis to estimate trainer size; the application of Ada COCOMO, SoftCost Ada, and SASET models to estimate schedule and efforts; and the application of AdaMAT/D to evaluate trainer quality. The report also describes results of a project profile study to characterize aspects of the development environment. GRA

N92-30769# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Mechanics Panel.

TECHNICAL EVALUATION REPORT ON THE FLIGHT MECHANICS PANEL SYMPOSIUM ON PILOTED SIMULATION EFFECTIVENESS [L'EFFICACITE DE LA SIMULATION PILOTEE]

A. G. BARNES (Barnes, A. G., Lytham Saint Annes, England) Apr. 1992 17 p In FRENCH Symposium held in Brussels, Belgium, 14-17 Oct. 1991

(AGARD-AR-315; ISBN-92-835-0669-3) Copyright Avail: CASI HC A03/MF A01

This report evaluates the AGARD Flight Mechanics Panel Symposium on Piloted Simulator Effectiveness, held from 14 to 17 Oct. 1991, in Brussels, Belgium. The intention of the Symposium was to assess the benefits and the future potential of flight simulation in contributing to aircraft development, skill training, and mission training, for both fixed wing and rotary wing aircraft. In particular, contributors were asked to compare the results of simulated and real tasks. The papers were wide ranging and of high quality; several new ideas emerged. The technology of flight simulation has greatly improved since the last symposium on this topic, in 1985. The emphasis of work related to fixed wing aircraft has shifted towards systems integration. A greater contribution to helicopter design and clearance is also evident. Although new visual display devices show great promise for military flight training at high speed, low level, they are not yet fully proven, and it is recommended that an early return is made to the topic of pilot training. Simulator validation and fidelity are also of growing importance. Author

N92-30777# Federal Aviation Administration, Washington, DC. Office of Aviation Policy and Plans.

ALLOCATION AND RECOVERY OF FEDERAL AIRPORT AND AIRWAY COSTS, 1991 Final Report

DANIEL E. TAYLOR Feb. 1992 24 p

(AD-A249436; FAA/APO-210; FAA/APO-91-4) Avail: CASI HC A03/MF A01

This report presents estimates of the allocation and recovery of federal airport and airway system costs. Estimates for 1991 were constructed using an econometric model that attributes fixed, joint, and marginal airspace system costs to aviation user groups. Two methods are used to allocate FAA costs. First, a full cost allocation attributes direct costs to each user and allocates all remaining joint and overhead costs among users. Second, a minimum cost allocation estimate is made for general aviation based on the concept of avoidable costs. The results of the full cost allocation indicate that about 62 percent of FAA costs in 1991 are attributable to air carriers. General aviation and the public sector accounted for 26 and 12 percent of FAA costs, respectively. GRA

N92-30849# Army Missile Command, Redstone Arsenal, AL. Weapons Science Directorate.

DESIGN AND CONSTRUCTION OF A HELMHOLTZ COIL MAGNETIC TEST CELL Final Report, Jun. - Oct. 1991

DARRYL HOLDER Feb. 1992 18 p

(AD-A249944; AD-E951786; AMSMI/TR-RD-WS-92-1) Avail: CASI HC A03/MF A01

A Helmholtz coil magnetic cell was designed and constructed in order to properly test various systems of interest which involve sensing a magnetic environment as part of their normal function. The electric current feed to the coil is provided by a low impedance, close-spaced busbar assembly so that nonsolenoidal magnetic fields are kept to a minimum. Based on the calibration run described in this report, the Helmholtz coil is seen to provide a usable magnetic field for the testing of smaller items. A more precise calibration and an impulse driver circuit designed to exactly simulate the required drive current waveform would substantially increase the ability to perform tests on an absolute basis. As it stands, this Helmholtz coil and its driver circuit is quite useful for a number of testing purposes. Author (GRA)

N92-30976# Federal Aviation Administration, Atlantic City, NJ.

GNAS MAINTENANCE CONTROL CENTER (GMCC) DESIGN QUALIFICATION TEST AND EVALUATION (DQT/E) TEST PROCEDURES

RICHARD VAN SUETENDAEL Jun. 1992 159 p

(DOT/FAA/CT-TN91/40; AD-A253853) Avail: CASI HC A08/MF A02

This document presents the procedures used for Design Qualification Test and Evaluation (DQT&E) testing of the General National Airspace System (GNAS) Maintenance Control Center (GMCC). The Test Director conducted DQT&E testing at the Federal Aviation Administration (FAA) Technical Center, Atlantic City International Airport, N.J. The purpose of the test is to verify that the phase 1 and phase 2 GMCC design requirements are met. Author

N92-31192# Department of the Navy, Washington, DC.

THRUST TEST FIXTURE Patent Application

CHRISTOPHER F. HILLENBRAND, inventor (to Navy) 27 Nov. 1991 9 p

(AD-D015259; US-PATENT-APPL-SN-800785) Avail: CASI HC A02/MF A01

The invention relates generally to test fixtures for measuring the thrust developed by a device which includes some sort of of rotating propeller or impeller designed to draw a fluid medium in one end of the device and eject the fluid medium out of the opposite end of the device. The device to be tested is supported from a beam by two parallel links so the thrust direction remains perpendicular to the direction of gravity. Each link is connected to the beam by a tension transducer also oriented perpendicular to the direction of gravity. The aim of the present invention is to provide a test fixture for evaluating the thrust output of submersible devices of the type used in subsurface remotely controlled vehicles. GRA

N92-31252*# Rochester Inst. of Tech., NY. Center for Imaging Science.

DIGITAL ANALYSIS OF WIND TUNNEL IMAGERY TO MEASURE FLUID THICKNESS Final Report

ROGER L. EASTON, JR. and JAMES ENGE Aug. 1992 41 p Original contains color illustrations

(Contract NAG3-1202)

(NASA-CR-189234; NAS 1.26:189234) Avail: CASI HC A03/MF A01; 1 functional color page

Documented here are the procedure and results obtained from the application of digital image processing techniques to the problem of measuring the thickness of a deicing fluid on a model airfoil during simulated takeoffs. The fluid contained a fluorescent dye and the images were recorded under flash illumination on photographic film. The films were digitized and analyzed on a personal computer to obtain maps of the fluid thickness. Author

N92-31640*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

SUPERSONIC THROUGHFLOW FAN TEST FACILITY AT NASA. LEWIS RESEARCH CENTER

DONALD C. URASEK, WALTER S. CUNNAN, RICHARD L. LANTZ, DENNIS L. FRONEK, RONALD A. DAWSON, and JEFFREY C. BROWN Sep. 1990 25 p

(Contract RTOP 505-62-61)

(NASA-TP-3038; E-5398; NAS 1.60:3038) Avail: CASI HC A03/MF A01

The increased need for efficient supersonic flight has revived interest in supersonic throughflow fans for advanced high-speed propulsion systems. NASA LeRC recently began a program to design, build, and test a single-stage fan that will operate with supersonic air velocity sustained through the blade rows. In a major revamping of the LeRC Multistage Compressor Facility, NASA has built a 20 in. diameter annular wind tunnel with a 0.7 hub-to-tip ratio. The wind tunnel houses a high-speed rotating fan package. The objectives of this research program are to demonstrate feasibility, to gain an understanding of the flow physics, and to

create a data base. The facility, test package, and instrumentation for supporting the operation of the supersonic throughflow fan program are described. Author

N92-31900*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DATA REDUCTION FORMULAS FOR THE 16-FOOT TRANSONIC TUNNEL: NASA LANGLEY RESEARCH CENTER, REVISION 2
CHARLES E. MERCER, BOBBY L. BERRIER, FRANCIS J. CAPONE, and ALAN M. GRAYSTON (Wyle Labs., Inc., Hampton, VA.) Jul. 1992 288 p Revised Supersedes NASA-TM-86319, revision 1
(Contract RTOP 505-62-30-01)
(NASA-TM-107646; NAS 1.15:107646) Avail: CASI HC A13/MF A03

The equations used by the 16-Foot Transonic Wind Tunnel in the data reduction programs are presented in nine modules. Each module consists of equations necessary to achieve a specific purpose. These modules are categorized in the following groups: (1) tunnel parameters; (2) jet exhaust measurements; (3) skin friction drag; (4) balance loads and model attitudes calculations; (5) internal drag (or exit-flow distribution); (6) pressure coefficients and integrated forces; (7) thrust removal options; (8) turboprop options; and (9) inlet distortion. Author

N92-32201*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
SYSTEM OVERVIEW OF THE NASA DRYDEN INTEGRATED TEST FACILITY
ROBERT L. BINKLEY and DALE MACKALL Aug. 1992 12 p Presented at the Society of Flight Test Engineers 23rd Annual Symposium, Hauppage, NY, Aug. 1992
(Contract RTOP 505-68-27)
(NASA-TM-104250; H-1831; NAS 1.15:104250) Avail: CASI HC A03/MF A01

The Integrated Test Facility, built at the NASA Dryden Flight Research Facility, provides new real-time test capabilities for emerging research aircraft. An overview of the test facility and the real-time systems developed to operate this unique facility is presented. The facility will reduce flight test risk by minimizing the difference between the flight and ground test environments. This ground test environment is provided by combining real-time flight simulation with the actual aircraft. A brief introduction to the facility is followed by a discussion of the generic capabilities of its real-time systems. The simulation system with flight hardware and the remotely augmented vehicle system is described. An overview of many hardware systems developed for the facility follows. The benefits of applying simulation to hardware-in-the-loop testing on the X-31 Flight Research Program are presented. 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.

A92-49258
IS THE AVIONICS SYSTEM OF THE HERMES SPACEPLANE CENTRALIZED OR DECENTRALIZED?
JEAN-CLAUDE VANNIER (Aerospatiale, Division Systemes Strategiques et Spatiaux, Les Mureaux, France) IN: IEEE/AIAA *Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct.* 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 38-42.
Copyright

The avionics system of Hermes is called spacionics. Spacionics is defined as a set of onboard items which treat, exchange, or store information in electrical form, and provide and distribute electrical power. The main drivers for spacionics design are mass and safety. The spacionics organization depends on the priorities assigned to different criteria. These priorities can lead to either a centralized or a decentralized data processing architecture. It has been necessary to centralize the widest part of the data processing, which is split into two pools of computers, one dedicated to guidance, navigation and control and one dedicated to mission and vehicle management. The first one, made of 4 computers and 4 data busses, is able to perform its functions autonomously and automatically even after 2 failures. The second one, including only 2 strings, requires the implementation of safety protection, activated, if necessary, either by the crew or by the control. I.E.

A92-49582
THREE-DIMENSIONAL OPTIMAL REENTRY TRAJECTORY AND AERODYNAMIC HEATING HISTORY OF THE SPACE SHUTTLE
HENGYUAN YAN and YING LI (Northwestern Polytechnical University, Xian, People's Republic of China) Northwestern Polytechnical University, Journal (ISSN 1000-2758), vol. 10, no. 3, July 1992, p. 364-371. In Chinese. refs

A nonlinear programming direct optimization method - the conjugate gradient method - is employed to solve the optimization problem of 3D trajectory constraints. Both the heat balancing equation and the equation of optimal trajectory are simultaneously solved numerically to give the time history of the temperature distribution of the vehicle's configuration surface. The method eliminates the difficulty involved in employing mathematical analysis to treat the optimization problem of 3D trajectory with constraints. Columbia data and the present method are used to estimate the space shuttle's maximum temperature at 1700 C. P.D.

A92-50498* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AEROSPACE PLANE GUIDANCE USING TIME-SCALE DECOMPOSITION AND FEEDBACK LINEARIZATION
MARK A. VAN BUREN and KENNETH D. MEASE (Princeton University, NJ) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 5, Sept.-Oct. 1992, p. 1166-1174. Previously cited in issue 21, p. 3605, Accession no. A91-49613. refs
(Contract NAG1-907)
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N92-30307*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THREE-DIMENSIONAL LASER WINDOW FORMATION
VINCENT G. VERHOFF Jul. 1992 12 p
(Contract RTOP 505-62-84)
(NASA-RP-1280; E-6096; NAS 1.61:1280) Avail: CASI HC A03/MF A01

The NASA Lewis Research Center has developed and implemented a unique process for forming flawless three-dimensional laser windows. These windows represent a major part of specialized, nonintrusive laser data acquisition systems used in a variety of compressor and turbine research test facilities. This report discusses in detail the aspects of three-dimensional laser window formation. It focuses on the unique methodology and the peculiarities associated with the formation of these windows. Included in this discussion are the design criteria, bonding mediums, and evaluation testing for three-dimensional laser windows. Author

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CHEMISTRY AND MATERIALS

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

A92-50007
ADDRESSING THE CHALLENGE OF AIRCRAFT COMPONENT DESIGN AND MANUFACTURE FROM METAL MATRIX COMPOSITES
D. CHARLES (British Aerospace /Commercial Aircraft/, Ltd., Bristol, England) Institution of Mechanical Engineers, Proceedings, Part G - Journal of Aerospace Engineering (ISSN 0954-4100), vol. 206, no. G1, 1992, p. 1-13. refs
Copyright

Recent developments in the use of metal matrix composites in the aerospace industry in the United States, Japan, and Europe are briefly reviewed, and the challenges posed by the design and manufacture of aerospace components from these materials are addressed with particular reference to programs carried out at British Aerospace. The objective of the programs was to develop low-cost manufacturing techniques and to demonstrate the potential of metal matrix composites by applying these techniques to the design, manufacture, and testing of representative aerospace structures. The activities related to mechanical property assessment, component fabrication technology, nondestructive testing, and design analysis are summarized. V.L.

A92-50255
TURBULENT DIFFUSION FLAME PROPERTIES BEHIND A BACKWARD-FACING STEP
M. Z. WU, R. E. WALTERICK, W. A. DE GROOT, J. I. JAGODA, and W. C. STRAHLE (Georgia Institute of Technology, Atlanta) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, no. 5, Sept.-Oct. 1992, p. 948-953. Previously cited in issue 06, p. 825, Accession no. A91-19126. refs
(Contract AF-AFOSR-88-0001)
Copyright

A92-51512
NEW THERMOPLASTIC POLYIMIDE COMPOSITE FOR SUPERSONIC AIRCRAFT STRUCTURES
T. NAGUMO, H. NAKAMURA (Fuji Heavy Industries, Ltd., Aerospace Engineering Div., Utsunomiya, Japan), T. NAKAKURA, and H. SAKAI (Mitsui Toatsu Chemicals, Inc., Yokohama, Japan) IN: International SAMPE Technical Conference, 23rd, Kiamesha Lake, NY, Oct. 21-24, 1991, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 153-161. Research sponsored by Society of Japanese Aerospace Companies.
Copyright

A novel thermoplastic polyimide composite system has been developed which furnishes excellent hot-wet compression and fracture toughness properties relative to conventional thermosets; in conjunction with innovative fabrication techniques that capitalize on the thermoplastic behavior of the matrix resin, fabrication costs may be significantly reduced. These techniques encompass press-forming, filament-winding, and fusion bonding. Attention is given to the applicability of this structural system to next-generation supersonic aircraft primary airframe structures. O.C.

A92-51555
DEVELOPMENT OF COMPOSITE STRUCTURES WITH ENHANCED DAMAGE TOLERANCE
JANICE R. MAIDEN and TAMMY S. EBERSOLE (Textile Technologies, Inc., Hatboro, PA) IN: International SAMPE Technical Conference, 23rd, Kiamesha Lake, NY, Oct. 21-24, 1991, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 855-869.
Copyright

A novel approach has been developed for damage-tolerant composite structures which applies existing textile technology to an interply stitching system which enhances a laminate's ability to withstand out-of-plane loading. The stitching mechanism interlocks multiple noncrimped fabric layers, and has been designated the 'mock-stitched woven' fiber architecture. By stitching yarn that is independent of the in-plane fabric, the in-plane reinforcing fibers are not impaled and in-plane properties are not degraded. The process has been verified to be applicable to various fiber diameters and moduli. O.C.

A92-51901
INTERNATIONAL SAMPE ELECTRONICS CONFERENCE, 5TH, LOS ANGELES, CA, JUNE 18-20, 1991, PROCEEDINGS
RON KEYSON, ED., DANA BASIULIS, ED., and BOON WONG, ED. (Hughes Aircraft Co., El Segundo, CA) Covina, CA, Society for the Advancement of Material and Process Engineering (International SAMPE Electronics Conference Series. Vol. 5), 1991, 654 p. For individual items see A92-51902 to A92-51930.
(ISBN 0-938994-58-1) Copyright

The papers presented in this volume provide a comprehensive survey of recent research in ceramics, resins and polymers, adhesives and encapsulants, and composites, as well as new developments in failure analysis, testing, robotics, and assembly. Topics discussed include new piezoelectric ceramics for sonar transducer applications, conductive sealants and gaskets for EMI and EMP shielding with corrosion inhibition, noncuring fuel and water resistant sealant adhesives, and recent research on sensor and knowledge-based robotics. Papers are also presented on mechanical and electrical properties of laminates for high performance printed wiring boards, application of resin and metal matrix composites to advanced avionics enclosure, deposition techniques for thin-film solar cells, and detailed investigation of causes of avionics field failures. V.L.

A92-51906
NON-CURING FUEL AND WATER RESISTANT SEALANT COMPOSITIONS
LESTER MORRIS (Products Research & Chemical Corp., International Research Laboratories, Burbank, CA) IN: International SAMPE Electronics Conference, 5th, Los Angeles, CA, June 18-20, 1991, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 105-114. refs
Copyright

Liquid polymers containing a major percentage of sulfur in their backbones, when manufactured to eliminate low molecular weight fractions, exhibit good thermal stability and resistance to extraction by water and aromatic containing fuels. Formulated with various pigments and fillers, they produce mastics which can be successfully used to seal channels in aircraft fuel tanks. Demonstrations of sealing characteristics are shown as well as ability to reseal a channel previously filled with polysiloxane based material. Properties of polymers and pigmented channel sealants are compared. Author

A92-51921
APPLICATION OF RESIN AND METAL MATRIX COMPOSITES TO ADVANCED AVIONICS ENCLOSURE
JOHN GLATZ, W. DITTMER (Sparta, Inc., San Diego, CA), and R. MORGAN (U.S. Navy, Naval Avionics Center, Indianapolis, IN) IN: International SAMPE Electronics Conference, 5th, Los Angeles, CA, June 18-20, 1991, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 434-450.
Copyright

A program aimed at designing and fabricating an advanced metal and resin matrix composite 3/4 Air Transportable Rack (3/4 ATR) enclosure is summarized. In particular, attention is given to methods used to achieve a 40-percent reduction in the enclosure structure weight and an improvement in the thermal management of the heat generated in the enclosure. The discussion also covers

processes used to fabricate the 3/4 ATR, enclosure test results, and potential enclosure applications. V.L.

A92-51922
APPLICATION OF ADVANCED COMPOSITES IN SEM-E HEATSINKS FOR THE THERMAL MANAGEMENT OF AVIONICS
JOHN GLATZ, F. BEAVERS (Sparta, Inc., San Diego, CA), and M. HOOK (U.S. Navy, Naval Avionics Center, Indianapolis, IN) IN: International SAMPE Electronics Conference, 5th, Los Angeles, CA, June 18-20, 1991, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 451-467. refs
Copyright

The progress of advanced composite material technology toward attaining some of the thermal management goals in Standard Electronic Module Format-E (SEM-E) heat sinks. The impact of the usage of these advanced materials on some of the other system requirements associated with the composite SEM-Es is also evaluated. The materials discussed include graphite/aluminum, graphite/copper, graphite-thermoplastic, SiC particulate reinforced aluminum, beryllium oxide reinforced beryllium, and graphite/epoxy-aluminum. The discussion covers the configuration of candidate SEM components, identification of advanced materials being evaluated for usage in the SEMs, a description of the results of analytical trade studies evaluating these materials, and a description of the proposed testing. V.L.

A92-52982
HIGH TEMPERATURE MMCS FOR AERO-ENGINES - CHALLENGE AND POTENTIAL
W. WEI (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, Germany) Metals and Materials (ISSN 0266-7185), vol. 8, no. 8, Aug. 1992, p. 430-435. refs
Copyright

A nearly 200 C increase in service temperatures is projected for numerous innovative applications of metal-matrix composites (MMCs) to aircraft gas turbine compressor and hot-section components. The selection and optimization of material properties for a given application must be weighed against the difficulties and expense of the component's fabrication. Representative matrix materials are the Ti, Ni, and Co alloys; Al and Mg alloys can significantly reduce compressor low-pressure stage weights. Attention is given to the 'blade ring' or 'bling' MMC rotor stage structure and the mechanical property reductions associated with increasing angle between the load and fiber axis. O.C.

A92-52983
STEELS FOR AEROSPACE APPLICATIONS
H. EVERSON (Stockbridge Engineering Steels, Sheffield, United Kingdom) Metals and Materials (ISSN 0266-7185), vol. 8, no. 8, Aug. 1992, p. 440, 441.
Copyright

Although the percentage of steel components in military and other high-performance aircraft has steadily declined over the past 20 years, steel continues to be the material of choice for landing-gear components. Such high-strength landing gear steels as VAR 4340 Mod and 35 NCD16 have limited defect sizes that are readily detected by such NDT techniques as immersion ultrasonic examination. The high corrosion resistance of these steels is as yet not easily duplicated in alternative materials and composites, which also pose inspection-related difficulties. O.C.

A92-53096
INVESTIGATION OF A METHOD FOR DETERMINING MACHINING STRESS IN POLYMETHYLMETHACRYLATE (PMMA) OF AIRPLANE CANOPIES
ZIMING WANG (Institute of Aeronautical Materials, Beijing, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 8, Aug. 1991, p. B417-B421. In Chinese. refs

The nature of the birefringence fringe and the relationship between the birefringence fringe and the residual stress induced by machining PMMA were investigated by means of experiment. A new method - birefringence measurement has been established for the quantitative determination and nondestructive evaluation of the machining stress in PMMA plates and the transparent pieces of airplane cabins. How to separate the birefringence induced by machining from the initial one quantitatively and how to get the distribution of the birefringence induced by machining through thickness are discussed. Author

A92-53330
AN IMPACT DYNAMICS INVESTIGATION ON SOME PROBLEMS IN BIRD STRIKE ON WINDSHIELDS OF HIGH-SPEED AIRCRAFT
LILI WANG, XIXIONG ZHU, SHAOQIU SHI, SU GAN, and HESHENG BAO (Ningbo University, Zhejiang, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 2, Feb. 1991, p. B27-B33. In Chinese. refs

Some problems of the dynamic response of aircraft windshields to birdstrike are investigated from the viewpoint of impact dynamics. Experimental results on an aeronautical PMMA tested at strain rates of 0.0001-1000/s and temperatures of -60-100 C are presented, and a nonlinear thermoviscoelastic constitutive equation is suggested. Experimental results on a cast magnesium alloy tested at strain rates of 0.0001-1000/s are also reported, and an apparent nonlinear elastoplastic constitutive equation is proposed. The character of impact loading is analyzed numerically using a characteristics method, and it is shown that determination of impact loading is coupled with the determination of the dynamic response of structure. It is found that the effects of constitutive characteristics of both birds and windshields on impact loading cannot generally be neglected. C.D.

N92-30256# Stanford Univ., CA. High Temperature Gasdynamics Lab.
TURBULENT REACTING FLOWS AND SUPERSONIC COMBUSTION Annual Technical Report, 15 Feb. 1991 - 14 Feb. 1992
C. T. BOWMAN, R. K. HANSON, M. G. MUNGAL, and W. C. REYNOLDS 15 Mar. 1992 30 p
(Contract AF-AFOSR-0151-90)
(AD-A251065; AFOSR-92-0456TR) Avail: CASI HC A03/MF A01

An experimental and computational investigation of supersonic non-reacting and combustion flows is in progress. The principal objective of the research is to gain a more fundamental understanding of mixing and chemical reaction in supersonic flows. The research effort comprises three inter-related elements: (1) an experimental study of mixing and combustion in a supersonic plane mixing layer; (2) development of laser-induced fluorescence techniques for time-resolved two-dimensional imaging of species concentration, temperature, velocity, and pressure; and (3) numerical simulations of compressible reacting flows. The specific objectives and the status of the research of each of these program elements are summarized in this report. GRA

N92-30321# Naval Air Development Center, Warminster, PA. Air Vehicle and Crew Systems Technology Dept.
IN-SERVICE EVALUATION OF 2090 ALUMINUM-LITHIUM ALLOY ON F/A-18 AIRCRAFT Interim Report, Feb. 1988 - Jun. 1991
J. KOZOL, E. S. TANKINS, J. J. THOMPSON, and C. E. NEU 1 Aug. 1991 31 p
(AD-A248472; NADC-91078-60) Avail: CASI HC A03/MF A01

Al-Li alloys can provide reduced weight and increased stiffness as replacements for conventional aluminum alloy aircraft components. A study was conducted to compare the performance of 2090 Al-Li and 7075 Al alloys in-service on Navy aircraft, during shipboard exposure and in laboratory accelerated tests. Results from this investigation indicated that no additional maintenance was required during in-service exposure and that the corrosion behavior of the two alloys in laboratory tests and during shipboard exposure was comparable. GRA

N92-30414# Technische Univ., Delft (Netherlands).
LOW-VELOCITY IMPACT LOADING ON FIBRE REINFORCED ALUMINUM LAMINATES (ARALL) AND OTHER AIRCRAFT SHEET MATERIALS Ph.D. Thesis
ARIE VLOT 1991 577 p Sponsored by Netherlands Foundation for Technical Research
(ETN-92-91613) Avail: CASI HC A25/MF A06

The impact properties of new aircraft materials play an important role for the design and certification of aircraft structures. Low velocity impact tests were carried out on monolithic aluminum alloys, various types of Arall laminates and thermoplastic composites. The damage resistance, the image tolerance (residual strength after impact damage) and residual strength of the various materials are compared. In the literature only dynamic linear elastic models and a static nonlinear elastic model are available. A Non Linear Elastic Impact Model (NOLEIM) was developed, which is able to calculate the force time, velocity time and deflection time curves accurately. The calculations of this model were compared with experimental and finite element results. A static Elasto Plastic Impact Model (EPIM) was derived which is able to calculate deflection energy and force deflection curves. ESA

N92-30767# Southwest Research Inst., San Antonio, TX.
LASER INDUCED FLUORESCENCE DETECTION OF GUMS IN JET FUELS Final Report, Jul. 1990 - May 1992
DAVID W. NAEGELI and RALPH H. HILL May 1992 59 p
(Contract F33615-90-C-2050)
(AD-A252685; SWRI-03-3685; WL-TR-92-2015) Avail: CASI HC A04/MF A01

The current method (ASTM D381) of determining the concentration of gums in jet fuels is a lengthy procedure requiring a large sample size. Because gum formation is believed to be an important step in the formation of deposits in fuel systems used in jet aircraft, a non-intrusive method of performing spatially resolved measurements of gum concentration in high temperature flow systems is a desired research tool. The present study was conducted to determine the feasibility of using laser-induced fluorescence (LIF) to monitor gum concentration in jet fuel. The study revealed several effects, such as aging and the interference of other fluorophores with gum fluorescence, which require further investigation before LIF is to be considered a quantitative technique for measuring gums in jet fuels. However, this study showed that the formation of gums in jet fuels is detectable by LIF. The results show that gum formation in some fuels correlates strongly with LIF while for other fuels the results are ambiguous. GRA

N92-30874# California Univ., Irvine. Dept. of Mechanical and Aerospace Engineering.
MECHANICAL BEHAVIOR AND PROCESSING OF ALUMINUM METAL MATRIX COMPOSITES Final Report, 1 Jan. 1989 - 31 Dec. 1991
E. J. LAVERNIA and F. A. MOHAMED 21 Feb. 1992 231 p
(Contract DAAL03-89-K-0027)
(AD-A249918; ARO-26439.48-MS) Avail: CASI HC A11/MF A03

The objectives of the present three year research program were threefold. First the program sought to explore the potential of using spray atomization and deposition to process aluminum metal matrix composites, not only with improved mechanical properties, but also with specifications suitable for applications of interest to the Army; these applications include light weight armor vehicles, helicopter engines, and other structural components. Second, the research program sought to develop an in-depth understanding of the various physical phenomena that occur during spray atomization and deposition of aluminum metal matrix composites. Third, the program sought to provide insight into the fundamental mechanisms governing the elevated temperature deformation behavior, not only of metal matrix composites processed by spray atomization and deposition, but also of metal matrix composites in general. GRA

N92-30969# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany).
DEVELOPMENT OF HARDNESS CYCLES FOR FIBER BOUND MATERIALS, USING DSC: FROM LABORATORY SPECIMENS TO COMPLEX HIGH DUTY STRUCTURAL MEMBERS [ENTWICKLUNG VON HAERTEZYKLEN FUER FASERVERBUNDWERKSTOFFE (FVW) MITTELS DSC: VOM REINHARZPRUEFKOERPER ZUR FERTIGUNG VON KOMPLEXEN HOCHLEISTUNGSBAUTEILEN]
KLAUS SCHMIDTKE, G. WACHINGER, and A. KELLER 1991 30 p In GERMAN Presented at Fachtagung Thermische Analyse fuer die Kunststoffe- und Kautschukindustrie, Wuerzburg, Fed. Republic of Germany, 18-19 Sep. 1991
(MBB-Z-0409-91-PUB; ETN-92-91898) Avail: CASI HC A03/MF A01

It is shown that the hardening of fiber bound structural members is often very complicated, when using 'one shot bounding'. The problems of fabricating structural members with great layer thickness are explained, taking a helicopter rotor head system as an example. The DSC investigation processes which can be used for developing hardness cycles, are described. The transfer from laboratory to production scale is represented in detail, with regard to material effects, and optimization of hardness cycles. ESA

N92-31360# Pratt and Whitney Aircraft, West Palm Beach, FL.
FATIGUE IN SINGLE CRYSTAL NICKEL SUPERALLOYS Interim Report, 16 Mar. - 15 Apr. 1992
CHARLES ANNIS 15 Apr. 1992 10 p
(Contract N00014-91-C-0124)
(AD-A250068; PWA-FR2198-06) Avail: CASI HC A02/MF A01

This program investigates the seemingly unusual behavior of single crystal airfoil materials. The fatigue initiation processes in single crystal (SC) materials are significantly more complicated and involved than fatigue initiation and subsequent behavior of a (single) macrocrack in conventional, isotropic materials. To understand these differences is the major goal of this project. GRA

N92-31399# Pennsylvania State Univ., University Park.
ADVANCED THERMALLY STABLE JET FUEL DEVELOPMENT PROGRAM. VOLUME 2: COMPOSITIONAL FACTORS AFFECTING THERMAL DEGRADATION OF JET FUELS Final Annual Report, Jul. 1990 - Jul. 1991
C. SONG, S. ESER, H. H. SCHOBERT, P. G. HATCHER, and M. M. COLEMAN May 1992 187 p
(Contract FY1455-89-N-0635)
(AD-A252656; WL-TR-91-2117-VOL-2) Avail: CASI HC A09/MF A02

This project focuses on the compositional factors affecting jet fuel thermal stability at high temperatures. The chemical composition of the four jet fuel samples (JP-8C, JP-8P, JP-7P, and Jet A1) and Wilsonville middle distillates was characterized by using selective ion monitoring technique in GC-MS analysis. The thermal treatment tests have been performed on jet fuels and a series of model compounds including tetralin, decalin, ethylcyclohexane, butylcyclohexane, nbutylbenzene, t-butyl-benzene, n-octane, n-decane, and n-tetradecane. Deposit samples from an actual aircraft fuel system as well as those produced from jet fuels and model compounds in microautoclaves were characterized by FTIR and polarized-light microscopy. Experiments were conducted to find the optimum amount of antioxidant 2,6-di-tert-butyl-4-methylphenol necessary to minimize the solid formation upon thermal stressing of JP8 neat and Jet A-1 fuel samples. The chemistry of thermal degradation of the fuel and antioxidant mixtures was studied by using FTIR to characterize the liquid products from thermal stressing. GRA

N92-31419# HCC Science and Technology Co., Summit, NJ.
POLYMER BLENDS, VOLUME 1 Final Report
MICHAEL JAFFE May 1992 119 p
(Contract F49620-88-C-0014)
(AD-A252112; AFOSR-92-0415TR) Avail: CASI HC A06/MF A01

Three generations of PBI and polyamide blends have been

evaluated for use as high temperature matrix resins for carbon fiber composites in aerospace applications. To enable property testing, a neat resin molding cycle was developed to produce plagues with less than 2 percent void volume. Phthalic anhydride end-capping of the PBI was shown to significantly reduce crosslinking as measured by the change in Tg after high temperature exposure. This reduction in end-group chemistry provided for maximum thermoplasticity of the blend during molding. Thermo-oxidative stability studies indicated that at 60 F and above, the weight loss of the blend was approximately proportional to its PBI content. Attempts to mitigate this effect by incorporating 6F moiety into the PBI backbone were unsuccessful. Phosphoric acid treatment of 85/15 molded blend samples was shown to provide a four-fold increase in weight retention. However, this effect was due to surface oxidation barrier effect. A series of nine copolymer polyimides were synthesized and evaluated. The blend of 10/90 ecPBI/6FcoPI-2 was chosen to be moved forward for aerospace evaluations. The blend with end capped chemistry was scaled up in steps from gram quantities to 50 kilograms. Prepregging of the neat resin onto plain weave AS-4 carbon fabric and onto AS-4 unidirectional tape was successfully demonstrated by YLA Incorporated. Three prepregging trials produced a total of 1450 linear feet of fabric and over 450 feet of unidirectional prepregs. Composite laminate fabrication was demonstrated by both Lockheed and Hoechst Celanese. Composite properties were demonstrated which either approached or exceeded GE Aircraft Engines specifications for PMR-15 composites. GRA

N92-31462# Sandia National Labs., Albuquerque, NM.
ADVANCED THERMALLY STABLE, JET FUELS DEVELOPMENT PROGRAM ANNUAL REPORT. VOLUME 1: MODEL AND EXPERIMENT SYSTEM DEVELOPMENT Interim Report, Jun. 1990 - Jun. 1991
ELMER KLAVETTER, WAYNE TROTT, TIM OHERN, and STEVE MARTIN Jan. 1992 58 p
(Contract AF PROJ. 3048)
(AD-A249625; WL-TR-91-2099) Avail: CASI HC A04/MF A01

A program entitled Thermally Stable Jet Fuels Development was initiated in FY-89 by the U.S. Air Force, Aero Propulsion and Power Directorate, working jointly with the Department of Energy, Pittsburgh Energy Technology Center. Aviation turbine fuel thermal stability is of concern because of the potential operational problems arising from the degradation of fuels when used to cool aircraft components. Within this program, investigations are proceeding to develop candidate advanced thermally stable fuels, kinetic models of fuel degradation and to measure parameters for computational fluid dynamic models to predict the degradation of fuel under various conditions. This report summarizes the development and testing of instrumentation systems to measure solid particle formation during fuel thermal stressing and to measure the accumulation rates of solids on a surface, and describes analyses of jet fuel liquids and formed solids. GRA

N92-31716# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany).
CUTTING TREATMENT BY DRILLING OF FIBER BOUND SYNTHETIC MATERIALS [SPANENDE BEARBEITUNG DURCH BOHREN VON FASERVERBUND-KUNSTSTOFFEN]
J. PELZL 1991 73 p In GERMAN Presented at the Deutsche Industrieforum fuer Technologie Conference, Berlin, Fed. Republic of Germany, 11-12 Nov. 1991
(MBB-UD-0609-91-PUB; ETN-92-91889) Avail: CASI HC A04/MF A01

It is shown that the quality of bore holes in fiber bound synthetic materials is influenced by a number of limiting conditions. The most important factors affecting the use are related to the type of fiber and matrix system, fiber structure and laminate texture, laminate thickness and bore hole diameter, other materials in hybrid texture, accessibility and usable machines, used cutting geometry and cutting material, selected cutting velocities and forward feeding. It is not possible to give a general 'recipe' for the boring of fiber bound synthetic materials. ESA

N92-31823# Air Force Inst. of Tech., Wright-Patterson AFB, OH.
THERMOMECHANICAL FATIGUE BEHAVIOR OF A SILICONE CARBIDE FIBER-REINFORCED CALCIUM ALUMINOSILICATE GLASS-CERAMIC MATRIX COMPOSITE M.S. Thesis
LAWRENCE M. BUTKUS 1991 139 p
(AD-A249870; AFIT/CI/CIA-91-126) Avail: CASI HC A07/MF A02

Ceramic matrix composites are being considered for use in advanced turbine engines and other applications where thermomechanical fatigue (TMF) conditions exist. Isothermal fatigue and in-phase TMF tests were performed on a unidirectional, continuous-fiber, Nicalon reinforced calcium aluminosilicate glass-ceramic material (O16, SiC/CAS-11). Monotonic tensile tests were performed at 1100 C (2012 F) and 100 MPa/sec to determine the material's ultimate strength and proportional limit. Isothermal fatigue tests at 1100 C (2012 F) employed two loading profiles, a triangular waveform with ramp times of 60 seconds, and a similar profile with a superimposed 60 second hold time. These tests used a maximum stress of 100 MPa (40 percent of sigma(sub pl)), R = 0.1. TMF loading profiles were identical to the isothermal loading profiles. During the TMF tests, the temperature was cycled between 500 and 1100 C (932 and 2012 F) in time with the load. Run out was arbitrarily set at 1000 cycles for all fatigue profiles. All fatigued specimens reached run out and were tested in tension at 1100 C and 100 MPa/sec immediately following the isothermal and thermomechanical tests. Residual modulus, residual strength, hysteretic modulus, and strain accumulation were all explored as possible damage indicators. Strain accumulation appeared to be the parameter which allowed for the greatest distinction to be made among the types of tests performed. Author

N92-31942# European Space Agency, Paris (France).
CONTRIBUTION TO THE MODELLING OF TURBULENT COMBUSTION IN THE CASE OF STABILISATION BY FLAME-LOCK [CONTRIBUTION A LA MODELISATION DE LA COMBUSTION TURBULENTE DANS LE CAS D'UNE STABILISATION PAR ACCROCHE-FLAMMES]
PASCALE GILBANK (Office National d'Etudes et de Recherches Aerospatiales, Paris, France) Nov. 1991 208 p Transl. into ENGLISH of French document (Paris, France, ONERA), 1989 Original language document was announced as N91-11090
(ESA-TT-1229; ONERA-NT-1989-8; ETN-92-91387) Avail: CASI HC A10/MF A03

A method for predicting turbulent reactive flows, capable of describing various combustion regimes and of being adapted to realistic reactive schemes, is suggested. In industrial configurations such as the afterburning combustors of aircraft engines, various turbulent combustion regimes can coexist at various locations of the combustor or at various times. The chemical kinetics in these flows are complex and it can be important to predict the variation of the various species involved, both intermediate species which determine the overall reaction rate, and the production of contaminating species. The particular feature of this method, called the PEUL model, is the use of Eulerian balance equations to describe the variation of the variables characterizing the flow; the source term involved in the Eulerian balance equations for the mass fractions of the chemical species is determined by Lagrangian equations. The Lagrangian approach has the advantage of describing the flow from a more phenomenological standpoint. The PEUL model thus allows numerical prediction of multireactive turbulent flows. The PEUL model is applied to a turbulent air/methane premixing flame developing in a two dimensional channel with constant section or in a channel possessing a step behind which a recirculation zone is established. ESA

N92-32066# Pratt and Whitney Aircraft, West Palm Beach, FL.
FATIGUE IN SINGLE CRYSTAL NICKEL SUPERALLOYS Report, 16 May - 15 Jun. 1992
15 Jun. 1992 7 p
(AD-A252492; PWA-FR21998-08) Avail: CASI HC A02/MF A01

This program investigates the seemingly unusual behavior of single crystal airfoil materials. The fatigue initiation processes in

single crystal (SC) materials are significantly more complicated and involved than fatigue initiation and subsequent behavior of a (single) macrocrack in conventional, isotropic materials. To investigate these differences is the major aim of this project.
GRA

N92-32076# TRW Space Technology Labs., Redondo Beach, CA.
LASER-INITIATED CONICAL DETONATION WAVE FOR SUPERSONIC COMBUSTION, PART 3
G. F. CARRIER, F. E. FENDELL, and M. S. CHOU Jul. 1992 12 p
(Contract F49620-90-C-0070)
(AD-A250522; AFOSR-92-0420TR) Avail: CASI HC A03/MF A01

Further theoretical and experimental studies are undertaken of the feasibility of an air-breathing supersonic combustor based on a stabilized, conically configured (oblique) detonation wave. The conical wave is the resultant of the interaction of a train of spherical detonation waves, each directly initiated by a brief, localized deposition of energy from a very-rapidly-repeated pulsed laser. The laser is tightly focused on a fixed site (in the combustor) where there is a steady uniform supersonic stream of combustible gas. Simple analysis and laboratory experiments on the (nonintrusive) direct initiation of an individual spherical detonation wave by a single laser pulse are reported, with emphasis on the pulse-energy and pulse-duration parameters. Then, an estimate is given of the entropy production associated with the interaction of spherical detonations created in a supersonic reactive stream by a train of laser pulses. The entropy production, which arises from reflected shocks in already-detonated mixture, is reduced either by increasing the repetition rate of the laser or by increasing the flow speed of the cold-gas mixture. GRA

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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.

A92-49274
LIQUID COOLED APPROACHES FOR HIGH DENSITY AVIONICS
ROBERT LEVASSEUR (GE Aerospace, Binghamton, NY) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 147-152. refs
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Next-generation aircraft will require avionics that provide greater system performance in a smaller volume, a process that requires highly developed thermal management techniques. To meet this need, a liquid-cooled approach has been developed to replace the conventional air-cooled approach for high-power applications. Liquid-cooled chassis and flow-through modules have been developed to limit junction temperatures to acceptable levels. Liquid cooling also permits emergency operation after loss of coolant for longer time intervals, which is desirable for flight-critical airborne applications. Activity to date has emphasized the development of chassis and modules that support the US Department of Defense's (DoD) two-level maintenance initiative as governed by the Joint Integrated Avionics Working Group (JIAWG). I.E.

A92-49275
HIGH PERFORMANCE HEAT SINK FOR SURFACE MOUNT APPLICATIONS
STEPHEN A. MCKEOWN and ROBERT D. LEVASSEUR (GE Aerospace, Binghamton, NY) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 153-157. refs
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Surface-mounted electronic module configurations are sensitive to thermal cycling because the reduced compliance between the component and module increases the thermally induced strain in the solder joint. Providing a thermal match between the component and the module reduces this strain, reduces low-cycle fatigue damage, and increases solder joint life. One way of achieving this thermal match is through the use of a thermally matched heat sink. In addition to having the required coefficient of thermal expansion (CTE), heat sinks for surface-mount avionic configurations require low weight and high thermal conductivity. A heat sink has been developed that has thermal conductivity close to aluminum, a CTE close to ceramic, and a weight density only 8 percent higher than aluminum. The flexural modulus of this heat sink is 40 percent higher than aluminum, which results in improved vibration performance. I.E.

A92-49276
PROGRESSIVE AVIONICS PACKAGING TECHNOLOGIES
STEPHEN L. BENNING (USAF, Wright Laboratory, Wright-Patterson AFB, OH) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 158-163. refs
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The author describes technologies that address the packaging, cooling, and interconnect concerns for avionics that are applicable to current aircraft and future weapon platforms, as well as retrofit systems. To meet added functional requirements, electronic devices must shrink to allow more devices on a module and to allow processing/interconnection speeds to increase. This however, produces a tremendous power density. This intensified heat load must be removed so that the components will remain reliable. The various device technologies are creating coefficient-of-thermal-expansion mismatch, thus creating failures. The number of interconnections at the chip and system level must also decrease to increase system reliability. Current and future device technologies are discussed. I.E.

A92-49277
NEXT-GENERATION AVIONICS PACKAGING AND COOLING 'TEST RESULTS FROM A PROTOTYPE SYSTEM'
J. D. SEALS (AT&T Bell Laboratories, Whippany, NY) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 164-169. Research supported by USAF.
Copyright

The author reports on the design, material characteristics, and test results obtained under the US Air Force's advanced aircraft avionics packaging technologies (AAAPT) program, whose charter is to investigate new designs and technologies for reliable packaging, interconnection, and thermal management. Under this program, AT&T Bell Laboratories has completed the preliminary testing of and is evaluating a number of promising materials and technologies, including conformal encapsulation, liquid flow-through cooling, and a cyanate ester backplane. A fifty-two module system incorporating these and and other technologies has undergone preliminary cooling efficiency, shock, sine and random vibration, and maintenance testing. One of the primary objectives was to evaluate the interaction compatibility of new materials and designs with other components in the system. I.E.

A92-49279
JIAWG MODULE FAULT COVERAGE METRICS METHODOLOGY
RICHARD S. MEJZAK (U.S. Navy, Naval Air Development Center, Warminster, PA) and KIRK T. SCHMIERER (USAF, Wright-Patterson AFB, OH) IN: IEEE/AIAA Digital Avionics

Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 175-180. refs
Copyright

The authors discuss the results of a Joint Integrated Avionics Working Group (JIAWG) evaluation of diagnostics initiative (JEDI) which is addressing the problem of accurately predicting and measuring fault detection, fault isolation, and other parameters of vendors' diagnostic designs. The JEDI program developed the metrics, methodology, and data package needed for the government to evaluate digital diagnostic designs at the module level. Lessons learned from the JEDI effort include: 1) the use of fault simulation in verifying diagnostics is feasible, 2) exhaustive fault simulation is not practical unless random sampling techniques are employed and, 3) checkpoint restart capability is required of the simulator. The JEDI methodology and the data package are discussed. I.E.

A92-49304
LOW COST HIRF TROUBLESHOOTING AND VERIFICATION METHOD FOR DIGITAL AVIONICS SYSTEMS
CHRIS KENDALL and K. P. SLATTERY (CKC Laboratories, Inc., Mariposa, CA) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 343-345. refs
Copyright

In the second phase of DO-160C, Section 20 HIRF type testing, the EUT (equipment under test) is subjected to RF fields in the range 30 MHz-(1.215 or 18 GHz), by radiating the EUT with antenna generated fields. Design engineers are concerned about the high cost of testing to 200(+) V/m. An alternate approach, using 10-15-W amplifiers, a signal generator, and a hand held probe is presented. The total cost of the system is less than $15,000 and yields 90 percent confidence in complying with the DO-160. Alternatively, the equipment can easily be used to pinpoint problems on aircraft. The near-field measurement technique can identify both case and cable penetrations quickly in the 1-100-MHz range. The method has been successfully used for over five years on military aircraft avionic systems. I.E.

A92-49516
NAVIER-STOKES COMPUTATIONS OF HORSESHOE VORTEX FLOWS
G. B. DENG and J. PIQUET (Ecole Nationale Superieure de Mecanique, Nantes, France) International Journal for Numerical Methods in Fluids (ISSN 0271-2091), vol. 15, no. 1, July 15, 1992, p. 99-124. refs
(Contract DRET-86-104; DRET-89-117)
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Computation of the incompressible 3D turbulent viscous flow about an aerofoil/flat plate junction is reviewed. An iterative, fully decoupled technique is applied to the Reynolds-averaged Navier-Stokes equations written in a nonorthogonal curvilinear body-fitted coordinate system. The existing experimental databases are used to compare the numerical outputs of the computational method with experimental results involving massive separation. O.G.

A92-49574
ROTATIONAL COHERENT ANTI-STOKES RAMAN SPECTROSCOPY MEASUREMENTS IN A ROTATING CAVITY WITH AXIAL THROUGHFLOW OF COOLING AIR - OXYGEN CONCENTRATION MEASUREMENTS
JOHN D. BLACK (Rolls-Royce, PLC, Derby, England) and CHRISTOPHER A. LONG (Sussex, University, Brighton, England) Applied Optics (ISSN 0003-6935), vol. 31, no. 21, July 20, 1992, p. 4291-4297. Research supported by Defence Research Agency of England. refs
Copyright

In a rotating cavity rig, which models cooling air flow in the spaces between disks of a gas turbine compressor, the buildup of oxygen concentration after the cooling gas was changed from nitrogen to air was monitored using rotational CARS. From this information an estimate of the fraction of the throughflow entering the rotating cavity was obtained. This demonstrates that rotational CARS can be applied as a nonintrusive concentration-measurement technique in a rotating engineering test rig. Author

A92-49578
OPTIMIZATION OF LONGITUDINAL CORRECTIONS OF HELICAL GEARS
DAWEI HE and ZONGDE FANG (Northwestern Polytechnical University, Xian, People's Republic of China) Northwestern Polytechnical University, Journal (ISSN 1000-2758), vol. 10, no. 3, July 1992, p. 323-329. In Chinese. refs

FEM and mathematical programming are used to obtain optimal longitudinal corrections of helical gears. Consideration is given to: the simultaneous engagement of three pairs of teeth; the influence of deformation of rims and webs; and the influence of deformation of shafts and bearings. A gear surface complex flexibility matrix is established in order to reduce the computer time needed. In the optimization of longitudinal corrections, a large number of iteration computations must be performed. Many meshing positions and contact lines must be considered. There are a great number of points on which forces may act. Flexibilities of points on which forces act are needed in iteration computations. In the past, flexibilities of contact points are computed when needed; as a result, the computer time required is unnecessarily great. Flexibilities of all points on which forces may act and store gear surface complex flexibility matrix in a database are computed. The flexibilities are recalled from data base whenever needed; as a result, the computer time needed is greatly reduced. Aircraft gears in actual use are taken as examples. Calculated results show that optimization or very good load equalization can be attained in theory. Author

A92-49579
VIBRATION CONTROL OF ROTOR-BEARING SYSTEM BY CONTROLLED SQUEEZE-FILM DAMPER BEARINGS
ERMING HE and JIALIU GU (Northwestern Polytechnical University, Xian, People's Republic of China) Northwestern Polytechnical University, Journal (ISSN 1000-2758), vol. 10, no. 3, July 1992, p. 337-343. In Chinese. refs

A new vibration control scheme for rotor-bearing systems is presented which offers many advantages over the scheme proposed by Gu (1990). Due to the nonlinear state feedback, closed-loop control becomes possible. Thus control can be readily adjusted in accordance with transient state information. Optimal structure parameters are determined by the optimal control law. The control force is applied on line; by merely adjusting CSFDB structure parameters, control forces can be applied to the system. The feasibility of the present design is confirmed by simulation, which is performed for a flexible Jeffcott rotor elastically supported at both ends on identical CSFDBs. P.D.

A92-49580
ON TRAVELLING WAVE VIBRATION OF HIGH-SPEED DUPLEX HELICAL GEARS
GENG LIU, YUNWEN SHEN, ZONGDE FANG, DAWEI HE, and XIANGQUN GAO (Northwestern Polytechnical University, Xian, People's Republic of China) Northwestern Polytechnical University, Journal (ISSN 1000-2758), vol. 10, no. 3, July 1992, p. 344-350. In Chinese. refs

Simulation calculations of dynamic responses of the traveling wave vibration of duplex helical gears in a star transmission are performed. Gear system vibration and gear structure vibration are analyzed as they actually occur. By analyzing the star transmission system, the dynamic loads acting on the duplex helical gears are obtained. The 3D FEM is used to obtain the responses of forward and backward traveling wave vibrations of the first three nodal diameters of duplex helical gears. The difference in the meshing frequencies of duplex helical gears is found to greatly affect the dynamic responses of traveling wave vibrations. Two different meshing frequencies may excite two different resonant vibration modes of gear structure and thus cause coupled vibrations. When

there is only dynamic load acting on star gear No. 2, the backward-traveling wave vibration of the third nodal diameter is excited; the calculated curve is illustrated. When the duplex gears are in meshing, coupled vibration occurs. Dynamic stresses of the traveling wave vibration of duplex gears do not necessarily decrease with increasing nodal diameter. P.D.

A92-49790
THE INTERACTION BETWEEN A PLANE SHEAR LAYER AND A SLENDER BODY
PARVIZ MERATI (Western Michigan University, Kalamazoo) and RONALD J. ADRIAN (Illinois, University, Urbana) International Journal of Heat and Fluid Flow (ISSN 0142-727X), vol. 12, no. 4, Dec. 1991, p. 315-322. refs
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The behavior of a shear layer in the neighborood of a thin flat plate is investigated for the cases of different angles of attack and for shear layers changed by the values of plate offset and length. A single stream is split with a plate into two streams in a two-stream plane shear-layer wind tunnel, and the pressure of the lower stream is reduced. Flow photographs are examined, and spectrum and hot-wire-probe measurements are taken to determine streamwise and cross-streamwise velocities. The flat plate is shown to interact with the shear layer by: (1) generating large vertical velocities at the plate's leading-edge stagnation point; (2) affecting a region 30 times plate thickness at zero angle of attack; and (3) generating a high-pressure field at the stagnation region that deflects the mixing layer toward the slower stream at large angles of attack. C.C.S.

A92-50039
A CONCENTRATION PROBE FOR THE STUDY OF MIXING IN SUPERSONIC SHEAR FLOWS
T. A. NINNEMANN and W. F. NG (Virginia Polytechnic and State University, Blacksburg) Experiments in Fluids (ISSN 0723-4864), vol. 13, no. 2-3, 1992, p. 98-104. Research supported by Johns Hopkins University. refs
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An aspirating hot-film probe is developed to measure local mean gas composition in supersonic flows. The probe consists of a constant temperature hot-film sensor operating in a channel with a choked exit. Thus, the flow over the hot film is influenced only by total temperature, total pressure, and gas concentration. The use of the probe requires a separate measurement of the total temperature in the gas flow. The probe has a spatial resolution of 0.011 in. and shows acceptable sensitivity to flow angularity. The probe is used in the study of an unheated supersonic air/helium mixing layer in a 23 cm x 23 cm supersonic wind tunnel. Data are presented in raw form and after reduction to concentration and mean flow quantities. Author

A92-50040* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FULL FIELD FLOW VISUALIZATION AND COMPUTER-AIDED VELOCITY MEASUREMENTS IN A BANK OF CYLINDERS IN A WIND TUNNEL
M. J. BRAUN, V. A. CANACCI (Akron, University, OH), and L. M. RUSSELL (NASA, Lewis Research Center, Cleveland, OH) Experiments in Fluids (ISSN 0723-4864), vol. 13, no. 2-3, 1992, p. 117-127. refs
(Contract NCC3-165)
Copyright

The full field flow tracking (FFFT) method that is presented in this paper uses a laser-generated, mechanically strobed planar sheet of light, a low luminosity TV camera coupled with a long distance microscope, and a computer-controlled video recorder to study nonintrusively and qualitatively the flow structures in a bank of cylinders that are placed in a wind tunnel. This setup simulates an upscale version of the geometry of internal cooling passageways characteristic of small air-cooled radial turbines. The qualitative images supplied by the FFFT system are processed by means of a computer-integrated image quantification (CIIQ) method into quantitative information, trajectories and velocities, that describe the flow upstream of and within the bank of cylinders. The tracking method is Lagrangian in concept, and permits identification and tracking of the same particle, thus facilitating construction of time dependent trajectories and the calculation of true velocities and accelerations. The error analysis evaluates the accuracy with which the seed particles follow the flow and the errors incurred during the quantitative processing of the raw data derived from the FFFT/CIIQ method. Author

A92-50137
THE ROLE OF PM IN THE DESIGN OF LIGHTWEIGHT AIRCRAFT ENGINE COMPONENTS
GERALD FRIEDMAN (Precision Castparts Corp., P/M Pilot Plant, Cleveland, OH) IN: 1991 P/M in aerospace and defense technologies; Proceedings of the Symposium, Tampa, FL, Mar. 4-6, 1991. Princeton, NJ, Metal Powder Industries Federation, 1991, p. 273-279. refs
Copyright

A novel class of net-shape gas turbine engine components characterized by hollow cores and thin, variable-thickness walls, is presently shown to be manufacturable on the basis of HIP consolidation of spherical prealloyed powder in precisely configured canisters. The metallurgical and mechanical properties thus obtained are conventionally associated with forgings (although forgings are not net-shape) and sheet metal fabrications (although fabrications are more complex and heavy). The seamless metal canisters used for HIPing contain steel cores and are derived from lost-wax process patterns. The components thus obtained are lighter than castings or fabrications, and require no machining. O.C.

A92-50204
CALCULATION OF FUEL SLOSHING AND ITS COUPLING VIBRATION WITH A TANK
SHULING SUN, YUQI LIU, ANNING ZHOU (Chinese Helicopter Research and Development Institute, People's Republic of China), ZHENXING FENG, BIQUAN YE, and CHENGWU SHEN (Wuhan University, People's Republic of China) Chinese Journal of Aeronautics (ISSN 1000-9361), vol. 4, no. 3, Aug. 1991, p. 279-286. refs
Copyright

The response of fuel-tank-sloshing to aircraft maneuver is a difficult mathematical problem to solve. Beginning by setting up the mechanical model and the respective mathematical model, this paper uses both FE and BEM to imitate the sloshing process. The paper has developed some special techniques to deal with strong nonlinear characteristics and provides satisfactory numerical results of displacements and stress for low frequency, resonance, high-frequency and fuel tank dynamic-response characteristics. The program not only assures convergence and stability of the solution, but also has the function of graphic display. It is a valuable technique to deal with the strong nonlinear oscillations of fuel tanks with large amplitudes and moving boundary conditions on free surfaces. Author

A92-50239
COMBINED APPLICATION OF THE ENERGY METHOD AND THE WEIGHTED RESIDUAL METHOD - A NEW WAY TO CONSTRUCT THE FINITE ELEMENTS
YU-QIU LONG and JUN-QING ZHAO (Tsinghua University, People's Republic of China) Chinese Journal of Aeronautics (ISSN 1000-9361), vol. 5, no. 2, May 1992, p. 130-136. refs
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In this paper, a new way to construct the finite elements by combined application of the energy method and the weighted residual method - EWR method is proposed. Firstly, the condition of displacement compatibility is relaxed by means of the method of weighted residuals. As a result, only one kind of variable (displacement) remains in the variational principle, as the energy item caused by the incompatible displacement no longer exists. Secondly, since the method of weighted residuals used here is considered relating to the energy functional, it is easy to give the weighted residual equation an obvious physical explanation. Thus,

if the weighted function is chosen properly, the satisfaction of the weighted residual equation will be equivalent to the element convergence criterion. Moreover, all the existing displacement-based elements can be derived from the proposed EWR method by changing the weighted functions. Author

A92-50448
OPTIMIZATION OF A THERMALLY NON-SYMMETRIC FIN - PRELIMINARY EVALUATION
D. C. LOOK, JR. and H. S. KANG (Missouri-Rolla, University, Rolla) International Journal of Heat and Mass Transfer (ISSN 0017-9310), vol. 35, no. 8, Aug. 1992, p. 2057-2060. refs
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An optimization procedure is presented for the heat loss from a rectangular 2D fin as a function of the fin ratio when the convection coefficients are constant but not equal. It is noted that the relationship between the fin ratio and the fin's usefulness is of particular importance. O.G.

A92-50553
NEXT GENERATION POWER ELECTRONICS FOR SPACE AND AIRCRAFT. II - PACKAGING
ARTHUR IVERSEN (Coriolis Corp., Saratoga, CA) IN: IECEC '91; Proceedings of the 26th Intersociety Energy Conversion Engineering Conference, Boston, MA, Aug. 4-9, 1991. Vol. 1. La Grange Park, IL, American Nuclear Society, 1991, p. 177-182. refs
Copyright

A class of semiconductor packaging incorporating a novel type of heat exchange process is described. The packaging technology is characterized by high power density, 0.005 kg/kW with beryllium construction, low junction to fluid specific thermal resistance 0.1-0.3 C/W(sq cm) for lower junction temperatures, and consequent improved reliability and increased efficiency, and rugged, hermetic, and low-cost construction. A curved surface cooling technology is incorporated into several package designs. Initial experiments with curved surface cooling have demonstrated a dissipation of 472 W/sq cm at rated junction temperature (150 C) for power MOSFETs. More important for high-reliability and high-efficiency applications is the demonstrated 60 C junction temperature at 200 W/sq cm dissipation. The packaging technology is substantially device transparent. I.E.

A92-50611
BOILING AND CONDENSING PUMPED LOOP MICROGRAVITY EXPERIMENT - CHALLENGES OF TESTING IN BOTH AIRCRAFT AND ROCKET ENVIRONMENTS
VAUGHN H. STANDLEY and JERRY F. FAIRCHILD (USAF, Kirtland AFB, NM) IN: IECEC '91; Proceedings of the 26th Intersociety Energy Conversion Engineering Conference, Boston, MA, Aug. 4-9, 1991. Vol. 2. La Grange Park, IL, American Nuclear Society, 1991, p. 56-60. Research supported by Sandia National Laboratories. refs
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The two-phase experiment (TPE) was conducted to demonstrate long-term operation of a two-phase pumped loop thermal system in microgravity and to compare data obtained in ground, aircraft, and rocket tests. The TPE was subject to two key constraints. Visual data, normally recorded in two-phase experiments, were absent and approximate equilibrium during aircraft tests were required. The first challenged investigators to provide for and measure substantial two-phase flow in the TPE during ground, aircraft, and rocket tests by using indirect methods. Although two-phase flow is shown to occur, errors associated with estimates of vapor fraction are high. The second required that the loop components be coplanar and properly oriented in the aircraft and that the loop velocity be sufficiently high to minimize the time required to reach equilibrium. As shown in the aircraft tests, characteristic times of transients caused by low gravity were much shorter than loop times. I.E.

A92-50771
IECEC '91; PROCEEDINGS OF THE 26TH INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, BOSTON, MA, AUG. 4-9, 1991. VOL. 5 - RENEWABLE RESOURCE SYSTEMS, STIRLING ENGINES AND APPLICATIONS, SYSTEMS AND CYCLES
Conference sponsored by SAE, ANS, IEEE, et al. La Grange Park, IL, American Nuclear Society, 1991, 562 p. For individual items see A92-50772 to A92-50810.
(ISBN 0-89448-163-0) Copyright

Various papers on energy conversion enegineering are presented. The general topics considered are: developments in nuclear power, energy from waste and biomass, system performance and materials in photovoltaics, solar thermal energy, wind energy systems, Stirling cycle analysis, Stirling cycle power, Stirling component technology, Stirling cooler/heat pump developments, Stirling engine concepts, Stirling engine design and optimization, Stirling engine dynamics and response, Stirling engine solar terrestrial, advanced cogeneration, AMTC, fossil fuel systems and technologies, marine energy. C.D.

A92-50785
REDUCTION OF TORQUE PULSATION OF STIRLING ENGINE-COMPRESSOR SYSTEM
TOSHIHIDE KODA, MICHIO FUJIWARA, and TAKUYA SUGANAMI (Mitsubishi Electric Corp., Central Research Laboratory, Amagasaki, Japan) IN: IECEC '91; Proceedings of the 26th Intersociety Energy Conversion Engineering Conference, Boston, MA, Aug. 4-9, 1991. Vol. 5. La Grange Park, IL, American Nuclear Society, 1991, p. 251-255. Research sponsored by MITI. refs
Copyright

The refrigerant compressor driven by a Stirling engine is built into the heat pump system. The Stirling engine-compressor unit generates rolling vibration due to a fluctuation in combined torque. In order to reduce the rolling vibration, the torque characteristics and the linkage construction of the crankshafts are investigated. The investigation was undertaken for the beta-displacer-type and the two-piston-type configurations. In addition to the Stirling engine, a four-stroke internal combustion engine was considered as a reference. When the Stirling engine drives the compressor, the vibration characteristics depend on its linkage construction. The combined torque which caused the rolling vibration was calculated on the Stirling engine-compressor unit. I.E.

A92-50795
LOWER-END DYNAMIC CHARACTERISTICS OF A MAGNETICALLY COUPLED FREE-PISTON STIRLING ENGINE/COMPRESSOR SYSTEM
G. CHEN and J. MCENTEE (Sunpower, Inc., Athens, OH) IN: IECEC '91; Proceedings of the 26th Intersociety Energy Conversion Engineering Conference, Boston, MA, Aug. 4-9, 1991. Vol. 5. La Grange Park, IL, American Nuclear Society, 1991, p. 326-330. Research supported by DOE. refs
Copyright

In a prototype, the engine power piston is connected to the compressor piston through a magnetic coupling; a linear starter is used to start the system and a variable-stiffness gas spring is used to resonate the system lower-end over the operating frequency range of the system. System characteristics of the lower end coupled through the coupling to the engine, and considerations of the engine response, are investigated analytically with a simplified model. The system analysis is also used to obtain an understanding of the free-piston Stirling engine/magnetic coupling/compressor assembly dynamic behavior for variations in engine power and lower-end resonance. In order for the machine to operate without excessively large forces transmitted through the magnetic coupling, the analysis indicates that both the engine and the compressor section should be independently resonant to keep the engine and the lower-end oscillating amplitude identical. I.E.

A92-50860
FAILURE ANALYSIS AND RELIABILITY IMPROVEMENT OF SMALL TURBINE ENGINE BLADES
H. K. SHEE, H. Y. CHEN, and T. W. YANG (Chung Shan Institute of Science and Technology, Lungtan, Republic of China) Engineering Fracture Mechanics (ISSN 0013-7944), vol. 42, no. 5, July 1992, p. 841-852. refs
Copyright

Analysis and testing procedures for small turbine engines are presented which are aimed at verifying the critical failure modes and improving the performance, reliability, and safety of operating engine blades. These procedures include metallographic examination; chemical ingredient, vibration, modal, and stress analyses; fatigue life prediction; and modal testing with and without coating. It is demonstrated that, for small turbine engine under consideration, the most probable failure mode is the fatigue fracture rather than the creep fracture. An approach based on the reduction of the number of stators from 17 to 14 is found to be the most beneficial for improving the fatigue performance and reliability of engine blades as compared to the surface coating and high strength material approaches. This approach removes vibrational frequencies of the turbine engine from the operating frequencies, thus significantly reducing the vibrational level of engine blades. O.G.

A92-51014
COMPARISON OF HEMISPHERICAL RESONATOR GYRO AND OPTICAL GYROS
A. MATTHEWS and F. J. RYBAK (Delco Systems Operations, Goleta, CA) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 7, no. 5, May 1992, p. 40-46. refs
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The basic design of the small Hemispherical Resonator Gyro (HRG) inertial and tactical grade sensors and associated electronics is described focusing on digital control and processing techniques. The HRG technology to-date exhibits highly competitive nature against Ring Laser Gyro and Fiber Optic Gyro sensors. O.G.

A92-51311
ALL-UNION CONFERENCE ON OPTICAL METHODS OF FLOW RESEARCH, 1ST, NOVOSIBIRSK, RUSSIA, APR. 1991, PROCEEDINGS [VSESOIUZNAIA KONFERENTSIIA PO OPTICHESKIM METODAM ISSLEDOVANIIA POTOKOV, 1ST, NOVOSIBIRSK, RUSSIA, APR. 1991, DOKLADY]
Sibirskii Fiziko-Tekhnicheskii Zhurnal (ISSN 0869-1339), no. 2, Mar.-Apr. 1992, 136 p. In Russian. For individual items see A92-51312 to A92-51325.
Copyright

The papers presented in this volume provide an overview of theoretical and experimental recent research related to the development and application of optical method for measuring the kinematic, structural, and thermodynamic parameters of flows of gases and condensed media. Topics discussed include systems for the optical diagnostics of flow dynamics and phase structure, integral Doppler anemometry, determination of the dynamic characteristics of nonstationary gas flows by interferometric methods, and visualization of hydrodynamic processes. Papers are also presented on using speckle photography in an aerophysical experiment, spectroscopic studies in a nonequilibrium hypervelocity gas flow, and determination of plasma flow velocity from the droplet shape. V.L.

A92-51316
PROCESSING OF AXISYMMETRIC FLOW INTERFEROGRAMS WITH DENSITY PROFILE BENDS OR DISCONTINUITIES [OB OBRABOTKE INTERFEROGRAMM OSESIMMETRICHNYKH POTOKOV PRI NALICHII IZLOMOV ILI RAZRYVOV PROFILIA PLOTNOSTI]
K. V. LYSENKO (NII Khimicheskogo Mashinostroeniia, Zagorsk, Russia) (Vsesoiuznaia Konferentsiia po Opticheskim Metodam Issledovaniia Potokov, 1st, Novosibirsk, Russia, Apr. 1991, Doklady. A92-51311 21-35) Sibirskii Fiziko-Tekhnicheskii Zhurnal (ISSN 0869-1339), no. 2, Mar.-Apr. 1992, p. 40-42. In Russian. refs
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An improved method is proposed for solving the delta-function equation used in reconstructing the refraction index field from interferograms with fringe discontinuities. In accordance with the approach proposed here, additional integration is used to substitute a function with a bend for a function with a discontinuity. This method makes it possible to improve the solution of the problem by enhancing the smoothness of functions resulting from the integration and by equalizing indeterminacies in the right terms of the equations. V.L.

A92-51409* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
THERMAL-STRUCTURAL PANEL BUCKLING TESTS
RANDOLPH C. THOMPSON (PRC, Inc., Edwards, CA) and W. L. RICHARDS (NASA, Flight Research Center, Edwards, CA) IN: Structural testing technology at high temperature; Proceedings of the Conference, Dayton, OH, Nov. 4-6, 1991. Bethel, CT, Society for Experimental Mechanics, Inc., 1991, p. 46.
Copyright

A titanium-matrix-composite (TMC) hat-stiffened panel of 61 cm sq area and 3.175 cm thick was nondestructively tested to 649 C to examine its buckling characteristics. Compressive loads were applied to the panel in a 978.6 kN uniaxial load frame system. High-temperature testing was performed using quartz lamp heating. A single-strain-age force/stiffness buckling prediction technique was developed to predict panel buckling loads. For the monolithic panel, these test predictions correlated within 10 percent with a finite-element buckling analyses performed elsewhere. Comparisons between force/stiffness predictions and analyses for the TMC panel are in progress. I.S.

A92-51438
RISK MANAGEMENT - EXPANDING HORIZONS IN NUCLEAR POWER AND OTHER INDUSTRIES
RONALD A. KNIEF, ED. (ERC Environmental and Energy Services Co., Mechanicsburg, PA), VICTORIA B. BRIANT, ED., ROBERT B. LEE, ED., ROBERT L. LONG, ED., and JEFFREY A. MAHN, ED. (GPU Nuclear Corp., Parsippany, NJ) New York, Hemisphere Publishing Corp., 1991, 283 p. For individual items see A92-51439 to A92-51441.
(ISBN 1-56032-231-4) Copyright

Topics presented include lessons learned from man-made catastrophes, airline industry safety management systems and feedback, an integrated approach to safety, including the human factors element, and risk sensitivity to human error. Also presented are human reliability methods for enhancing performance, the integrated use of probabilistic safety assessment in reactor design, risk-based plant performance indicators, and a framework for systematic risk management. R.E.P.

A92-51505
ADVANCED EXPERIMENTAL DESIGN APPLIED TO DAMAGE TOLERANCE OF COMPOSITE MATERIALS
TODD SACZALSKI, BRAD LUCHT, and DOUG STEEB (General Dynamics Corp., Space Systems Div., San Diego, CA) IN: International SAMPE Technical Conference, 23rd, Kiamesha Lake, NY, Oct. 21-24, 1991, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 38-50. refs
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This paper focuses on a factorial-based design strategy. The approach provides an efficient and statistically reliable means for assessing the influence of multivariable effects. It is applied to the detection and evaluation of damage in impacted composite sandwich panels. The experimental results obtained from this test strategy are utilized to form an empirical response function. The resulting polynomial relates damage area to residual compression strength at values of independent variables for which testing did not occur. The response function also identifies nonlinear interaction effects of key variabes that cannot be easily ascertained by traditional single-variable test strategies. Independent variables

evaluated include core thickness, number of face sheet plys and impact energy. The methodology presented allows the designer to predict with more confidence the damage tolerance of a composite material component, and the analyst to more accurately assess the effect of any damage that does occur. Author

A92-51513
KGR-1 THICK ADHEREND SPECIMEN EVALUATION FOR THE DETERMINATION OF ADHESIVE MECHANICAL PROPERTIES
CHRISTOS KASSAPOGLOU and JOHN C. ADELMANN (Sikorsky Aircraft, Stratford, CT) IN: International SAMPE Technical Conference, 23rd, Kiamesha Lake, NY, Oct. 21-24, 1991, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 162-176. refs
Copyright

The KGR-1 measuring device and the corresponding thick adherend specimen design used to determine adhesive shear properties are examined using a test program and finite element analysis. While affirming the overall value of this approach, it is found that the specimen geometry and materials will give nonuniform shear stress distributions for some adhesive thicknesses and stiffnesses. This nonuniformity introduces inaccuracies in the calculations of adhesive properties. Further inaccuracies may be introduced by using a dummy specimen without adhesive to correct for the adherend deformation. Finally, motion of the measuring pins relative to the adherend during testing may also lead to erroneous results. The objective of this paper is to improve user value of the KGR-1 procedure by providing recommendations for minimizing the sources of inaccuracies.
Author

A92-51537
RTM - SIMULTANEOUS DESIGN AND TOOLING REDUCES COST AND LEAD TIME
WAYNE BECKER (Wichita State University, KS) IN: International SAMPE Technical Conference, 23rd, Kiamesha Lake, NY, Oct. 21-24, 1991, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 601-608.
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Resin transfer molding (RTM) is a highly efficient aircraft composite structure production process for which tool and process design must be conducted concurrently with structural component design. These processes are presently illustrated for the RTM production of a private-aircraft vertical fin fairing. Although tool costs are higher than those of alternative methods, RTM led to lower raw materials cost per component, fewer expendable materials, reduced parts counts, and the extension of mold control to both inner and outer surfaces of the component. O.C.

A92-51545
INDUCTION BONDING PROCEDURES FOR GRAPHITE REINFORCED THERMOPLASTIC ASSEMBLIES
J. MAHON, C. RUTKOWSKI, and W. OELCHER (Grumman Corp., Aircraft Systems Div., Bethpage, NY) IN: International SAMPE Technical Conference, 23rd, Kiamesha Lake, NY, Oct. 21-24, 1991, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 724-738.
(Contract F33615-86-C-5008; F33615-83-C-3253)
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Three T650-42/PAS-2 graphite-reinforced thermoplastic (Gr/TP) demonstration components representative of an F-111A horizontal stabilizer leading edge were successfully fabricated and destructively tested. Two of these components were assembled by induction bonding using 3M AF-191 film adhesive and vacuum bag pressure. The third component was joined using the current industry baseline process, autoclave co-consolidation. The three rib components were machined to provide two rib test elements which were tested in four-point beam bending at ambient temperature. Prior to testing, one of the induction-bonded elements was deliberately damaged and then repaired. Structural test results for the Gr/TP components were compared to corresponding data developed for graphite/bismaleimide (Gr/BMI) leading edge test elements fabricated for an earlier Air Force funded program. This comparison and preliminary cost analysis indicated the potential cost effectivity and structural efficiency of induction-bonded Fr/TP hardware. Author

A92-51546
CHARACTERIZATION OF STAINLESS STEEL PRETREATMENTS FOR ADHESIVE BONDING
G. B. GASKIN and S. R. BROWN (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: International SAMPE Technical Conference, 23rd, Kiamesha Lake, NY, Oct. 21-24, 1991, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 739-750. Research supported by U.S. Army. refs

This study determines significant process factors contributing to adhesive/stainless steeel interface performance, and develops a single, reliable prebond process for stainless steels. Mechanical analysis, SEM, and durability tests were performed to characterize the processes. Both low chromium and high chromium austenitic steels as well as a precipitation hardened stainless steel were used in determining pretreatment effectiveness. The results of the study conducted to determine the most effective adhesive bonding pretreatment for stainless steels are discussed. Author

A92-51626
CLOSE-RANGE PHOTOGRAMMETRY MEETS MACHINE VISION; PROCEEDINGS OF THE MEETING, ZURICH, SWITZERLAND, SEPT. 3-7, 1990
ARMIN GRUEN, ED. and EMMANUEL P. BALTSAVIAS, ED. (*Zuerich, Eidgenoessische Technische Hochschule, Zurich,* Switzerland) Meeting sponsored by International Society for Photogrammetry and Remote Sensing and Swiss Federal Institute of Technology of Zurich. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Vol. 1395, pts. 1 & 2), 1990, p. Pt. 1, 670 p.; pt. 2, 602 p. For individual items see A92-51627 to A92-51664.
(SPIE-1395; ISBN 0-8194-0441-1) Copyright

The present conference addresses topics arising from such issues in photogrammetry as the development status of metric vision systems, the integration of photogrammetry with CAD and with CAD/CAM systems, CCD-camera performance and calibration, low cost photogrammetric methods, algorithmic aspects in image analysis, analog cameras, digitization and calibration, robot vision and real-time tracking, photogrammetry for industrial measurement, and systems for image analysis and surface reconstruction. Also discussed are the processing of large-scale aerial photographs, hardware architectures for real-time image synthesis and analysis, 3D medical imaging and microscopy, special recording systems and recording procedures, archeological applications, benefits of image analysis/synthesis, biological surface measurements and motion analysis, and digital photogrammetry for industrial measurement. O.C.

A92-51649
THE USE OF PHOTOGRAMMETRY IN AVIATION EQUIPMENT FLIGHT TESTING
KIRA ALBAKIAN (Flight Research Institute, Zhukovski, Russia) IN: Close-range photogrammetry meets machine vision; Proceedings of the Meeting, Zurich, Switzerland, Sept. 3-7, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 830-836.
Copyright

Information on the application of the photogrammetric (PG) method in the flight testing of aviation equipment is summarized. A variety of different approaches are discussed, with reference to specific flight experiment conditions, and special features, advantages, drawbacks, and accuracy characteristics. Results are presented of the repeated application of the PG method for evaluating the accuracy characteristics of various navigation systems and sensors, based on different physical principles. The efficiency of using the PG method in flight-navigation-equipment flight testing is shown. L.M.

A92-51845
PERFORMANCE OF A HYBRID CYLINDRICAL ROLLER BEARING
STEPHEN M. SCHRADER (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) (STLE and ASME Tribology Conference, Saint Louis, MO, Oct. 14-16, 1991) Lubrication Engineering (ISSN 0024-7154), vol. 48, no. 8, Aug. 1992, p. 665-672. refs
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A 206-size hybrid (ceramic/steel) cylindrical roller bearing was tested in MIL-L-23699 C oil at several speeds and loads. Heat-generation data was collected and subsequently correlated with bearing-analysis software. Bearing-cage slip data was also collected at various oil-flow rates, oil temperatures, and with both MIL-L-7808 J and MIL-L-23699 C oils. The hybrid bearing was tested in MIL-L-23699 C oil for for 25 hours at 2220 N radial load and 1.08 MDN shaft speed. The hybrid bearing technology demonstrated in the report is applicable to the Integrated High Performance Turbine Engine Technology Initiative. Author

A92-51895
THE STATIC AND FATIGUE COMPUTATION OF THE PROPELLER BLADES RETENTION SYSTEM
OLGA MARTIN (Polytechnic Institute, Bucharest, Romania) Revue Roumaine des Sciences Techniques, Serie de Mecanique Appliquee (ISSN 0035-4074), vol. 37, no. 1, Jan.-Feb. 1992, p. 47-57. refs

The static and the fatigue computation of the propeller blades retention system to the monobloc hub with four blades is considered. The retention system contains a three-row ball bearing. The steel balls in parallel circumferential rows are placed around the blade root and are working along raceways of the blade retaining socket and those of the barrel. Author

A92-51925
DETAILED INVESTIGATION OF CAUSES OF AVIONICS FIELD FAILURES
J. M. KALLIS, D. W. BUECHLER, Z. C. RICHARDSON, P. G. BACKES, S. B. LOPEZ, J. J. ERICKSON, and D. H. VAN WESTERHUYZEN (Hughes Aircraft Co., El Segundo, CA) IN: International SAMPE Electronics Conference, 5th, Los Angeles, CA, June 18-20, 1991, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 526-542. refs
(Contract F33615-87-C-3403)
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A detailed analysis of digital and analog modules from the F-15 AN/APG-63 Radar was performed to identify the kinds, types, and number of life models based on observed failure modes, mechanisms, locations, and characteristics needed to perform a Failure Free Operating Period prediction for these items. It is found that a significant fraction of the failures of the analog module and a small fraction of those of the digital module resulted from the exacerbation of latent defects by environmental stresses. It is also found that the fraction of failures resulting from thermal cycling and vibration is small. V.L.

A92-51950
DISCS LOW CYCLE FATIGUE LIFE PREDICTIONS FOR GAS TURBINE ENGINES IN CSFR BY USING FRACTOGRAPHIC INFORMATION
JIRI STATECNY, JAN DREXLER, and ANTONIN JANAK Zprava VZLU, no. Z-64, 1991, p. 1-18. refs
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Besides the conventional SL (Safe Life) philosophy for disk cyclic life predictions, the DT (Damage Tolerance) philosophy starts to be used in connection with the RFC (Retirement for Cause) strategy. The present paper is aimed especially at the certification demonstrations proofs. The use of advanced life prediction approaches is quite dependent on a reliable NDIT (Nondestructive Inspection Technique). Therefore the reliability of the information gained by NDI macrographic findings during the LCF (Low Cycle Fatigue) tests must be verified by micrographic analysis of the failed components. The approach used in ARTI and some experience from tests are presented. Several models have been developed in ARTI in recent years as a means for life prediction on a probabilistic basis. A new one is presented which may be useful for disks with critical circumferentially shaped concentrators. Author

A92-52470* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
INERTIAL NAVIGATION SENSOR INTEGRATED MOTION ANALYSIS FOR AUTONOMOUS VEHICLE NAVIGATION
BARRY ROBERTS and BIR BHANU (Honeywell Systems and Research Center, Minneapolis, MN) (IEEE, Special Workshop on Passive Ranging, Princeton, NJ, Oct. 10, 1991) Journal of Robotic Systems (ISSN 0741-2223), vol. 9, no. 6, Sept. 1992, p. 817-842. refs
(Contract NAS2-12800)
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Recent work on INS integrated motion analysis is described. Results were obtained with a maximally passive system of obstacle detection (OD) for ground-based vehicles and rotorcraft. The OD approach involves motion analysis of imagery acquired by a passive sensor in the course of vehicle travel to generate range measurements to world points within the sensor FOV. INS data and scene analysis results are used to enhance interest point selection, the matching of the interest points, and the subsequent motion-based computations, tracking, and OD. The most important lesson learned from the research described here is that the incorporation of inertial data into the motion analysis program greatly improves the analysis and makes the process more robust. L.M.

A92-52722
BROWNIAN-MOTION LIMITED AERODYNAMIC FOCUSING OF HEAVY MOLECULES
R. FERNANDEZ-FERIA, P. RIESCO-CHUECA (E.T.S.I.I., Seville, Spain), J. ROSELL-LLOMPART, J. O'BRIEN, and J. FERNANDEZ DE LA MORA (Yale University, New Haven, CT) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 214-221. refs
(Contract DE-FG02-87ER-13750; NSF CBT-88-12070; NSF CBT-88-09548; DAAL03-87-K-0127)
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Thermal agitation is the major phenomenon limiting how narrowly a beam of heavy molecules suspended in a light carrier gas can be focused by acceleration through a converging nozzle. Here, the problem is studied numerically by two different methods: hypersonic theory and Brownian dynamics simulation, with a good agreement between both. A near-axis simplification of the hypersonic equations yields the focusing characteristics of inviscid two-dimensional flows in nozzles with straight walls converging at various angles. Author

A92-52763
RAREFIED GAS NUMERICAL WIND TUNNEL
KATSUHISA KOURA (National Aerospace Laboratory, Chofu, Japan), EMI KANEMATSU, and YUKIKO KIMURA (Fujitsu, Ltd., Tokyo, Japan) IN: Rarefied gas dynamics; Proceedings of the 17th International Symposium, Aachen, Germany, July 8-14, 1990. Weinheim, Germany and New York, VCH Verlagsgesellschaft mbH, 1991, p. 663-670. refs
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The 'rarefied gas numerical wind tunnel' (RGNWT) is constructed using the null-collision (NC) direct-simulation Monte Carlo (DSMC) method for the simulation of rarefied gas flows around a two- or three-dimensional whole flight body. The NC-DSMC method is efficient in the simulation of 2D or 3D flows, because its lower limit of the mean molecular number per collision cell is as small as one and its computation time is comparable with that for the time-counter DSMC method. The computation domain, collision, and data cells are taken as rectangular solids. In the present paper, the RGNWT results without real gas effects

are presented for a 2D circular cylinder and a 3D flat-plate delta wing at a large angle of attack. The effects of the collision-cell size, time step, and molecular number per data cell on RGNWT results are investigated for the circular cylinder. Author

A92-52981
PSEUDOSTREAM FUNCTION FORMULATION - A METHOD OF SOLVING THREE-DIMENSIONAL AERODYNAMIC ANALYSIS AND DESIGN PROBLEMS IN TURBOMACHINERY
JIAN-ZHONG XU, CHUN-WEI GU, JIAN-CHENG SHI, and JIAN-YI DU (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, China) Science in China, Series A - Mathematics, Physics, Astronomy and Technological Sciences (ISSN 1001-6511), vol. 35, no. 3, March 1992, p. 344-355. refs
Copyright

Two pseudostream functions are defined in view of the characteristic features of the momentum equations and the requirement of continuity. The principal equations of pseudostream functions only contain the terms of its own second-order partial derivatives and do not include those of the other. The entire 3D solution is then obtained through solving the principal equations of both pseudostream functions separately and iterating the two solutions. The principal equations of the pseudostream functions in a nonorthogonal curvilinear coordinates are given with the corresponding boundary conditions. The 3D aerothermodynamic analysis problem and design problem are discussed, and the results are compared with the analytical solution and other methods. This method is accurate in theory and simple in computation, and can be widely used in 3D flow calculations. Author

A92-53011
FINITE ANALYTIC NUMERICAL SOLUTION OF NAVIER-STOKES EQUATIONS
DIAO XU and GUOCHUAN WU (Nanjing Aeronautical Institute, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 11, Nov. 1991, p. A568-A574. In Chinese. refs

The finite analytic method is used here in this study to calculate the turbulent flow field described with Navier-Stokes equations in body-fitted curvilinear coordinate system. The finite analytic method invokes the analytic solution of governing particle differential equations in formulating the algebraic equation that relates a nodal value in an element to its neighboring nodal values. The good numerical stability and accuracy of the method is shown. The turbulent flow fields through a single cascade of airfoils and a tandem cascade of airfoils are numerically simulated by a finite analytic method together with the k-epsilon turbulence model and wall function method. Good agreement is found between the numerical solution and the experimental results. C.D.

A92-53013
ANTI-FATIGUE OPTIMIZATION DESIGN BY ARTIFICIAL INTELLIGENCE STRATEGY
BIN XING (Air Force College of Engineering, China) and QINGXIONG YANG (Northwestern Polytechnical University, Xian, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 11, Nov. 1991, p. A579-A583. In Chinese. refs

The artificial intelligence strategy is applied to the optimum antifatigue design of structural details. A set of approaches quite different from the traditional mathematical programming method is put forward. By setting up a state space of discrete design variables to which the intelligence search strategy is applied, the integralization of discrete variables can be avoided. An example of optimum antifatigue design for a typical structure detail of aircraft is worked out using the present method. Comparison between the results obtained by this method and those obtained by the mathematical programming method shows that the present method is better. Verification experiments conducted by the author show that the method proposed is feasible and reliable. Author

A92-53015
MIXING FOR MULTI-STAGE AXIAL-FLOW COMPRESSORS
SHIMING LI and MAOZHANG CHEN (Beijing University of Aeronautics and Astronautics, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 11, Nov. 1991, p. A592-A599. In Chinese. refs

A set of equations has been derived for through-flow fields in multistage axial-flow compressors, and all the spanwise mixing effects in a unified form are presented, including both turbulence and secondary flows. The relations have been discussed between 3D shear structures of the compressors' flow fields and the turbulent mixing effects in the 2D throughflow fields. It has been found that the turbulent mixing in the 2D throughflow fields is determined by the 3D shear structures, rather than the 2D shear structures alone. From the comparison of the computational results of the equations and experimental results as well as the results of Gallimore's mixing calculations, it has been shown that the characteristics of spanwise mixing can be modeled better by applying these equations. Author

A92-53055
EXPERIMENTAL INVESTIGATION ON FLUTTER CHARACTERISTICS OF COMPOSITE TORSION-BOX
FENGHUI ZHU and TAO QIU (Shenyang Aircraft Research Institute, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 12, Dec. 1991, p. B550-B553. In Chinese. refs

An experimental investigation on flutter characteristics of a composite torsion-box is presented. Vibration test, wind tunnel flutter test, and the corresponding calculations are conducted. Two models of the same frame are tested, one of them covered with composite skin, the other with aluminum alloy skin of the same thickness. Experimental and calculated date indicate that, for the model with composite skin, the flutter speed is 16.7 percent higher than that with aluminum alloy skin, and the weight of the torsion-box is 17.7 percent lower. Author

A92-53067
DAMAGE TOLERANCE AND DURABILITY DESIGN OF COMPOSITE AIRCRAFT STRUCTURES
ZHEN SHEN, XIAODONG TANG, and PUHUI CHEN (Aircraft Strength Research Institute, Yaoxian, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 12, Dec. 1991, p. B620-B622. In Chinese. refs

Based on the previous researches, a design approach to damage tolerance and durability of composite aircraft structures is proposed. That is, (1) the main object for damage tolerance design is impact damage; (2) the basis of damage tolerance design is to choose barely visible impact damage as the initial defect; and (3) the main approach to satisfying the damage tolerance requirements is to limit the design allowables, and the determination of the design allowables is based on the impact damage failure curves. Generally speaking, the aircraft structures which are designed based on the residual strength consideration stated above might automatically satisfy the durability requirement and the damage no-growth design concept. Author

A92-53070
SAFETY FACTOR AND RELIABILITY FOR COMPOSITE LAMINATES
LING YANG, ZUKANG MA (Northwestern Polytechnical University, Xian, China), and GUOZHENG FU (Institute of Aero Structure Thermal Strength, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 12, Dec. 1991, p. B631-B634. In Chinese. refs

A concept is proposed of a comprehensive safety factor for composite laminates, based on reliability analysis. This reliability-based safety factor relates to the disperse degrees of strength and load and to the value of required reliability. Several failure modes of the laminate, the different load groups, and the effect of structural parameters on this reliability-related safety factor are considered. It is shown that the application of this comprehensive safety factor is as convenient as that of the general safety factor f. I.S.

A92-53071
STUDY OF DYNAMIC STRENGTH ON COMPOSITE WING

LIANZHU HE (Shenyang Aircraft Research Institute, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 12, Dec. 1991, p. B635-B638. In Chinese. refs

The analysis of dynamic characteristics of the composite wing, its dynamic response due to missile launching, and impact response during landing by impact loads is presented. The design of laying lamina has been improved based on local vibration phenomenon that appeared in analysis of the dynamic characteristics. Hence, it ensures the requirements of dynamic strength during the design of composite wings to be met. Author

A92-53074
DESIGN VARIABLES AND CONSTRAINT DERIVATIVES IN AEROELASTIC TAILORING
PING GAO and ZHILONG ZHANG (Beijing University of Aeronautics and Astronautics, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 12, Dec. 1991, p. B647-B650. In Chinese.

Two important point in aeroelastic tailoring, namely, determination of design variables and calculation of constraint derivatives, were discussed. Two different methods in the determination of the design variables were evaluated. It seems that the polynormal expression of the thickness of the composite ply of the skin is more beneficial in practical application. By use of a simple box model and a delta wing model, the calculation of the derivatives of normal frequencies, mode shapes, and flutter speeds are performed. Derivatives of normal frequencies and mode shapes calculated by stiffness and flexiblity methods are all reasonable. In the calculation of the derivatives of flutter speeds, the effect of mode shape can be neglected. Author

A92-53099
FROM FATIGUE TEST LIFE TO STRUCTURE SAFE LIFE
ZHIWEI CHEN (Aeronautical Engineering Research Institute, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 8, Aug. 1991, p. B443-B446. In Chinese. refs

According to Chinese military specifications a suitable fatigue life scatter factor must be used in determining aircraft safe life from fatigue test life. The relationship between the reliability and the life distribution scatter factor has been discussed. The difference between the life distribution scatter factor and the specification life scatter factor has been pointed out. The concept of spectrum variation factor has been emphasized. It is argued that the specification fatigue life scatter factor should be the product of the life distribution scatter factor and the spectrum variation factor. Determination of structure safe life from fatigue test results of used structures has also been considered. Two points are of significance: when converting used time to fatigue test life the time should be reduced instead of being increased, different specification fatigue life scatter factors should be chosen for service time and test time. Author

A92-53100
A MICROPROCESSOR-BASED AUTOMATION TEST SYSTEM FOR THE EXPERIMENT OF THE MULTI-STAGE COMPRESSOR
HUISHENG ZHANG and CHONGPING LIN (Northwestern Polytechnical University, Xian, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 8, Aug. 1991, p. B447-B450. In Chinese. refs

An automation test system that is controlled by the microprocessor and used in the multistage compressor experiment is described. Based on the analysis of the compressor experiment performances, a complete hardware system structure is set up. It is composed of a IBM PC/XT computer, a large scale sampled data system, the moving machine with three directions, the scanners, the digital instrumentation and some output devices. A program structure of real-time software system is described. The testing results show that this test system can take the measure of many parameter magnitudes in the blade row places and on a boundary layer in different states. The automatic extent and the accuracy of experiment is increased and the experimental cost is reduced. Author

A92-53107
AUTOMATIC PRODUCTION TEST EQUIPMENT (APTE) FOR THE B-2
PAUL ROBINSON, RICHARD GILLETTE (Northrop Corp., Electronics Systems Div., Rolling Meadows, IL), RONALD TUCKER, and BRIAN AUST (Northrop Corp., B-2 Div., Palmdale, CA) IN: AUTOTESTCON '91; IEEE Systems Readiness Technology Conference, Anaheim, CA, Sept. 24-26, 1991, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 73-77.
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The automatic production test equipment was developed to provide an integrated capability for seven test conductors and one chief test conductor to interactively test a system with bus architecture. Each test conductor has access to 35 data buses and a centralized database to generate stimuli and monitor responses from the vehicle subsystems. The chief test conductor resolves potential resource conflicts and monitors critical parameters for safety considerations. Test program development is accomplished using windows, graphics, and a menu-driven environment to eliminate the need for extensive operator training and software language skills. I.E.

A92-53263
DISCUSSION ON SIDEWALL SUCTION IN TWO-DIMENSIONAL WIND TUNNEL
KEMING CHENG (Nanjing Aeronautical Institute, China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956), vol. 24, no. 3, June 1992, p. 357-360. In Chinese. refs

This paper studies the sidewall suction in a 2D wind tunnel. The investigation presented in this paper considers the effects of porosity and suction orifice inclination, and therefore, more perfectly describes the influence of the sidewalls on the flow in a wind tunnel than previous research. Moreover, the control of the sidewall suction is explored theoretically so as to eliminate the interference from the sidewalls. Author

A92-53292
THE SYSTEM RELIABILITY ANALYSIS AND OPTIMIZATION DESIGN FOR WING-BOX STRUCTURES
YUANSHENG FENG and BIFENG SONG (Northwestern Polytechnical University, Xian, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 7, July 1991, p. A359-A364. In Chinese. refs

Methods of system reliability analysis and optimization for wing-box structures are studied. The optimality criterion method is adopted to enumerate the significant failure modes, and the highly accurate Feng method is used for computing system failure probability. Two iterative formulas are presented to minimize the structural weight. The illustrative examples show that these methods are very efficient, especially for medium and large scale structures. Author

A92-53293
TRANSIENT RESPONSE OF THE ROTOR-SUPPORT SYSTEM OF AEROENGINES
JIALIU GU and XINGMIN REN (Northwestern Polytechnical University, Xian, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 7, 1991, p. A373-A3780. In Chinese. refs

This paper develops a transfer matrix-direct integration method. In this research the support reactions, squeeze-film forces, and unbalance forces are separated into different vectors. Therefore, it is easy to analyze the response from unbalance of any disk or some disks by the governing equations derived for a definite characteristic disk. It can be used to analyze the vibrations matching of the rotor and stator, to modify the structure, and make sensitivity analysis. This method is also applicable to the analysis of the rotor-support system with unsymmetric stiffness. To solve the transient response of the system, expressions of the transient squeeze-film force and expressions of the transfer matrix of a disk in transient response are derived. An numerical example of a double-spool-support system is given. Author

A92-53297
CALCULATION OF THE EXERTING FORCE NECESSARY TO FORM THE AIRCRAFT HULL PLATE IN THE SYMMETRY PLATE BENDER WITH THREE ROLLS AND THE FEEDING VALUE OF THE CENTRE ROLL
FUREN XU (Shanghai Jiao Tong University, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 7, July 1991, p. A401-A410. In Chinese. refs

In this paper, forces and deformations of the aircraft hull plate in the symmetry plate bender with three rolls are systematically analyzed and investigated by means of elasticity-plasticity theory, and a group of theoretical calculation formulas is put forward by which the feeding value and the exerting force of the center roll may be determined according to the thickness of the hull plate, the elasticity modulus and yield point of the hull plate material, and the curvature which the aircraft hull plate should have after forming. Author

A92-53332
SOLUTION OF STRESS INTENSITY FACTOR BY WEIGHT FUNCTION FOR SMALL SURFACE CRACKS IN PLATES
WEI ZHAO, XUEREN WU, and MINGGAO YAN (Institute of Aeronautical Materials, Beijing, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 2, Feb. 1991, p. B44-B49. In Chinese. refs

The 3D weight function method is used to determine SIFs for small surface cracks in plates subjected to remote tension and bending. The geometry parameters considered over the range of small surface crack problems are those commonly encountered in fatigue and fracture studies and applications. Very good agreement is obtained with solutions found in the literature. The limiting behaviors of SIFs as the crack aspect ratio tends to zero are also investigated. The solutions presented here should be useful in damage tolerance and durability analysis of aircraft structures and in the study of small fatigue cracks. C.D.

N92-30380*# Nevada Univ., Reno. Engineering Research and Development Center.
NUMERICAL INVESTIGATIONS IN THREE-DIMENSIONAL INTERNAL FLOWS Semiannual Status Report, 1 Jan. - 30 Jun. 1992
WILLIAM C. ROSE 30 Jun. 1991 24 p
(Contract NCC2-507)
(NASA-CR-190498; NAS 1.26:190498) Avail: CASI HC A03/MF A01

In previous efforts, a two-dimensional full Navier-Stokes (FNS) code (SCRAM2D) was used in a design process that involved parametric modifications of the inlet geometry to arrive at what appeared to be an optimum inlet flowfield that produced a uniform flow at the exit in a very short distance. In these previous studies, the technologies for determining the contours with a 'man-in-the-loop' approach for both the ramp and cowl of the inlet were demonstrated, and nearly shock-free exiting flowfields were shown to be obtainable. The resulting two-dimensional compression contours were then used with swept sidewalls to form a three-dimensional inlet. Then the three-dimensional Navier-Stokes code (SCRAM3D) was used to investigate the inlet's three-dimensional flow. One of the major difficulties encountered in the previous studies was that associated with the relatively long time required to obtain a solution using even the 2D FNS code in the design process. Since one of the goals of high-speed inlet design is to produce inputs to the overall aircraft design in a timely manner, it was proposed for this year's research to examine 2D and 3D viscous flow solver techniques alternative to the NFS codes used to date. Areas of the inlet particularly identified for code speed up are those associated with the forebody and external flow ramp systems of the inlet. In these areas, parabolized, or space-marched, Navier-Stokes codes were proposed to be investigated for their applicability in the design process developed previously. This report describes the results of an investigation into the use of two other codes for analyzing the forebody and inlet ramp systems of high-speed inlets. Author

N92-30390*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
METHOD OF MEASURING CROSS-FLOW VORTICES BY USE OF AN ARRAY OF HOT-FILM SENSORS Patent Application
NAVAL K. AGARWAL, inventor (to NASA) (Analytical Services and Materials, Inc., Hampton, VA.), DAL V. MADDALON, inventor (to NASA), and SIVA M. MANGALAM, inventor (to NASA) (Analytical Services and Materials, Inc., Hampton, VA.) 7 Jan. 1991 15 p
(NASA-CASE-LAR-14824-1-SB; NAS 1.71:LAR-14824-1-SB; US-PATENT-APPL-SN-823805) Avail: CASI HC A03/MF A01

The invention is a method for measuring the wavelength of cross-flow vortices of air flow having streamlines of flow traveling across a swept airfoil. The method comprises providing a plurality of hot-film sensors. Each hot-film sensor provides a signal which can be processed, and each hot-film sensor is spaced in a straight-line array such that the distance between successive hot-film sensors is less than the wavelength of the cross-flow vortices being measured. The method further comprises determining the direction of travel of the streamlines across the airfoil and positioning the straight-line array of hot film sensors perpendicular to the direction of travel of the streamlines, such that each sensor has a spanwise location. The method further comprises processing the signals provided by the sensors to provide root-mean-square values for each signal, plotting each root-mean-square value as a function of its spanwise location, and determining the wavelength of the cross-flow vortices by noting the distance between two maxima or two minima of root-mean-square values. NASA

N92-30396*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DEVELOPMENT OF A FULL-SCALE TRANSMISSION TESTING PROCEDURE TO EVALUATE ADVANCED LUBRICANTS
DAVID G. LEWICKI, HARRY J. DECKER, and JOHN T. SHIMSKI (Naval Air Propulsion Test Center, Trenton, NJ.) Aug. 1992 25 p
(Contract DA PROJ. 1L1-62211-A-47-A; RTOP 505-63-36)
(NASA-TP-3265; E-6531; NAS 1.60:3265; AVSCOM-TR-91-C-026)
Avail: CASI HC A03/MF A01

Experimental tests were performed on the OH-58A helicopter main rotor transmission in the NASA Lewis 500-hp Helicopter Transmission Test Stand. The testing was part of a joint Navy/NASA/Army lubrication program. The objective of the program was to develop a separate lubricant for gearboxes and demonstrate an improved performance in life and load-carrying capacity. The goal of the experiments was to develop a testing procedure to fail certain transmission components using a MIL-L-23699 base reference oil, then run identical tests with improved lubricants and demonstrate performance. The tests were directed at failing components that the Navy has had problems with due to marginal lubrication. These failures included mast shaft bearing micropitting, sun gear and planet bearing fatigue, and spiral bevel gear scoring. A variety of tests were performed and over 900 hours of total run time accumulated for these tests. Some success was achieved in developing a testing procedure to produce sun gear and planet bearing fatigue failures. Only marginal success was achieved in producing mast shaft bearing micropitting and spiral bevel gear scoring. Author

N92-30423# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany). Aircraft Div.
MBB-LAGRANGE: A GENERAL STRUCTURAL RELIABILITY AND OPTIMIZATION STRUCTURAL SYSTEM
RAINER ZOTEMANTEL 6 Sep. 1991 21 p Repr. from Reliability and Optimization of Structural Systems 2 (R. Rackwitz u P. Thoft-Christensen) 1991 Presented at the IFIP Conference, Munich, Fed. Republic of Germany, 11-13 Sep. 1991
(MBB/FW321/S/PUB/467; ETN-92-91901) Copyright Avail: CASI HC A03/MF A01

MBB-LAGRANGE is a program system which allows the optimization of general structural systems. The geometry and properties of these structures are idealized by a finite element

model with isotropic, orthotropic, anisotropic and composite materials. The design variables and a variety of constraints characterize the optimization model. The design variables are element thicknesses, cross sections, concentrated masses and fiber angles. The design can be restricted with respect to statics (e.g., stresses, displacements), dynamics (natural frequencies, dynamic response) and aeroelastics (efficiencies, flutter speed). In general the aim is to minimize the structure weight subject to the constraints. But often it is necessary to get only a feasible design. The highlights of the program system are: simultaneous optimization, a wide range of mathematical programming algorithms, a modular architecture within computer aided engineering environment. A lot of large scale problems, especially space and aircraft structures, demonstrate the power of MBB-LAGRANGE. ESA

N92-30583# Army Electronic Proving Ground, Fort Huachuca, AZ.
COMPACT RANGE TEST APPLICATIONS, PHASE 2 Methodology Investigation, Oct. 1990 - Oct. 1991
FRANCIS L. DAVIS Jan. 1992 54 p
(AD-A248790; USAEPG-FR-1420-PHASE-2) Avail: CASI HC A04/MF A01

Georgia Tech Research Institute (GTRI) has designed and fabricated a large outdoor Compact Antenna Range for the U.S. Army Electronic Proving Ground (USAEPG). This range enables USAEPG to test antenna systems of large ground vehicles or aircraft that weigh up to 70 tons and are up to 50 feet in size over a frequency range of 6 to 40 GHz. Ongoing investigation and study are being conducted to determine the compatibility and adaptability of this antenna pattern measurement range to measure other system parameters such as target return signals and system responses to specialized electromagnetic environments. GRA

N92-30654*# Stanford Univ., CA.
STRUCTURE OF THREE-DIMENSIONAL TURBULENT BOUNDARY LAYERS
P. BRADSHAW and O. SENDSTAD *In its* Studying Turbulence Using Numerical Simulation Databases. 3: Proceedings of the 1990 Summer Program p 75-84 Dec. 1990
Avail: CASI HC A02/MF A03; 2 functional color pages

The changes that occur in the Reynolds-stress-producing motion when a cross-stream pressure gradient is applied to an initially two-dimensional turbulent flow are discussed. Two examples are used: (1) a temporal simulation of a channel flow with crossflow applied by a spanwise pressure gradient for t is greater than 0; and (2) a spatial simulation of the boundary layer on an infinite swept wing. Evidence examined to date suggests that the structural changes in the two cases are similar, but the mechanisms may be significantly different, even if effects peculiar to the viscous wall region are ignored. The results from (2) are provisional, based on too short a time series for accurate statistical averages to be obtained. We treat turbulence 'statistics' (solutions of the Navier-Stokes equations in three space dimensions and time) in the same way as experiments: both have limitations of accuracy but both are acceptable representations of real fluid flows. Author

N92-30755# Rand Graduate Inst. for Policies Study, Santa Monica, CA.
THE RISE OF ACTIVE-ELEMENT PHASED-ARRAY RADAR
IKE CHANG 1991 14 p
(RAND-P-7747-RGS) Avail: CASI HC A03/MF A01

The War in the Persian Gulf has recently underscored the vast leverage of advanced electronics to U.S. military power. Advanced electronics will likely play an even greater role in the U.S. military in the future. Under declining budgets, the U.S. forces are experiencing drastic reductions in manpower and resources. To offset these reductions, the military has turned to high technology in general as a force multiplier. In terms of projecting air power, a key force multiplier involves the use of electronic sensors for reconnaissance, surveillance, and tracking. One type of sensor for tactical aircraft, fire control radar, has proven to be a crucial element in establishing air superiority over potential adversaries in war. The advantages, history of development, and enabling technologies of a superior and emerging technology for fire control radars are discussed. Author

N92-30765*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
INTERSECTING SHOCK-WAVE/TURBULENT BOUNDARY-LAYER INTERACTIONS AT MACH 8.3
M. I. KUSSOY (Eloret Corp., Palo Alto, CA.) and K. C. HORSTMAN (Eloret Corp., Palo Alto, CA.) Feb. 1992 68 p
(Contract RTOP 505-59-40)
(NASA-TM-103909; A-92027; NAS 1.15:103909) Avail: CASI HC A04/MF A01

Experimental data for two 3-D intersecting shock-wave/turbulent boundary-layer interaction flows at Mach 8.3 are presented. The test bodies, composed of two sharp fins fastened to a flat-plate test bed, were designed to generate flows with varying degrees of pressure gradient, boundary-layer separation, and turning angle. The data include surface pressure and heat transfer distributions as well as mean flow-field surveys both in the undisturbed and interaction regimes. The data are presented in a convenient form to be used to validate existing or future computational models of these hypersonic flows. Author

N92-30766# Politecnico di Milano (Italy). Dipartimento di Ingregneria Aerospaziale.
COMPOSITE BEAM ANALYSIS LINEAR ANALYSIS OF NATURALLY CURVED AND TWISTED ANISOTROPIC BEAMS Final Report
MARCO BORRI, GIAN L. GHIRINGHELLI, and TEODORO MERLINI May 1992 88 p
(Contract DAJA45-90-C-0037)
(AD-A252652; R/D-6571-AN-01) Avail: CASI HC A05/MF A01

The aim of this report is to present a consistent theory for the deformation of a naturally curved and twisted anisotropic beam. The proposed formulation naturally extends the classical Saint-Venant approach to the case of curved and twisted anisotropic beams. The mathematical model developed under the assumption of span-wise uniform cross-section, curvature and twist, can take into account any kind of elastic coupling due to the material properties and the curved geometry. The consistency of the presented math-model and its generality about the cross-sectional shape, make it a useful tool even in a preliminary design optimization context such as the aeroelastic tailoring of helicopter rotor blades. The advantage of the present procedure is that it only requires a two-dimensional discretization; thus, very detailed analyses can be performed and interlaminar stresses between laminae can be evaluated. Such analyses would be extremely time consuming if performed with standard finite element codes: that prevents their recursive use as for example when optimizing a beam design. Moreover, as a byproduct of the proposed formulation, one obtains the constitutive law of the cross-section in terms of stress resultant and moment and their conjugate strain measures. This constitutive law takes into account any kind of elastic couplings, e.g., torsion-tension, tension-shear, bending-shear, and constitutes a fundamental input in aeroelastic analyses of helicopter blades. Four simple examples are given in order to show the principal features of the method. GRA

N92-30893# Sandia National Labs., Albuquerque, NM.
REPETITIVE HIGH ENERGY PULSED POWER (RHEPP) TEMPERATURE MONITORING SYSTEM UTILIZING LUXTRON FLUOROPTIC SENSORS AND THERMOCOUPLES TECHNICAL REFERENCE MANUAL
G. E. LADERACH Jan. 1992 42 p
(Contract DE-AC04-76DP-00789)
(DE92-013461; SAND-91-1624) Avail: CASI HC A03/MF A01

This document describes the Temperature Monitoring System for the RHEPP project at Sandia National Laboratories. The system is designed to operate in the presence of severe repetitive high voltage and electromagnetic fields while providing real time thermal data on component behavior. The thermal data is used in the

design and evaluation of the major RHEPP components such as the magnetically switched pulse compressor and the linear induction voltage adder. Particular attention is given to the integration of commercially available hardware and software components with a custom written control program. While this document is intended to be a reference guide, it may also serve as a template for similar applications. DOE

N92-30903# Sandia National Labs., Albuquerque, NM.
NUMERICAL CALCULATIONS OF TWO-DIMENSIONAL SINGLE AND MULTI-MATERIAL FLOW FIELDS WITH CCICE
A. R. LOPEZ and R. S. BATY Jan. 1992 45 p
(Contract DE-AC04-76DP-00789)
(DE92-015778; SAND-91-2650) Avail: CASI HC A03/MF A01

This report documents the progress that Sandia National Laboratories has made toward establishing a capability to numerically simulate flow fields around arbitrary bodies for high speed water entry and water exit problems. The two-dimensional, compressible, unsteady, inviscid code, CCICE (Cell Centered Implicit Continuous-fluid Eulerian), developed at Los Alamos National Laboratory (LANL), has been benchmarked for a variety of flow problems. CCICE provides a sufficient description of fluid flows to predict the unsteady pressure forces experienced by vehicles entering or exiting the water. An incompressible version of CCICE, CCMAC (Cell Centered Marker and Cell), has also been benchmarked for a variety of flow problems. CCMAC was obtained from LANL and is a two-dimensional, incompressible, unsteady, inviscid code which can simulate fluid-vehicle interaction in low speed water entry and water exit problems. This report also documents practical information necessary to run the CCICE and CCMAC codes. DOE

N92-30923*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.
PROCEEDINGS OF THE WORKSHOP ON ADVANCED NETWORK AND TECHNOLOGY CONCEPTS FOR MOBILE, MICRO, AND PERSONAL COMMUNICATIONS
LORI PAUL, ed. 15 Sep. 1991 325 p Workshop held in Pasadena, CA, 30-31 May 1991
(Contract NAS7-918; RTOP 650-60-15-01-00)
(NASA-CR-190459; NAS 1.26:190459; JPL-PUBL-91-35) Avail: CASI HC A14/MF A03

The Workshop on Advanced Network and Technology Concepts for Mobile, Micro, and Personal Communications was held at NASA's JPL Laboratory on 30-31 May 1991. It provided a forum for reviewing the development of advanced network and technology concepts for turn-of-the-century telecommunications. The workshop was organized into three main categories: (1) Satellite-Based Networks (L-band, C-band, Ku-band, and Ka-band); (2) Terrestrial-Based Networks (cellular, CT2, PCN, GSM, and other networks); and (3) Hybrid Satellite/Terrestrial Networks. The proceedings contain presentation papers from each of the above categories.

N92-30988*# State Univ. of New York, Binghamton. Dept. of Mechanical and Industrial Engineering.
ACOUSTIC FATIGUE LIFE PREDICTION FOR NONLINEAR STRUCTURES WITH MULTIPLE RESONANT MODES Final Report, Apr. 1989 - Mar. 1992
R. N. MILES Mar. 1992 157 p
(Contract NAG1-978)
(NASA-CR-190471; NAS 1.26:190471) Avail: CASI HC A08/MF A02

This report documents an effort to develop practical and accurate methods for estimating the fatigue lives of complex aerospace structures subjected to intense random excitations. The emphasis of the current program is to construct analytical schemes for performing fatigue life estimates for structures that exhibit nonlinear vibration behavior and that have numerous resonant modes contributing to the response. Author

N92-31023*# National Center for Atmospheric Research, Boulder, CO.
SIMPLIFIED SIGNAL PROCESSING FOR AN AIRBORNE CO2 DOPPLER LIDAR
R. L. SCHWIESOW and M. P. SPOWART *In* NASA. Langley Research Center, 16th International Laser Radar Conference, Part 2 p 417-420 Jul. 1992 Sponsored in part by NSF
Avail: CASI HC A01/MF A03

In the development of the National Center for Atmospheric Research (NCAR) airborne infrared lidar system (NAILS), we have emphasized a simple, modular design to suit the instrument to its mission of providing measurements of atmospheric structure and dynamics from an aircraft platform. Based on our research to this point, we believe that a significant simplification of the signal processing approach compared to that now used is possible by using high speed digitization of the signal. The purpose here is to place signal processing in the context of the overall system design and to explore the basis of the alternative technique so that the community can comment on the approach. Author

N92-31043*# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (Germany). Inst. of Optoelectronics.
TRIAL OF A SLANT VISUAL RANGE MEASURING DEVICE
J. STREICHER, C. MUENKEL (Impulsphysik G.m.b.H., Hamburg, Germany, F.R.), and H. BORCHARDT (Deutscher Wetterdienst, Hamburg, Germany, F.R.) *In* NASA. Langley Research Center, 16th International Laser Radar Conference, Part 2 p 493-496 Jul. 1992
Avail: CASI HC A01/MF A03

Each year, fog at airports renders some landing operations either difficult or impossible. The visibility that a pilot of a landing aircraft can expect is in that case the most important information. It could happen that the visibility versus the altitude is constantly decreasing or increasing. However, it is not possible to distinguish this with the existing sensors at an airport. If the visibility is decreasing with the altitude, one has the worst case - ground fog. The standard visibility sensor, the transmissometer, determines only the horizontal visual range, which will be underestimated in comparison with the real visibility a pilot has on his landing approach. Described here is a new technique to measure the slant visual range, making use of a slant scanning device - an eye-safe laser radar. A comparison with commercial visibility sensors shows that it is possible to measure visibilities with the slant looking laser radar in the range from 50 meters up to 2000 meters and even distinguish inhomogenities like ground fog. Author

N92-31059*# Office National d'Etudes et de Recherches Aerospatiales, Meundon (France).
THEORETICAL SIMULATION OF A 2 MICRON AIRBORNE SOLID STATE LASER ANEMOMETER
BEATRICE IMBERT and JEAN-PIERRE CARIOU *In* NASA. Langley Research Center, 16th International Laser Radar Conference, Part 2 p 555-558 Jul. 1992 Sponsored in part by the Direction des Constructions Aeronautiques
Avail: CASI HC A01/MF A03

In the near future, military aircraft will need to know precisely their true airspeed in order to optimize flight conditions. In comparison with classical anemometer probes, an airborne Doppler lidar allows measurement of the air velocity without influence from aircraft aerodynamic disturbance. While several demonstration systems of heterodyne detection using a CO2 laser have been reported, improvements in the technology of solid state lasers have recently opened up the possibility that these devices can be used as an alternative to CO2 laser systems. In particular, a diode pumped Tm:Ho:YAG laser allows a reliable compact airborne system with an eye safe wavelength (lambda = 2.09 microns) to be achieved. The theoretical study of performances of a coherent lidar using a solid state diode pumped Tm:Ho:YAG laser, caled SALSA, for measuring aircraft airspeed relative to atmospheric aerosols is described. A computer simulation was developed in order to modelize the Doppler anemometer in the function of

atmospheric propagation and optical design. A clever analysis of the power budget on the detector area allows optical characteristic parameters of the system to be calculated, and then it can be used to predict performances of the Doppler system. Estimating signal to noise ratios (SNR) and heterodyne efficiency provides the available energy of speed measurement as well as a useful measurement of the alignment of the backscattered and reference fields on the detector. Author

N92-31067*# Litton Industries, Moorpark, CA. Aero Products Div.

A STUDY OF ATMOSPHERIC OPTICAL SCATTERING PARAMETERS AT 1.5 AND 2 MICRON REGION FOR SOLID STATE DOPPLER LIDAR APPLICATIONS

ELI MARGALIT, FARZIN AMZAJERDIAN, RODNEY BENOIST, and RICHARD DUBINSKY (Sky Council, Toronto, Ontario) *In* NASA. Langley Research Center, 16th International Laser Radar Conference, Part 2 p 585-588 Jul. 1992

Avail: CASI HC A01/MF A03

The increasing interest in the development of an eye-safe, solid state, Doppler lidar for avionic applications has created the need for a quantitative evaluation of atmospheric effects on performance. Theoretical calculations were completed for optical scattering parameters to be compared with the field measurements. Computer codes were developed for the required calculations and designed to be interactive and user friendly in order to support comparison with experimental results and, thus, provide the basis for evaluation of eye-safe Doppler lidar over a wide range of atmospheric conditions and geographical locations. A holmium Doppler lidar operating at 2.09 microns was constructed for atmospheric backscattering, attenuation, and wind velocity measurements. Theoretical calculations and field studies were performed for backscatter coefficients. The selected wavelengths correspond to Er:glass, Tm:YAG, and Tm,Ho:YAG solid state lasers that are suitable for use in an eye-safe Doppler lidar system. Author

N92-31068*# Thomson-TRT Defense, Guyancourt (France).

A CABLE DETECTION LIDAR SYSTEM FOR HELICOPTERS

BENOIST GROSSMANN, ALAIN CAPBERN, MARTIN DEFOUR, and REMI FERTALA *In* NASA. Langley Research Center, 16th International Laser Radar Conference, Part 2 p 589-592 Jul. 1992

Avail: CASI HC A01/MF A03

Helicopters in low-level flight are endangered by power lines or telephone wires, especially when flying at night and under poor visibility conditions. In order to prevent 'wire strike', Thomson has developed a lidar system consisting of a pulsed diode laser emitting in the near infrared region (lambda = 0.9 microns). The HOWARD (Helicopter Obstacle Warning and Detection) System utilizes a high repetition rate diode laser (PRE = 20 KHz) along with counter-rotating prisms for laser beam deflection with a total field of view of 30 degrees. This system was successfully field tested in 1991. HOWARD can detect one inch wires at ranges up to 200 meters. We are presently in the process of developing a flyable compact lidar system capable of detection ranges in the order of 400 meters. Author

N92-31155*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

A DEMONSTRATION OF PASSIVE BLADE TWIST CONTROL USING EXTENSION-TWIST COUPLING

RENEE C. LAKE, MARK W. NIXON, MATTHEW L. WILBUR, JEFFREY D. SINGLETON, and PAUL H. MIRICK Jun. 1992 11 p Presented at the 33rd Structures, Structural Dynamics and Materials Conference, Dallas, TX, 13-15 Apr. 1992 Previously announced in IAA as A92-34358

(Contract RTOP 505-63-36; DA PROJ. 1L1-62211-A-47AB)

(NASA-TM-107642; NAS 1.15:107642; USAAVSCOM-TR-92-B-010) Avail: CASI HC A03/MF A01

The results from a study aimed at improving the dynamic and aerodynamic characteristics of composite rotor blades through the use of extension-twist coupling are presented. A set of low twist model-scale helicopter rotor blades was manufactured with a view towards demonstrating the passive blade twist control concept. Hover testing of the blades was conducted to measure the change in blade twist as a function of rotor speed. The blades were spun through the 0-800 rpm range, with a corresponding sweep of collective pitch to determine the effect on the blade elastic twist. Hover data were obtained for both a ballasted and unballasted blade configuration in atmospheric conditions, where maximum twist changes of 2.54 and 5.24 degrees were respectively observed. These results compared well with those from a finite element analysis of the blade, which yielded maximum twists of 3.01 and 5.61 degrees for the unballasted and ballasted blade configurations, respectively. The aerodynamic-induced effects on the blade elastic twist, determined by testing a ballasted blade configuration in a near-vacuum condition, were found to be minimal with a maximum twist difference of 0.17 degrees observed between the two test environments. The effect of collective pitch sweep on the elastic twist was minimal. Author

N92-31156*# Arizona State Univ., Tempe. Coll. of Engineering and Applied Science.

ADVANCED ELECTROMAGNETIC METHODS FOR AEROSPACE VEHICLES Semiannual Progress Report, 1 Jan. - 30 Jun. 1992

CONSTANTINE A. BALANIS, WEIMIN SUN, EL-BUDAWY EL-SHARAWY, JAMES T. ABERLE, CRAIG R. BIRTCHER, JIAN PENG, and PANAYIOTIS A. TIRKAS 30 Jun. 1992 63 p

(Contract NAG1-1082)

(NASA-CR-190650; NAS 1.26:190650; TRC-EM-CAB-9203)

Avail: CASI HC A04/MF A01

The Advanced Helicopter Electromagnetics (AHE) Industrial Associates Program continues its research on variety of main topics identified and recommended by the Advisory Task Force of the program. The research activities center on issues that advance technology related to helicopter electromagnetics. While most of the topics are a continuation of previous works, special effort has been focused on some of the areas due to recommendations from the last annual conference. The main topics addressed in this report are: composite materials, and antenna technology. The area of composite materials continues getting special attention in this period. The research has focused on: (1) measurements of the electrical properties of low-conductivity materials; (2) modeling of material discontinuity and their effects on the scattering patterns; (3) preliminary analysis on interaction of electromagnetic fields with multi-layered graphite fiberglass plates; and (4) finite difference time domain (FDTD) modeling of fields penetration through composite panels of a helicopter. Author

N92-31281*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

STAGNATION-POINT HEAT-TRANSFER RATE PREDICTIONS AT AEROASSIST FLIGHT CONDITIONS

ROOP N. GUPTA, JIM J. JONES (Analytical Mechanics Associates, Inc., Hampton, VA.), and WILLIAM C. ROCHELLE (Lockheed Engineering and Sciences Co., Houston, TX.) Sep. 1992 21 p

(Contract RTOP 506-40-91-02)

(NASA-TP-3208; L-17039; NAS 1.60:3208) Avail: CASI HC A03/MF A01

The results are presented for the stagnation-point heat-transfer rates used in the design process of the Aeroassist Flight Experiment (AFE) vehicle over its entire aeropass trajectory. The prediction methods used in this investigation demonstrate the application of computational fluid dynamics (CFD) techniques to a wide range of flight conditions and their usefulness in a design process. The heating rates were computed by a viscous-shock-layer (VSL) code at the lower altitudes and by a Navier-Stokes (N-S) code for the higher altitude cases. For both methods, finite-rate chemically reacting gas was considered, and a temperature-dependent wall-catalysis model was used. The wall temperature for each case was assumed to be radiative equilibrium temperature, based on total heating. The radiative heating was estimated by using a correlation equation. Wall slip was included in the N-S calculation method, and this method implicitly accounts for shock slip. The

N-S/VSL combination of projection methods was established by comparison with the published benchmark flow-field code LAURA results at lower altitudes, and the direct simulation Monte Carlo results at higher altitude cases. To obtain the design heating rate over the entire forward face of the vehicle, a boundary-layer method (BLIMP code) that employs reacting chemistry and surface catalysis was used. The ratio of the VSL or N-S method prediction to that obtained from the boundary-layer method code at the stagnation point is used to define an adjustment factor, which accounts for the errors involved in using the boundary-layer method. Author

N92-31349*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EXPERIMENTAL TESTING OF PROTOTYPE FACE GEARS FOR HELICOPTER TRANSMISSIONS
R. HANDSCHUH, D. LEWICKI, and R. BOSSLER (Lucas Western, Inc., City of Industry, CA.) 1992 15 p Proposed for presentation at the Gearbox Configurations of the 1990's, Solihull, England, 28 Oct. 1992; sponsored by Inst. of Mechanical Engineers Prepared in cooperation with Army Aviation Systems Command, Cleveland, OH
(Contract RTOP 505-63-36; DA PROJ. 1L1-62211-A-47-A)
(NASA-TM-105434; E-7084; NAS 1.15:105434;
AVSCOM-TR-92-C-008) Avail: CASI HC A03/MF A01

An experimental program to test the feasibility of using face gears in a high-speed and high-power environment was conducted. Four face gear sets were tested, two sets at a time, in a closed-loop test stand at pinion rotational speeds to 19,100 rpm and to 271 kW. The test gear sets were one-half scale of the helicopter design gear set. Testing the gears at one-eighth power, the test gear set had slightly increased bending and compressive stresses when compared to the full scale design. The tests were performed in the LeRC spiral bevel gear test facility. All four sets of gears successfully ran at 100 percent of design torque and speed for 30 million pinion cycles, and two sets successfully ran at 200 percent of torque for an additional 30 million pinion cycles. The results, although limited, demonstrated the feasibility of using face gears for high-speed, high-load applications. Author

N92-31469# National Research Council of Canada, Ottawa (Ontario). Engine Lab.
A PRELIMINARY STUDY IN THE USE OF PHASE DEMODULATION TECHNIQUES FOR THE ANALYSIS OF GEAR VIBRATION DATA [ETUDE PRELIMINAIRE SUR L'UTILISATION DE TECHNIQUES DE DEMODULATION DE PHASE POUR L'ANALYSE DES DONNEES VIBRATOIRES DES ENGRENAGES]
J. NICKS and G. KRISHNAPPA Oct. 1990 52 p
(NRC-32083; NRC-TR-ENG-005; CTN-92-60310) Avail: CASI HC A04/MF A01

The assessment of component health by vibration analysis is an integral part of monitoring of gas turbine engines. This report presents a preliminary study of a vibration analysis method for the early detection of gear tooth damage. Using a phase demodulation technique, the condition of a gear based on the characteristics of the phase component of the vibration signal is evaluated. Vibration data from both a high-speed test rig and from a commercial aero-engine gearbox were examined. Preliminary results indicate that phase modulation analysis can provide very early and reliable detection of faults in gears. It is important that the analysis procedure be performed on a gear when it is in good condition to establish an acceptable baseline. Any mesh harmonic may be demodulated about, providing that stable baseline analysis results can be obtained. This analysis method appears to be more suited for trend monitoring, to obtain the earliest possible fault warning, rather than single-shot assessment. It is shown that kurtosis is not a reliable analysis parameter for use with phase demodulation. Combining the percent modulation of the unwrapped phase function with the maximum kurtosis of the wrapped and unwrapped phase function resulted in more reliable diagnosis of faults. CISTI

N92-31484*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A GENERAL NUMERICAL MODEL FOR WAVE ROTOR ANALYSIS
DANIEL W. PAXSON Jul. 1992 38 p
(Contract RTOP 505-62-10)
(NASA-TM-105740; E-7141; NAS 1.15:105740) Avail: CASI HC A03/MF A01

Wave rotors represent one of the promising technologies for achieving very high core temperatures and pressures in future gas turbine engines. Their operation depends upon unsteady gas dynamics and as such, their analysis is quite difficult. This report describes a numerical model which has been developed to perform such an analysis. Following a brief introduction, a summary of the wave rotor concept is given. The governing equations are then presented, along with a summary of the assumptions used to obtain them. Next, the numerical integration technique is described. This is an explicit finite volume technique based on the method of Roe. The discussion then focuses on the implementation of appropriate boundary conditions. Following this, some results are presented which first compare the numerical approximation to the governing differential equations and then compare the overall model to an actual wave rotor experiment. Finally, some concluding remarks are presented concerning the limitations of the simplifying assumptions and areas where the model may be improved. I.I.C.

N92-31485*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MODAL SIMULATION OF GEARBOX VIBRATION WITH EXPERIMENTAL CORRELATION
FRED K. CHOY (Akron Univ., OH.), YEEFENG F. RUAN (Akron Univ., OH.), JAMES J. ZAKRAJSEK, and FRED B. OSWALD 1992 17 p Presented at the 28th Joint Propulsion Conference and Exhibit, Nashville, TN, 6-8 Jul. 1992; sponsored by AIAA, SAE, ASME, and ASEE
(Contract DA PROJ. 1L1-62211-A-47-A; RTOP 505-63-36)
(NASA-TM-105702; E-7090; NAS 1.15:105702;
AVSCOM-TR-92-C-018; AIAA PAPER 92-3494) Avail: CASI HC A03/MF A01

A newly developed global dynamic model was used to simulate the dynamics of a gear noise rig at NASA Lewis Research Center. Experimental results from the test rig were used to verify the analytical model. In this global dynamic model, the number of degrees of freedom of the system are reduced by transforming the system equations of motion into modal coordinates. The vibration of the individual gear-shaft system are coupled through the gear mesh forces. A three-dimensional, axial-lateral coupled, bearing model was used to couple the casing structural vibration to the gear-rotor dynamics. The coupled system of modal equations is solved to predict the resulting vibration at several locations on the test rig. Experimental vibration data was compared to the predictions of the global dynamic model. There is excellent agreement between the vibration results from analysis and experiment. Author

N92-31617# Federal Aviation Administration, Atlantic City, NJ.
EFFECT OF GUARD BAND REDUCTION ON MARKER BEACON RECEIVER PERFORMANCE
MARTIN BADINELLI, SAM BARTO, ARTHUR CUSHMAN, and Y. VIET TRUONG Jul. 1992 46 p
(DOT/FAA/CT-TN92/18) Avail: CASI HC A03/MF A01

Aircraft Marker Beacon Receivers, which are a part of the Instrument Landing System, operate at a frequency of 75 megahertz (MHz) and until 1 Jan. 1990, were protected by a guard band of +/- 400 kilohertz (kHz). After this date, the guard band was reduced to +/- 200 kHz. This report details testing performed at the Federal Aviation Administration (FAA) Technical Center to assess the effect emitters, using this new guard band, will have on Marker Beacon Receivers. The effect of the interference on the Marker Beacon Receivers was determined by performing a desensitization test, a no-desired signal test, and a selectivity measurement on five general aviation Marker Beacon Receivers. For these tests, emitters that use amplitude modulation, frequency

modulation, pulse modulation, and continuous wave were simulated. It was found that emitters using these new frequencies can cause interference to Marker Beacon Receivers. Recommendations for limiting the interference effect are provided in the body of the report. Author

N92-31619*# Vermont Univ., Burlington. Dept. of Mathematics and Statistics.
CSM SOLUTIONS OF ROTATING BLADE DYNAMICS USING INTEGRATING MATRICES Final Report, 1 Mar. 1991 - 28 Feb. 1992
WILLIAM D. LAKIN 28 Feb. 1992 14 p
(Contract NAG1-1097)
(NASA-CR-190577; NAS 1.26:190577) Avail: CASI HC A03/MF A01

The dynamic behavior of flexible rotating beams continues to receive considerable research attention as it constitutes a fundamental problem in applied mechanics. Further, beams comprise parts of many rotating structures of engineering significance. A topic of particular interest at the present time involves the development of techniques for obtaining the behavior in both space and time of a rotor acted upon by a simple airload loading. Most current work on problems of this type use solution techniques based on normal modes. It is certainly true that normal modes cannot be disregarded, as knowledge of natural blade frequencies is always important. However, the present work has considered a computational structural mechanics (CSM) approach to rotor blade dynamics problems in which the physical properties of the rotor blade provide input for a direct numerical solution of the relevant boundary-and-initial-value problem. Analysis of the dynamics of a given rotor system may require solution of the governing equations over a long time interval corresponding to many revolutions of the loaded flexible blade. For this reason, most of the common techniques in computational mechanics, which treat the space-time behavior concurrently, cannot be applied to the rotor dynamics problem without a large expenditure of computational resources. By contrast, the integrating matrix technique of computational mechanics has the ability to consistently incorporate boundary conditions and 'remove' dependence on a space variable. For problems involving both space and time, this feature of the integrating matrix approach thus can generate a 'splitting' which forms the basis of an efficient CSM method for numerical solution of rotor dynamics problems. Author

N92-31824# Princeton Univ., NJ.
THE STRUCTURE AND CONTROL OF THREE-DIMENSIONAL SHOCK WAVE TURBULENT BOUNDARY LAYER INTERACTIONS Final Report, 1 Oct. 1988 - 31 Aug. 1991
SEYMOUR M. BOGDONOFF and ALEXANDER J. SMITS 20 Mar. 1992 30 p
(Contract AF-AFOSR-0033-89)
(AD-A250209; AFOSR-92-0388TR) Avail: CASI HC A03/MF A01

The three year period covered in the subject report was a considerable shift from the previous years of work on shock wave turbulent boundary layer interactions. The earlier work concentrated on simple building block experiments and a search for a fundamental understanding of the flow phenomena. In the subject research, most of the work on fundamentals for the simple configurations was stopped. The main emphasis for the first two years of the current program was on complex configurations and the final year was a close-out program on a new approach. The work on complex configurations was limited to two geometries which used the much studied single sharp fin interaction as the initial conditions. This shift in emphasis had two main purposes: (1) block experiments in more complex interactions required for applications and (2) to provide a more critical test of computation which, although giving the general characteristics for the building block experiments, did not give highly quantitative results. The primary activities for the first two years will be discussed in three major groupings: (1) and (2) discussions of the two complex configurations, and (3) a description of the boundary layer conditions which are critical to the definition of the experiment and the check by computational fluid dynamics. GRA

N92-31886# Israel Aircraft Industries Ltd., Ben-Gurion Airport.
THE CALCULATION OF INCOMPRESSIBLE SEPARATED TURBULENT BOUNDARY LAYERS
A. KOGAN and S. MIGEMI *In* Israel Society of Aeronautics and Astronautics, 31st Israel Annual Conference on Aviation and Astronautics p 185-196 22 Feb. 1990 Previously announced in IAA as A90-51025
Avail: CASI HC A03/MF A03

The algebraic turbulent model of Baldwin-Lomax was incorporated into the incompressible Navier-Stokes code FIDAP. This model has been extensively tested in the past in finite difference codes. We believe that the incorporation of the model into the finite element code also has resulted in a practical method to compute a variety of separated turbulent two-dimensional flows. Firstly, the model is used to compute the attached flow about an airfoil. Next, the application of the model to separated flows is presented, by computing the flows at high angles of attack up to maximum lift. It is shown that the model is capable of predicting separation, steady stall and C(sub L MAX). As a difficult test of the model, we compute the laminar separation bubble development directly, using the full Navier-Stokes finite elements code. As far as we know, this approach has not been reported previously. The importance of using an appropriate upwinding is discussed. When possible, comparison of computed results with experiments is presented and the agreement is good. ISA

N92-31933# Sandia National Labs., Albuquerque, NM.
AXISYMMETRIC BLUFF-BODY FLOW: A VORTEX SOLVER FOR THIN SHELLS
J. H. STRICKLAND May 1992 67 p
(Contract DE-AC04-76DP-00789)
(DE92-016748; SAND-91-2760) Avail: CASI HC A04/MF A01

A method which is capable of solving the axisymmetric flow field over bluff bodies consisting of thin shells such as disks, partial spheres, rings, and other such shapes is presented in this report. The body may be made up of several shells whose edges are separated by gaps. The body may be moved axially according to arbitrary velocity time histories. In addition, the surfaces may possess axial and radial degrees of flexibility such that points on the surfaces may be allowed to move relative to each other according to some specified function of time. The surfaces may be either porous or impervious. The present solution technique is based on the axisymmetric vorticity transport equation. Physically, this technique simulates the generation of vorticity at body surfaces in the form of discrete ring vortices which are subsequently diffused and convected into the boundary layers and wake of the body. Relatively large numbers of vortices (1000 or more) are required to obtain good simulations. Since the direct calculation of perturbations from large numbers of ring vortices is computationally intensive, a fast multipole method was used to greatly reduce computer processing time. Several example calculations are presented for disks, disks with holes, hemispheres, and vented hemispheres. These results are compared with steady and unsteady experimental data. DOE

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GEOSCIENCES

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

A92-49771
A COMPARISON OF MEASURED AND MODELED BROADBAND FLUXES FROM AIRCRAFT DATA DURING THE ICE '89 FIELD EXPERIMENT
R. W. SAUNDERS (Meteorological Office, Farnborough, England), G. BROGNIEZ, J. C. BURIEZ (Lille I, Universite, Villeneuve d'Ascq, France), R. MEERKOETTER, and P. WENDLING (DLR, Institut

fuer Physik der Atmosphaere, Oberpfaffenhofen, Federal Republic of Germany) Journal of Atmospheric and Oceanic Technology (ISSN 0739-0572), vol. 9, no. 4, Aug. 1992, p. 391-406. Research supported by CEC. refs
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During the 1989 intensive field campaign of the International Cirrus Experiment over the North Sea, broadband radiative fluxes were measured in, above, and below cirrus cloud by a number of European meteorological research aircraft. One mission during the campaign was an intercomparison flight in clear air with no cloud above in order to compare, among other things, radiative flux measurements made by the U.K. C-130, the French Merlin, and the German Falcon aircraft. All three aircraft measured shortwave flux (0.3-3 microns) with standard Eppley pyranometers above and below the fuselage. The intercomparison showed agreement between the three aircraft of within 2 percent for both the upwelling and downwelling shortwave flux components. Using a coincident temperature and humidity radiosonde profile, the downwelling clear-sky fluxes at the level of the aircraft were also calculated using a variety of different radiation models. Modeled shortwave fluxes were all higher than the measured values. In addition to shortwave fluxes the C-130 and Merlin also measured near-infrared fluxes by having additional Eppley pyranometers mounted with red domes over the thermopiles. The near-infrared fluxes measured by the Merlin and C-130 were different because slightly different red-dome filters were used; model calculations show the difference between the measured fluxes was consistent with the different pass band of the filters. Infrared fluxes were measured using standard Eppley pyrgeometers on the Falcon and pyrgeometers developed at the Meteorological Research Flight on the C-130; comparisons show no significant differences for the downwelling fluxes but the Falcon upwelling fluxes were 7 percent higher than the corresponding C-130 values. This latter difference is higher than would be expected for these instruments. The modeled infrared fluxes were up to 9 percent lower than the C-130 and Falcon measurements. Author

N92-30837# Midwest Research Inst., Golden, CO.
YAW DYNAMICS OF HORIZONTAL AXIS WIND TURBINES
A. C. HANSEN (Utah Univ., Salt Lake City.) May 1992 175 p
(Contract DE-AC02-83CH-10093)
(DE92-001245; NREL/TP-442-4822) Avail: CASI HC A08/MF A02

Designers of a horizontal axis wind turbine yaw mechanism are faced with a difficult decision. They know that if they elect to use a yaw-controlled rotor then the system will suffer increased initial cost and increased inherent maintenance and reliability problems. On the other hand, if they elect to allow the rotor to freely yaw they know they will have to account for unknown and random, though bounded, yaw rates. They will have a higher-risk design to trade-off against the potential for cost savings and reliability improvement. The risk of a yaw-free system could be minimized if methods were available for analyzing and understanding yaw behavior. The complexity of yaw behavior has, until recently, discouraged engineers from developing a complete yaw analysis method. The objectives of this work are to (1) provide a fundamental understanding of free-yaw mechanics and the design concepts most effective at eliminating yaw problems, and (2) provide tested design tools and guidelines for use by free-yaw wind systems manufacturers. The emphasis is on developing practical and sufficiently accurate design methods. DOE

N92-31362# Naval Ocean Systems Center, San Diego, CA.
REMOTE SENSING OF TRAPPING LAYER BASE HEIGHT USING ATIS TRANSMISSIONS
T. M. VUONG Dec. 1991 26 p
(AD-A250074; NOSC/TR-1487) Avail: CASI HC A03/MF A01

This report describes an experiment that examined the method of determining a trapping layer directly from VHF and UHF radio measurements. The experiment used existing radio broadcasts along the coast of southern California. Some strong correlations between the observed signal strengths and the inferred trapping layer base heights of the various radio paths were shown, indicating the height of the trapping layer is an important factor in controlling radio propagation on over-the-horizon paths. GRA

N92-31498# Midwest Research Inst., Golden, CO. National Renewable Energy Lab.
A SURFACE DEFINITION CODE FOR TURBINE BLADE SURFACES
S. L. YANG (Michigan Technological Univ., Houghton.), D. ORYANG, and M. J. HO (Tuskegee Inst., AL.) May 1992 207 p
(Contract DE-AC02-83CH-10093)
(DE92-010574; NREL/TP-257-4099) Avail: CASI HC A10/MF A03

A numerical interpolation scheme has been developed for generating the three-dimensional geometry of wind turbine blades. The numerical scheme consists of (1) creating the frame of the blade through the input of two or more airfoils at some specific spanwise stations and then scaling and twisting them according to the prescribed distributions of chord, thickness, and twist along the span of the blade; (2) transforming the physical coordinates of the blade frame into a computational domain that complies with the interpolation requirements; and finally (3) applying the bi-tension spline interpolation method, in the computational domain, to determine the coordinates of any point on the blade surface. Detailed descriptions of the overall approach to and philosophy of the code development are given along with the operation of the code. To show the usefulness of the bi-tension spline interpolation code developed, two examples are given, namely CARTER and MICON blade surface generation. Numerical results are presented in both graphic data forms. The solutions obtained in this work show that the computer code developed can be a powerful tool for generating the surface coordinates for any three-dimensional blade. DOE

N92-32103# Massachusetts Inst. of Tech., Cambridge.
A COMPARISON OF THE PERFORMANCE OF TWO GUST FRONT DETECTION ALGORITHMS USING A LENGTH-BASED SCORING TECHNIQUE
D. L. KLINGLE-WILSON, M. F. DONOVAN, S. H. OLSON, and F. W. WILSON 8 May 1992 45 p
(Contract DTFA01-89-Z-02033)
(AD-A250862; ATC-185; DOT/FAA/NR-92/1) Avail: CASI HC A03/MF A01

The Terminal Doppler Weather Radar (TDWR) Gust Front Algorithm provides, as products, estimates of the current locations of gust fronts, their future locations, the wind speed and direction behind the gust fronts, and the wind shear hazard to landing or departing aircraft. These products are used by air traffic controllers and supervisors to warn pilots of potentially hazardous wind shears during take-off and landing and to plan runway reconfigurations. Until recently, an event-based scoring scheme was used to evaluate the performance of the algorithm. With the event-based scoring scheme, if any part of a gust front was detected, a valid detection was declared. Unfortunately, this scheme gave no indication of how much of the gust front length was detected, nor could the probabilities be easily related to the probability of issuing a wind shear alert for a specific approach or departure path which was being impacted by a gust front. To make the scoring metric more nearly reflect the operational use of the product, a new length-based scoring scheme was devised. This scheme computes the length of the gust front detected by the algorithm. When computed over a large number of gust fronts, this length-based scoring scheme yields the probability that any part of the gust front will be detected. GRA

N92-32147*# Lawrence Livermore National Lab., CA.
NASA HIGH SPEED RESEARCH PROGRAM, EMISSIONS SCENARIOS COMMITTEE REPORT OF MEETINGS ON 26 SEPTEMBER 1991 AND 9 JANUARY 1992
D. J. WUEBBLES 23 Mar. 1992 11 p Sponsored by NASA, Washington

(Contract W-7405-ENG-48)
(NASA-CR-190379; NAS 1.26:190379; DE92-012409;
UCRL-ID-109860) Avail: CASI HC A03/MF A01

An important step in the process of assessing the environmental effects of possible future High-Speed Civil Transports (HSCTs) is the definition of scenarios for the emissions from a fleet of such aircraft. These scenarios are then used in numerical models of the chemistry and physics of the global atmosphere to determine potential environmental effects, including concerns about changes in ozone and in climate. The Emissions Scenarios Committee was formed to provide a forum for meeting the combined needs of the atmospheric science community, the aircraft industry, NASA and the federal government in undertaking the development of scenarios for such assessments. DOE

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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.

A92-49261
APPLICATION OF SYNDROME PATTERN-MATCHING APPROACH TO FAULT ISOLATION IN AVIONIC SYSTEMS
ROBERT HAMMETT and ROBERT LUPPOLD (Charles Stark Draper Laboratory, Inc., Cambridge, MA) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 56-61. refs
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The authors examine several attributes of a fault detection, isolation, and reconfiguration (FDIR) approach that is categorized as syndrome pattern matching. This approach is based on the premise that effective fault isolation algorithms must process the capability of identifying patterns in the results of many fault detection tests, i.e., the fault syndrome. Examples of tests that constitute the syndrome are comparisons of redundant signals, hardware built-in test (BIT) results and status indication from other systems or equipment. The syndrome pattern-matching method outlined presents a simple approach to implementing efficient and effective FDIR logic. Performance issues discussed include: (1) intermittent faults, (2) multiple sequential failures, and (3) unanticipated syndromes. I.E.

A92-49278
THE OFFICE OF NAVAL RESEARCH INITIATIVE ON ULTRADEPENDABLE MULTICOMPUTERS AND ELECTRONIC SYSTEMS
GARY M. KOOB (U.S. Navy, Computer Science Div., Arlington, VA) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 170-174. refs
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The US Office of Naval Research initiative in ultradependable multicomputers and electronic systems is focused on the development of novel techniques for achieving high dependability in parallel and distributed systems. Some of the approaches being funded through the initiative and their role in the program as a whole are surveyed. The objective of the program is to achieve greater effectiveness and efficiency (than traditional massive redundancy) through the following: increased understanding of physical failure modes and their effects in real systems; increased sensitivity to the structure, semantics, and requirements of real applications; exploitation of the inherent redundancy in parallel systems; and examination of hardware/software tradeoffs. To achieve these objectives, an integrated program has been constructed around four major components: (1) measurement and modeling of real systems; (2) software-based methods such as robust algorithms; (3) efficient hardware-based methods and (4) real-time systems. I.E.

A92-49288
A NEW APPROACH TO EMBEDDED COMPUTER PERFORMANCE MEASUREMENT
DIANE KOHALMI, JOHN NEWPORT (U.S. Navy, Naval Avionics Center, Indianapolis, IN), DIANE PAUL, CHUCK ROARK, and DAVID G. STRUBLE (Texas Instruments, Inc., Defense Systems and Electronics Group, Plano) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 232-235.
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The authors report on the results of Phase I and options of the advanced avionics technology demonstration (AATD) embedded computer performance measurement (ECPM) program performed by Texas Instruments (TI) for the Naval Avionics Center (NAC). During this effort TI and NAC personnel developed novel techniques for measuring spare throughput and space I/O to be used (1) for comparison of different computing systems, and (2) as a systems engineering capability for determination of system reserves. The following aspects of the program are described in detail: problem definition, software structure, results, and system engineering aspects. I.E.

A92-49289
AN INTEGRATED ANALYSIS AND SIMULATION TOOL FOR AVIONICS SYSTEM DEVELOPMENT
JOHN R. LAPLANTE (Loral Instrumentation, San Diego, CA) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 236-241. refs
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The Loral Instrumentation System 500 is a complete avionics simulation and analysis development tool that addresses the spectrum of MIL STD 1553 avionics development needs, including: real-time monitoring; simulations; data capture, time stamping, and archival; multiple bus correlation; interactive data browsing; exhaustive postanalysis; and report generation. The expandable and portable System 500 is based on a UNIX/X Window System foundation. It uses OSF Motif for its multiwindowed graphical user interface. Loral plans to support other avionics bus standards, including the next-generation high-speed data bus under development for the advanced avionics architecture. I.E.

A92-49299
AUTOMATIC DOCUMENT GENERATION WITH CASE ON A DOD AVIONICS PROJECT
JOCK A. RADER (Hughes Aircraft Co., Radar Systems Group, Los Angeles, CA) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 305-310. refs
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Between December 1989 and June 1991 three major document deliveries were made to a US Navy customer, with all three documents automatically generated from a computer-aided-software-engineering (CASE) database. Some of the most significant improvements made between the June 1990 delivery and the February 1991 delivery are described, to give the flavor of the evolution of the CASE environment. The requirements specification generation was built around structured analysis. Problems encountered in introducing CASE are described. Guidelines developed for CASE introduction are discussed. I.E.

A92-49300
THE CATALYST SOFTWARE ENGINEERING ENVIRONMENT
H. E. ROMANOWSKY and S. L. MULHOLLAND (Collins Commercial Avionics, Cedar Rapids, IA) IN: IEEE/AIAA Digital

Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 311-316. refs
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The Catalyst software engineering environment provides a workstation-based approach which gives language-independent support for software requirements analysis and software preliminary design activities; it then narrows its scope to the support of Ada and C specific implementation work for the rest of the life cycle. Catalyst currently provides a set of loosely integrated tools which assist project members in their work as opposed to just using point solutions. Users of Catalyst have received benefits in the areas of automated requirements engineering, requirements management, software development process, and project management as a result of using version one of Catalyst. The authors focus on some of the challenges in Catalyst's development, its capabilities, and benefits of its use. I.E.

A92-49302
COMPUTER SOFTWARE IN CIVIL AIRCRAFT

J. P. P. POTOCKI DE MONTALK (Airbus Industrie, Blagnac, France) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 324-330.
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Airborne software is only one element of an aircraft's systems, and only one element of the aviation software environment. Consequently, it cannot be considered in isolation. Airborne software, is used where its benefits outweigh its advantages, notably to improve human factors, which are involved in most aircraft accidents. The timescales involve extend over many decades, and involve a large number of supplies. Airborne software is produced in accordance with uniquely severe aviation standards. These standards ensure that very great efforts are made to aim at freedom from errors, but freedom from faults is not assumed, and thus fault consequences are assessed and dealt with on a continuing basis. A number of powerful tools have been developed to facilitate software development and compliance with these standards. I.E.

A92-49317
ROUTE PLANNING

PETER STILES and IRA GLICKSTEIN (IBM Corp., Federal Sector Div., Owego, NY) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 420-425. refs
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Route planning is discussed as part of an avionics system. A very rapid route planning technique was developed based on the cellular automata (CA) paradigm. A CA consists of a 2-D, 3-D or higher-dimensional grid of cells. Each cell has either a real or virtual processor assigned to it, and communicates with neighboring cells to solve a variety of spatial-temporal problems. The route planner operates within a multidimensional cellular search space where there is a cost associated with travel through every cell. This cost is a weighted combination of many factors. To provide a dynamically adaptable level of resolution appropriate to the problem under consideration, a quadtree-based technique was developed. The basic route planning algorithm extends very naturally into the time dimension. I.E.

A92-49329
THE DATA FLOW SIMULATOR, A TOOL FOR SYSTEM SIMULATION

KATHLEEN M. JONES (Westinghouse Electric Corp., Baltimore, MD) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 504-509. refs
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Westinghouse has developed a unique and innovative tool, the data flow simulator (DFS), that directly links the software design to a hardware/operation system model that provides detailed information on the execution of the input software application and determines the system performance statistics, including processor utilization, bus utilization, memory utilization, critical transmission paths, operating system overhead and overall throughput for each application scenario that is input to the model. The DFS has been used on the AWACS radar system improvement program. Simulation has provided critical feedback to the software engineers as a result of DFS outputs that showed the impact of bus conflicts on processor utilization, bottlenecks in the design, the impact of the software to hardware mapping on overall throughput, and the impact of various Ada tasking schemes on system performance. I.E.

A92-49339
THE CONCEPT EXPLORATION STAGE OF A DEPENDABLE AVIONIC SYSTEM

TIMOTHY P. MONAGHAN (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 572-576. refs
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The fault tolerant aspects of the evaluations and trade studies done in the concept evaluation stage of a mission avionics system are discussed. These studies are considered from the point of view of the government program office in charge of the RFP, SOW, design review and milestone deliverables. The author touches on some of the possible fault-tolerant specifications, a fault-tolerant evaluation criteria for the qualitative analysis of the design in the system requirements review (SRR) and system design review (SDR), and the wide range of possible fault injection methods and validation techniques. I.E.

A92-49585
ON MULTIPLE GRID METHOD

OUYANG JIE and TIEJUN NIE (Northwestern Polytechnical University, Xian, People's Republic of China) Northwestern Polytechnical University, Journal (ISSN 1000-2758), vol. 10, no. 3, July 1992, p. 410-417. In Chinese. refs

It is determined that, up to six layers, the greater the number of layers used in the multiple grid (MG), the higher the computational efficiency. The computational efficiency increases markedly with each additional layer. Within the allowable range of 0 to 1, different values of the two controlling parameters are found to have only a slight influence on the computation time. For linear elliptic equations, the MG method requires much less computation time than the Gauss or SOR methods. Controlling parameters are easily selected for the MG method, but the choice of an approximate optimum relaxation factor for the SOR method requires much experimenting. P.D.

A92-50013
THE USE OF MATH-DYNAMIC MODELS TO AID THE DEVELOPMENT OF INTEGRATED HEALTH AND USAGE MONITORING SYSTEMS

H. AZZAM and M. J. ANDREW (MJA Dynamics, Ltd., Hamble, England) Institution of Mechanical Engineers, Proceedings, Part G - Journal of Aerospace Engineering (ISSN 0954-4100), vol. 206, no. G1, 1992, p. 71-76. Research supported by Bristow Helicopters, Ltd., Ministry of Defence of England, and Civil Aviation Authority. refs
Copyright

Development of integrated health and usage monitoring systems (IHUMS) involved the use of personal computer-based math-dynamic models, which in this particular case simulate a range of helicopter rotor system faults and potentially catastrophic failures. Using both theoretical and in-field data, over 120 fault cases have been analyzed to identify discriminatory characteristics. This paper reports on the background of the math-dynamic models and the findings of the diagnostic analysis. Author

A92-50466* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ON CENTRAL-DIFFERENCE AND UPWIND SCHEMES
R. C. SWANSON (NASA, Langley Research Center, Hampton, VA) and ELI TURKEL (Tel Aviv University, Israel; ICASE, Hampton, VA) Journal of Computational Physics (ISSN 0021-9991), vol. 101, no. 2, Aug. 1992, p. 292-306. Previously announced in STAR as N90-26595. refs
Copyright

A class of numerical dissipation models for central-difference schemes constructed with second- and fourth-difference terms is considered. The notion of matrix dissipation associated with upwind schemes is used to establish improved shock capturing capability for these models. In addition, conditions are given that guarantee that such dissipation models produce a Total Variation Diminishing (TVD) scheme. Appropriate switches for this type of model to ensure satisfaction of the TVD property are presented. Significant improvements in the accuracy of a central-difference scheme are demonstrated by computing both inviscid and viscous transonic airfoil flows. Author

A92-50471
A FAST CONFORMAL MAPPING ALGORITHM WITH NO FFT
P. LUCHINI and F. MANZO (Napoli, Universita, Naples, Italy) Journal of Computational Physics (ISSN 0021-9991), vol. 101, no. 2, Aug. 1992, p. 368-374. Research supported by MPI. refs
Copyright

While most existing iterative techniques rely on the FFT algorithm for calculating a convolution integral that represents the most time-consuming phase of the computation, the FFT cannot be applied to nonuniform spacing. An alternative algorithm is presented for broad application to fluid dynamics which computes a conformal mapping that is discretized on a nonuniformly spaced point set. This algorithm proceeds from the construction of a calculation method for convolution integrals which maintains a computation time that is of the same order as that of the FFT. The technique is illustrated through application to the conformal mapping of a closely spaced airfoil cascade onto a circle. O.C.

A92-50490* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
H-INFINITY SYNTHESIS USING A BILINEAR POLE SHIFTING TRANSFORM
R. Y. CHIANG (JPL, Pasadena, CA) and M. G. SAFONOV (Southern California, University, Los Angeles, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 5, Sept.-Oct. 1992, p. 1111-1117. refs
(Contract F49620-92-J-0014)
Copyright

An H-inifinity control law design is presented for a benchmark problem consisting of an undamped pair of spring-coupled masses with a sensor and actuator that are not collocated. This simple mechanical system captures many of the salient features of more complex aircraft and space structure vibration control problems. The H-infinity problem formulation enables the issue of stability robustness in the face of large mass and spring constant variation to be directly addressed. Constraints on closed-loop dominant pole locations and settling time are accommodated via a simple s-plane bilinear transform. The transform parameter can give direct control of closed-loop disturbance settling time and controller open-loop pole-zero locations. A four-state H-infinity minimum phase controller was found to meet the given specifications of each design. Detailed analysis on the tradeoffs of sensor noise vs control energy are also presented. Author

A92-50499
OPTIMAL DISCRETE-TIME STATIC OUTPUT-FEEDBACK DESIGN - A W-DOMAIN APPROACH
CHEOLKEUN HA and UY-LOI LY (Washington, University, Seattle) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 5, Sept.-Oct. 1992, p. 1175-1182. Research supported by Boeing Advanced Systems Group. Previously cited in issue 21, p. 3735, Accession no. A91-49754. refs

A92-50505* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
STOCHASTIC PREDICTION TECHNIQUES FOR WIND SHEAR HAZARD ASSESSMENT
D. A. STRATTON and ROBERT F. STENGEL (Princeton University, NJ) (IEEE Conference on Decision and Control, 29th, Honolulu, HI, Dec. 5-7, 1990, Proceedings. Vol. 2, p. 702-707) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 5, Sept.-Oct. 1992, p. 1224-1229. Previously cited in issue 01, p. 116, Accession no. A92-11381. refs
(Contract NAG1-834)
Copyright

A92-50513
NEGATIVE STATE WEIGHTING IN THE LINEAR QUADRATIC REGULATOR FOR AIRCRAFT CONTROL
F. M. AL-SUNNI, B. L. STEVENS (Georgia Institute of Technology, Atlanta), and F. L. LEWIS (University of Texas at Arlington, Fort Worth) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 5, Sept.-Oct. 1992, p. 1279-1281. refs
Copyright

A relation is developed between the state-weighting matrix in the linear quadratic objective function and the open-loop and closed-loop eigenvalues of single-input systems. A stability augmentation system is designed for the F-16 aircraft short-period approximation. In this design, negative weighting is found necessary to achieve the MIL qualifications. P.D.

A92-51328
CONDITIONS OF OPTIMALITY IN PROBLEMS OF GENERALIZED CONTROL. II - SUFFICIENT CONDITIONS OF OPTIMALITY [USLOVIIA OPTIMAL'NOSTI V ZADACHAKH OBOBSHCHENNOGO UPRAVLENIIA. II - DOSTATOCHNYE USLOVIIA OPTIMAL'NOSTI]
B. M. MILLER (PO Krasnogorskii Zavod, Tsentral'noe Konstruktorskoe Biuro, Krasnogorsk, Russia) Avtomatika i Telemekhanika (ISSN 0005-2310), no. 4, April 1992, p. 39-48. In Russian. refs
Copyright

The paper examines the problem of the sufficiency of the generalized maximum principle as the condition of optimality in problems of the control of systems with a linear-convex structure. Examples of the use of the results obtained in problems of observer control are presented. The results are also of interest in connection with flight-control problems. L.M.

A92-52440#
DEVELOPMENT OF A REAL-TIME SIMULATION OF A SHIP-CORRELATED AIRWAKE MODEL INTERFACED WITH A ROTORCRAFT DYNAMIC MODEL
WARREN F. CLEMENT, PETER J. GORDER, and WAYNE F. JEWELL (Systems Technology, Inc., Mountain View, CA) IN: AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers. Washington, American Institute of Aeronautics and Astronautics, 1992, p. 127-137. refs
(Contract N00019-91-C-0176)
(AIAA PAPER 92-4149) Copyright

This paper describes a study outlining approaches for modeling mathematically in real-time simulation the kinematics of a ship and the dynamics of a rotorcraft interacting aerodynamically within the ship's airwake on approach and landing aboard the moving ship. Specific recommendations are made to modify an extant real-time simulation model of a rotorcraft, including the interfacing of the ship-correlated airwake model with the blade element aerodynamic model of the rotor. A method for modeling the three-dimensional, spatially correlated airwake is also presented. Author

A92-52448*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ALGORITHMIC IMPROVEMENTS FOR SIMULATOR MOTION DRIVE

SOREN LAFORCE and JOHN W. BUNNELL (SYRE, Inc.; NASA, Ames Research Center, Moffett Field, CA) IN: AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers. Washington, American Institute of Aeronautics and Astronautics, 1992, p. 213-219. refs
(AIAA PAPER 92-4158) Copyright

Contemporary simulator motion drive algorithms typically are designed in an analog (continuous) environment, but are implemented in a digital (discrete) environment. The intended continuous system, specified as frequency domain (Laplace transform) transfer functions, may not be represented properly by the algorithms used for digital implementation. The motion drive software in use with the Vertical Motion Simulator at Ames Research Center was investigated recently; the original algorithms (Euler) were changed to a state transition method. Comparison of the frequency responses of the original and new implementations showed that the state transition method more closely approximates the desired analog responses. In addition, test pilots who evaluated both implementations preferred the motions generated with the state transition method over those generated with the Euler integration method. Author

A92-52450#
SIMULATION SOFTWARE FLOWDOWN IN THE AIRCRAFT DESIGN PROCESS - PROBLEMS AND SOLUTIONS
L. M. LANDRY, JR. and DOROTHY M. BALDWIN (General Dynamics Corp., Fort Worth, TX) IN: AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers. Washington, American Institute of Aeronautics and Astronautics, 1992, p. 229-234. refs
(AIAA PAPER 92-4160) Copyright

Software models of aircraft systems are typically developed several times in the design of Military aircraft. As many as four different sets of software which model the aircraft may be developed, resulting in additional cost and schedule, and requiring additional validation at each step. This paper addresses this process, discusses some of the impediments to software reuse in the design process, gives examples of software reuse in recent programs, overviews recent developments which offer potential for improvements, and gives examples of improved processes. Author

A92-52451#
MANIPULATION AND MANAGEMENT OF DATA COLLECTED AT THE CREW STATION RESEARCH AND DEVELOPMENT FACILITY - A CASE STUDY
STEVEN B. ROGERS (U.S. Army, Crew Station Research and Development Branch, Moffett Field, CA), DAVID KENNEDY (Monterey Technologies, Inc., Carmel, CA), and PERRY MEADE (CAE Electronics, Ltd., St. Laurent, Canada) IN: AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers. Washington, American Institute of Aeronautics and Astronautics, 1992, p. 235-243.
(AIAA PAPER 92-4162)

The collection, manipulation, and storage of data from simulations of combat mission flight is examined based on experiences at the Crew Station Research and Development Facility. The rotorcraft simulator facility is described with attention given to data flow from collection through processing and delivery. Data collection is shown to be improved by conducting a dry run to: (1) verify data-list collection; (2) identify additional collection needs; and (3) verify avaliable recording time. Run-time documentation and experimental run information can enhance the processing and analysis of the data, and data-recording systems should be able to freeze the data collection to protect data integrity. The data can also be stored in a relational database to optimize the organization and manipulation of the data products. Other techniques are discussed for data visualization and delivery that can enhance the use and dissemination of useful information from simulation facilities. C.C.S.

A92-52454#
SPECIAL ROTATION VECTORS QUATERNIONS IN THREE COMPONENTS
AMNON KATZ (Alabama, University, Tuscaloosa) IN: AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers. Washington, American Institute of Aeronautics and Astronautics, 1992, p. 261-266. refs
(AIAA PAPER 92-4168) Copyright

Special Rotation Vectors (SRV) are a means for specifying orientation in three dimensions that is a cross between a generalization of Wigner's rotation vectors and Euler/Hamilton quaternions. SRV constitute a continuous one to one mapping of orientation over a three dimensional manifold. Orientations are specified by three parameters while retaining virtually all the computational advantages of the quaternion method. Author

A92-52455#
NETWORKED SIMULATION OF MULTIPLE AIRCRAFT USING SEMI-AUTOMATED FORCES
G. R. VRABLIK and ROBERT B. CALDER (Bolt Beranek & Newman, Inc., BBN Systems and Technologies Div., Cambridge, MA) IN: AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers. Washington, American Institute of Aeronautics and Astronautics, 1992, p. 267-276. Research supported by DARPA. refs
(Contract MDA972-90-C-0061; DACA76-91-C-0005; DACA76-91-C-0006)
(AIAA PAPER 92-4170) Copyright

This paper examines the development of a networked semiautomated fixed-wing and rotary-wing aircraft simulation. Semi-Automated Forces (SAF) is a system which simulates multiple (currently approximated 100) vehicles under the control of a single operator for use with networked simulations. This system was constructed to provide an extensive and realistic threat to manned ground-vehicle and air-vehicle simulators in a distributed simulation environment. The software which implemented the fixed-wing aircraft and rotary-wing aircraft simulation was built upon an existing SAF system, which operated in a ground-vehicle environment. The problems encountered and solutions produced during the development of this software, called AIRNET SAF are described. Author

A92-52456#
DEAD RECKONING FOR AIRCRAFT IN DISTRIBUTED INTERACTIVE SIMULATION
SURESH GOEL and KENNETH D. MORRIS (Northrop Corp., Hawthorne, CA) IN: AIAA/AHS Flight Simulation Technologies Conference, Hilton Head Island, SC, Aug. 24-26, 1992, Technical Papers. Washington, American Institute of Aeronautics and Astronautics, 1992, p. 277-284. refs
(AIAA PAPER 92-4171) Copyright

The application of large numbers of networked simulators is considered for fighter aircraft by means of distributed interactive simulation (DIS) using a number of extrapolation algorithms. Specific attention is given to the differences between first- and second-order extrapolation and to compensation techniques for second-order extrapolation delays caused by large distances. Low-frequency updating is shown to cause large jumps in the networks, and Euler algorithms in conjunction with smoothing methods are found to be suitable for compensation. Second-order dead reckoning combined with smoothing procedures leads to low update rates with delays of up to 750 msec. A time tag can be sent with each update message to update position and attitude parameters. Roll maneuvers are shown to produce the most significant effects on update rates, but DIS is shown to be feasible with high-speed aircraft simulations. C.C.S.

A92-53023
MAXIMUM LIKELIHOOD ALGORITHM AND ITS APPLICATION TO PARAMETER IDENTIFICATION OF CLOSED-LOOP FLIGHT VEHICLES
PINGYUAN CUI, DI YANG, YAOHUA WU, and XUEXIAO WANG

(Harbin Institute of Technology, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 11, Nov. 1991, p. A644-A649. In Chinese. refs

The maximum likelihood algorithm is used to estimate the aerodynamic coefficients of closed-loop flight vehicles. Based on the dynamic model of aircraft, using the differential smooth technique, the linear estimation formula of aerodynamic parameters is given. For closed-loop flight vehicles, determination of an aerodynamic model and the effect of nonlinearity of sensors on the accuracy of identification of aerodynamic coefficients are investigated. Finally, some considerations on aerodynamic parameters estimation in the case of closed-loop flight are given by the estimation results of aerodynamic coefficients from 6DOF simulated data of a closed-loop vehicle. Author

A92-53069
A REVIEW OF SOME COMPUTER PROGRAMS OF COMPOSITES
LINRUI ZHANG (Chengdu Aircraft Corp., China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 12, Dec. 1991, p. B628-B630. In Chinese. refs

A review is presented on the computer programs designed for the analysis of composite materials for aviation structures. These include computer programs for linear and nonlinear static analyses, stability analyses, analyses of vibration and flutter, and for optimum design. Consideration is given to the relative advantages, the salient features, the drawbacks, the possibility of future improvements, and the application of these programs. Particular attention is given to newly developed programs; for example, programs for the coupling and hygrothermal effects, for interlaminar stress, and for impact damage. I.S.

A92-53093
DEVELOPMENT OF DATA BASE SYSTEM IN CIEM PROJECT
DEGANG CUI (Shenyang Aircraft Corp., China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 8, Aug. 1991, p. B369-B376. In Chinese.

The Computer Integrated Engineering and Manufacturing (CIEM) system is used to develop a computer software integration system to meet aircraft development requirements. Both the data base system and file management system (archive system) are introduced in the integration system. How to develop a data base system in this project is given. It includes the data scheme definition in the aeronautical field and the data management solution using the data base and archive system. After testing and running it has been proved that the development of the CIEM data base system is successful. Author

A92-53109
STANDARDIZING OPERATIONAL FLIGHT DATA HANDLING
FRED SHOWS, JESSE AYALA (USAF, San Antonio Air Logistics Center, Kelly AFB, TX), and PAUL J. BREAUX (Southwest Research Institute, San Antonio, TX) IN: AUTOTESTCON '91; IEEE Systems Readiness Technology Conference, Anaheim, CA, Sept. 24-26, 1991, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 113-115.
Copyright

Improving system effectiveness through standardization of data transfer operations required to support avionics system is an objective of logistics centers. The Digital Computer System (DCS) was developed in response to this objective. This automated support system standardizes the loading, unloading, and verification of operational flight information transferred to and from avionic systems. It is estimated that this should save the US Air Force a minimum of two million dollars in the first year of deployment as the replacement of multiple outdated data transfer systems. I.E.

A92-53382
A REVERSED-FRAME NORMALIZATION DESIGN OF ROBUST FLIGHT CONTROL SYSTEM
CHANGSHENG JIANG, CHUNLIN SHEN, and ZHONGHAN HU (Nanjing Aeronautical Institute, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 3, March 1991, p. A159-A166. In Chinese. refs

The theory and a method of a reversed-frame normalization design of robust flight control system are discussed. A robust stability theorem of the normal transfer function matrix with the same characteristic gain loci is presented. A practical example of designing flight control system is used for illustrating the application and the advantage of this method. Author

N92-30322# University of Southern California, Los Angeles.
PRACTICAL METHOD'S FOR ROBUST MULTIVARIABLE CONTROL Final Report, 1 Aug. 1989 - 31 Oct. 1991
MICHAEL G. SAFONOV and EDMOND A. JONCKHEERE 31 Dec. 1991 9 p
(Contract AF-AFOSR-0398-89)
(AD-A248473) Avail: CASI HC A02/MF A01

The theme of the research was making modern control theory work. The product of the research has been theory, algorithms, and software applicable to multivariable feedback control problems in which there are design constraints requiring robust attainment of stability and control performance objectives in the face of both structured and unstructured uncertainty. Advances in the past two years have included relative-error methods for system identification, model reduction and control, better algorithms for H- and H2 control computations, and new results on the analysis of stability robustness in the presence of several uncertain real parameters. Although the research was aimed primarily at developing basic concepts, theory, and methodology for robust control design, the theory that is emerging from the research is already beginning to play a significant role in facilitating the control design process in a variety of aerospace engineering applications where robust performance is prerequisite, including aircraft stability augmentation systems, highly maneuverable aircraft design, missile guidance systems, and precision pointing and tracking systems. GRA

N92-30335# Illinois Univ., Urbana. Coordinated Science Lab.
NONLINEAR SYSTEM DESIGN: ADAPTIVE FEEDBACK LINEARIZATION WITH UNMODELED DYNAMICS Final Report, 1 Oct. 1989 - 30 Sep. 1991
PETER V. KOKOTOVIC 30 Sep. 1991 44 p
(Contract AF-AFOSR-0011-90)
(AD-A248484; AFOSR-92-0215TR) Avail: CASI HC A03/MF A01

The main goal of this research is to develop a unified geometric-asymptotic-adaptive methodology for feedback design of nonlinear control systems. Such a methodology is needed because the existing differential geometric results are restrictive and often violated by small modeling errors. Effects of these errors can be analyzed asymptotically by singular perturbation methods, which however, are still lacking a clear geometric interpretation. Neither geometric, nor perturbational problem formulations can cope with large parametric uncertainty, for which an adaptive approach seems suitable. Conversely, both geometric and asymptotic techniques are to be merged into a methodology which eliminates their individual shortcomings. GRA

N92-30898*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A SIMPLIFIED DYNAMIC MODEL OF THE T700 TURBOSHAFT ENGINE
AHMET DUYAR (Florida Atlantic Univ., Boca Raton.), ZHEN GU (Florida Atlantic Univ., Boca Raton.), and JONATHAN S. LITT Jun. 1992 22 p Presented at the 48th American Helicopter Society Annual Forum, Washington, DC, 3-5 Jun. 1992; sponsored by the American Helicopter Society
(Contract NAG3-1198; DA PROJ. 1L1-61102-AH-45)
(NASA-TM-105805; E-7235; NAS 1.15:105805;
AVSCOM-TR-92-C-024; RTOP 505-62-0K) Avail: CASI HC A03/MF A01

A simplified open-loop dynamic model of the T700 turboshaft engine, valid within the normal operating range of the engine, is developed. This model is obtained by linking linear state space models obtained at different engine operating points. Each linear model is developed from a detailed nonlinear engine simulation

using a multivariable system identification and realization method. The simplified model may be used with a model-based real time diagnostic scheme for fault detection and diagnostics, as well as for open loop engine dynamics studies and closed loop control analysis utilizing a user generated control law. Author

N92-30907*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DELAUNAY TRIANGULATION AND COMPUTATIONAL FLUID DYNAMICS MESHES
MARY-ANNE K. POSENAU and DAVID M. MOUNT (Maryland Univ., College Park.) Aug. 1992 10 p Presented at the 4th Canadian Conference on Computational Geometry, Aug. 1992
(Contract RTOP 505-90-53-02)
(NASA-TM-107663; NAS 1.15:107663) Avail: CASI HC A02/MF A01

In aerospace computational fluid dynamics (CFD) calculations, the Delaunay triangulation of suitable quadrilateral meshes can lead to unsuitable triangulated meshes. Here, we present case studies which illustrate the limitations of using structured grid generation methods which produce points in a curvilinear coordinate system for subsequent triangulations for CFD applications. We discuss conditions under which meshes of quadrilateral elements may not produce a Delaunay triangulation suitable for CFD calculations, particularly with regard to high aspect ratio, skewed quadrilateral elements. Author

N92-30954# Air Inter, Lignes Aeriennes Interieures, Paris (France).
PREPARATION FOR A NEW PLANE (A 320): EXPERIENCE REVIEWED [PREPARATION A L'ACCUEIL D'UN NOUVEAU AVION (A 320): RETOUR D'EXPERIENCE]
D. BOUBEL *In* CEP Systemes, ILS, CE, CALS? From Design to Operation 56 p 1991 In FRENCH
Avail: CASI HC A04/MF A02

The main tasks accomplished in preparation for a new A320 plane are presented. The topics discussed are: fleet age of international airlines; the IT fleet age on the 01/01/92; A-320 delivery schedule; maintenance policy and program development; airplane control and technical documentation; material supply, maintenance operations, and required tools; computer aided monitoring and control for the plane and the turbine; the ACARS program; the maintenance teams and places; cooperation with flight crew; results; and technical, economic and human improvements. ESA

N92-31864# Boeing Commercial Airplane Co., Seattle, WA. Program Management Div.
INTEGRATED COMPUTER SYSTEMS IN AIRCRAFT DESIGN AND MANUFACTURE: DIFFICULTIES AND IMPLICATIONS
W. W. BRAITHWAITE *In* Israel Society of Aeronautics and Astronautics, 31st Israel Annual Conference on Aviation and Astronautics p 18-26 22 Feb. 1990 Previously announced in IAA as A91-43079
Avail: CASI HC A02/MF A03

Boeing's aircraft design process begins with a mathematical model of the aircraft shell, implemented on CDC/CYBER equipment and IBM mainframe computers. A model extraction system is used to extract contours from the model onto desired planes. Analyses of element kinematics, section properties and structural members is based on the model or on detail design. Drawing preparation involves interactive graphics, an automatically programmed tool (APT) system. Boeing has developed interface systems for data exchange among the various design and engineering systems, and network interface processors for converting data for exchange among several networks. The CATIA system enables solid and wireframe models to be simulated and digital mockups of structural units to be constructed. Use of such digital mockups yields considerable cost and time savings in routing cables, wiring, tubes, etc. ISA

N92-32229# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Guidance and Control Panel.
PROCEEDINGS OF THE 53RD SYMPOSIUM ON AIR VEHICLE MISSION CONTROL AND MANAGEMENT [LA GESTION ET LE CONTROLE DES MISSIONS DES VEHICULES AERIENS]
DUNCAN E. MCIVER Jul. 1992 14 p Symposium held in Amsterdam, Netherlands, 22-25 Oct. 1991
(AGARD-AR-310; ISBN-92-835-0678-2; CP-504; CP-504S)
Copyright Avail: CASI HC A03/MF A01

This document gives summaries of papers presented at the Guidance and Control Panel 53rd Symposium held from Oct. 22 to Oct. 25, 1991. Topics covered by these papers include: operational mission considerations; situation assessment; route planning; planning techniques; and implementation aspects. H.A.

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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.

A92-49475
MEASUREMENT OF ACOUSTIC PROPERTIES OF THE COMPOSITE MATERIALS CONSTITUTING THE MAIN ROTOR HUB OF THE AGUSTA-WESTLAND HELICOPTER EH-101 (CIVIL VERSION)
L. TENTI (Agusta S.p.A., Cascina Costa di Samarate, Italy), R. DENIS, and F. LAKESTANI (CEC, Joint Research Centre, Ispra, Italy) NDT & E International (ISSN 0963-8695), vol. 24, no. 5, Oct. 1991, p. 253-258. refs
Copyright

The acoustic properties of the EH-101 helicopter rotor hub are tested by characterizing the ultrasonic propagation phenomena in the main directions of the composite materials. The carbon fiber and epoxy resin that make up the rotor hub are measured to determine the attenuation coefficient, phase propagation at normal incidence, and phase propagation as a function of angle of incidence. The speeds are measured for external box and filler samples, and strap samples are discussed separately because of their anisotropic nature and structural importance. Deviations angles of 5 deg cause refraction angles of 10 deg in the deviation of the phase propagation; therefore planar defects with an angle of 10 deg relative to the fiber direction can be easily detected. The method presented is useful in characterizing and locating defects in the composite materials that make up the main rotor hub of helicopters. C.C.S.

A92-50206
THE ENGINEERING PREDICTION FOR AIRCRAFT NOISE
DIYI TANG, WENLAN LI, WEIYANG QIAO, and ZHENXIA LIU (Northwestern Polytechnical University, Xian, People's Republic of China) Chinese Journal of Aeronautics (ISSN 1000-9361), vol. 4, no. 3, Aug. 1991, p. 295-304. Previously cited in issue 07, p. 1108, Accession no. A91-22370. refs
Copyright

A92-50296* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DIRECT EVALUATION OF AEROACOUSTIC THEORY IN A JET
JAMES BRIDGES (Sverdrup Technology, Inc.; NASA, Lewis Research Center, Cleveland, OH; Houston, University, TX) and FAZLE HUSSAIN (Houston, University, TX) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 240, July 1992, p. 469-501. refs
(Contract NAG3-639; N00014-89-J-1361)
Copyright

Aeroacoustic theory is applied to low-Mach (M = 0.08) cold

jets, focusing on motion at scales which allow the assumption that the entire jet diameter is acoustically compact. The primary result is that the measured sound field directivity of vortex ring pairing in circular jets is similar to that predicted by the theory: a stationary axisymmetric lateral quadrupole. It is also shown that pairing of purely axisymmetric coherent structures is not the dominant sound source in low-Mach-number jets and that vortex asymmetry must be an essential aspect of the vortex motions which produce noise in such jets. V.L.

A92-50401
GENERAL PERFORMANCE CHARACTERISTICS OF REAL HEAT ENGINE
J. M. GORDON (Negev, University, Sede Boqer, Israel) and MAHMOUD HULEIHIL (Negev, University, Beersheba, Israel) Journal of Applied Physics (ISSN 0021-8979), vol. 72, no. 3, Aug. 1, 1992, p. 829-837. Research supported by Licht Foundation and Blaustein International Center. refs
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Realistic upper bounds can be placed on the power and efficiency of real heat engines via a relatively simple analytic treatment of primary sources of irreversibility. Generalized curves for heat engine performance, their universal nature, and quantitative evaluation of upper bounds for power and efficiency are derived for the following engine types: Brayton cycle (gas turbines); Rankine cycles (steam turbines); and cycles with sizable heat leaks, such as thermoelectric generators. The key irreversibility sources include fluid friction, the constraint of the equation of state of the engine's working fluid, and heat leak. It is demonstrated that maximum power and maximum efficiency operating points are usually relatively close, with the associated implications for the selection of optimal heat engine operating conditions. Author

A92-52847
PROGRESS TOWARDS QUIETER CIVIL HELICOPTERS
M. V. LOWSON (Bristol, University, United Kingdom) (European Rotorcraft Forum, 17th, Berlin, Germany, Sept. 24-27, 1991) Aeronautical Journal (ISSN 0001-9240), vol. 96, no. 956, June-July 1992, p. 209-223. refs
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A review of recent developments in helicopter noise reduction is presented. The paper includes a discussion of the present state of understanding of helicopter noise radiation mechanisms and a review of actual noise reductions achieved by the manufacturers over the past decade. An analysis of progress achieved in meeting certification limits is given, together with an evaluation of the impact on design. Future trends in helicopter noise reduction based on current noise research programs are discussed and suggestions advanced for possible additional areas of study. Author

A92-53091
IMPROVEMENT IN TRANSMISSION LOSS OF AIRCRAFT DOUBLE WALL WITH RESONATORS
JINCAI SUN, LIMING SHI, and XINING YE (Northwestern Polytechnical University, Xian, China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, no. 8, Aug. 1991, p. B358-B363. In Chinese. refs

A little volume low frequency resonator applicable to double-wall configuration of propeller-driven aircraft was designed on the basis of the principle of Helmholtz resonator. The normal incidence absorption coefficient of the various single resonator has been measured. The agreement between theoretical and experimental results is encouraging. An array of resonators whose resonant frequency at 85 Hz and 160 Hz, respectively, are installed between aircraft double-panel, and it has been shown that transmission loss of the double wall structure with resonators improve 4 dB and 6.5 dB in 1/3rd octave bandwidth at 80 Hz and 160 Hz center frequency, respectively, and 5 dB and 7 dB at resonant frequencies, compared with that of the double wall configuration without resonators. Author

A92-53257
EXPERIMENTAL STUDY OF THE EQUIVALENT SOUND SOURCE CENTER OF THE PROPELLER ROTATING NOISE
QIANG ZHANG and JIAJIN GU (Nanjing Aeronautical Institute, China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956), vol. 24, no. 3, June 1992, p. 265-273. In Chinese. refs

The theory and experimental technique for identifying the source of various propeller rotating noises using a cross-spectrum analysis method are discussed. The measurement of the equivalent source center of such noise on the light aircraft AD-200 is presented as an example. The efficiency of the method gives it excellent prospects for large-scale application. C.D.

N92-31248*# General Electric Co., Cincinnati, OH. Aircraft Engines.
HIGH SPEED TURBOPROP AEROACOUSTIC STUDY (COUNTERROTATION). VOLUME 2: COMPUTER PROGRAMS
C. E. WHITFIELD, R. MANI, and P. R. GLIEBE Jul. 1990 177 p
(Contract NAS3-23721; RTOP 535-05-01)
(NASA-CR-185242; NAS 1.26:185242) Avail: CASI HC A09/MF A02

The isolated counterrotating high speed turboprop noise prediction program developed and funded by GE Aircraft Engines was compared with model data taken in the GE Aircraft Engines Cell 41 anechoic facility, the Boeing Transonic Wind Tunnel, and in the NASA-Lewis 8 x 6 and 9 x 15 wind tunnels. The predictions show good agreement with measured data under both low and high speed simulated flight conditions. The installation effect model developed for single rotation, high speed turboprops was extended to include counter rotation. The additional effect of mounting a pylon upstream of the forward rotor was included in the flow field modeling. A nontraditional mechanism concerning the acoustic radiation from a propeller at angle of attack was investigated. Predictions made using this approach show results that are in much closer agreement with measurement over a range of operating conditions than those obtained via traditional fluctuating force methods. The isolated rotors and installation effects models were combined into a single prediction program. The results were compared with data taken during the flight test of the B727/UDF (trademark) engine demonstrator aircraft. Author

N92-31454# General Accounting Office, Washington, DC. Resources, Community, and Economic Development Div.
AVIATION NOISE: COSTS OF PHASING OUT NOISY AIRCRAFT
Jul. 1991 58 p
(GAO/RCED-91-128; B-239410) Avail: CASI HC A04/MF A01; GAO, PO Box 6015, Gaithersburg, MD 20877 HC

In Sept. 1990 this group testified on the costs of phasing out older, relatively noisy aircraft and on how these costs would be affected by the independent adoption of noise restrictions by airports. In Nov. 1990 the Airport Noise and Capacity Act of 1990 was enacted. This act phased out the noisiest jets currently in use by the year 2000 and limits the discretion of airports to adopt their own noise restrictions. This report briefly describes the likely effects of this Act on the costs to the airline industry of aviation noise restrictions. H.A.

N92-31767# Naval Postgraduate School, Monterey, CA.
FURTHER STUDIES IN FILMWISE CONDENSATION OF STEAM ON HORIZONTAL FINNED TUBES M.S. Thesis
KEITH A. SWENSEN Mar. 1992 141 p
(AD-A252705) Avail: CASI HC A07/MF A02

Over the years, there has been significant variation in the filmwise steam condensation data at NPS on horizontal low-integral finned tubes. With a view to increasing the accuracy of the data, inserts were used inside the tubes to reduce inside thermal resistance; however, significant discrepancies then occurred in the calculated outside heat-transfer coefficient when compared to data taken without an insert. These discrepancies arose due to the data reduction technique which assumes a known inside heat-transfer resistance and subtracts this from a measured overall

resistance. If the assumed value on the inside is inaccurate, then the outside value is equally inaccurate. The present work uses an instrumented smooth tube to obtain accurate inside heat-transfer correlations both with and without inserts and uses these to obtain accurate outside coefficients for a family of uninstrumented finned tubes with a view to finding an optimum fin spacing for steam condensation. GRA

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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.

A92-49269
AVIONICS SYSTEMS ENGINEERING EDUCATION
JAMES RANKIN (Saint Cloud State University, MN) IN: IEEE/AIAA Digital Avionics Systems Conference, 10th, Los Angeles, CA, Oct. 14-17, 1991, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 110-114. refs
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The Rockwell International-Collins Avionics Divisions are developing an avionics systems engineering graduate program with Iowa State University. The author discusses the proposed curriculum and the four avionics systems engineering courses that will be offered. The four courses are: Systems Engineering and Analysis, Avionics Systems Engineering, System Project Management, and Software Systems Engineering. The Systems Engineering and Analysis course introduces system engineering concepts and principles. The second course applies the system engineering techniques presented in the first course to avionics. Current avionics functions are presented and then used to discuss avionics systems. The third course discusses avionics systems engineering from the project management viewpoint. The Software Systems Engineering course examines the systems aspect of software. I.E.

A92-49380
NAVIGATION CHARTS ON TRIAL - HOW SAFE IS SAFE?
ROBERT B. SCHULTZ (Mendes & Mount, Los Angeles, CA) Navigation (ISSN 0028-1522), vol. 39, no. 1, Spring 1992, p. 25-49. refs
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The facts in several aircraft crash law suits where the plaintiff claimed that the accident was caused at least in part by defects in an air navigation chart are reviewed. This paper does not address the question of how navigation charts might be designed to ensure safety or to avoid product liability lawsuits. Attention is focused on a survey of actual lawsuits against a chartmaker and the U.S. Government, and to give the potential mapmaker an appreciation for the variety of claims that have recently been made. R.E.P.

A92-49835
RESEARCH ON AIRCRAFT LIFE CYCLE COST REDUCTION
RUGEN WANG (Air Force College of Engineering, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, no. 3, July 1992, p. 235-237. In Chinese. refs

On the basis of cost data collected from factories and the air force, the variation of life cycle cost is analyzed for the fighters in which one of four kinds of engine is installed, respectively. It has been found that there should be a marked drop in the aircraft life cycle cost, if the suitable fund is allocated to increasing reliability, decreasing specific fuel consumption and lengthening time between two overhauls of the aircraft engine. Author

A92-51424
A NEW ASPECT OF FUTURE AIR NAVIGATION SYSTEMS - HOW SECONDARY SURVEILLANCE RADAR MODE S COULD PROTECT CIVIL AVIATION
STEFAN A. KAISER Zeitschrift fuer Luft- und Weltraumrecht (ISSN 0340-8329), vol. 41, no. 2, June 1992, p. 154-164. refs
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Technical aspects of the electronic identification of aircraft are briefly reviewed, and the existing legal regime for the protection and identification of medical and civil aircraft is described. A future identification regime based on Secondary Surveillance Radar Mode S is outlined. C.D.

A92-51450
ANNALS OF AIR AND SPACE LAW. VOL. 16
NICOLAS MATEESCO MATE, ED. (McGill University, Montreal, Canada) Montreal/Paris, McGill University/Editions A. Pedone, 1991, 554 p. In English and French. No individual items are abstracted in this volume.
Copyright

The present volume on air and space law encompasses current legal issues regarding the use of airspace, space transportation and commercialization, activities in international space organizations, leading cases in aerospace law, legislative texts, and reviews of key books. Specific issues addressed include aircraft financing and drugs, products liability in Germany, a system for liability in air carriage, a comparison of Canadian and American recordation of rights in aircraft, the law of space war, and the emerging industry of commercial space transportation. Also addressed are U.S. legislation of private commercial launch services, a leading case regarding seizure and arrest of aircraft in Italy, an accord reached between the ESA and the former Soviet Union for the exploration of outer space, and a discussion of the postal monopoly and air-courier services. C.C.S.

A92-51565
MANUFACTURING COST MODEL FOR COMPOSITES
R. L. RAMKUMAR, R. B. VASTAVA, and S. K. SAHA (Northrop Corp., Aircraft Div., Hawthorne, CA) IN: International SAMPE Technical Conference, 23rd, Kiamesha Lake, NY, Oct. 21-24, 1991, Proceedings. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 982-994. refs
Copyright

This paper presents a summary of the approach followed in the development of a manufacturing cost model for composites (MCMC). The Northrop-developed MCMC is a PC-based design-to-cost model that will facilitate rapid cost projections for multiple design concepts during the 'trade studies' phase of a structural airframe design development effort. A three-tier cost model development approach is described, with emphasis on the design level model. Industry-wide variation in the cost accounting system is acknowledged and accounted for. Sample results are presented to illustrate the use of the design level cost model in comparing a baseline metallic airframe structure to multiple composite airframe design concepts. Author

N92-30957# Air Inter, Lignes Aeriennes Interieures, Paris (France). Centre d'Instruction de Personnel Navigant.
FLIGHT CREW INTEGRATION IN THE MAINTENANCE CHAIN OF A COMMERCIAL AIRCRAFT (A 320) [INTEGRATION DE L'EQUIPAGE DANS LA CHAINE DE MAINTENANCE D'UN AVION COMMERCIAL (A 320)]
C. RAFIN and G. RAFFIN *In* CEP Systemes, ILS, CE, CALS? From Design to Operation 9 p 1991 In FRENCH
Avail: CASI HC A02/MF A02

An integration of flight crews and maintenance teams was carried out for the acquisition of an A-320. The characteristics of the aircraft are underlined. Personnel training, meetings, implementation of maintenance and management computer systems were put into practice. Real time computer systems for the management of technical data and an aircraft communication addressing and reporting system were implemented. The following topics are included: the operation of a radio-telephone network

and the flight crew technical tasks. The objectives of the company concerning the integration of several different sections and personnel were achieved. The successful operation and safety of the A-320 was reached thanks to the information exchanges between flight crews and ground supporting systems and teams.
ESA

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GENERAL

N92-30733*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RESEARCH AND TECHNOLOGY, 1991. LANGLEY RESEARCH CENTER
Feb. 1992 283 p Original contains color illustrations
(NASA-TM-4331; L-17018; NAS 1.15:4331) Avail: CASI HC A13/MF A03; 28 functional color pages

The mission of the NASA Langley Research Center is to increase the knowledge and capability of the United States in a full range of aeronautics disciplines and in selected space disciplines. This mission will be accomplished by performing innovative research relevant to national needs and Agency goals, transferring technology to users in a timely manner, and providing development support to other United States Government agencies, industry, and other NASA centers. Highlights are given of the major accomplishments and applications that have been made during the past year. The highlights illustrate both the broad range of the research and technology (R&T) activities at NASA Langley Research Center and the contributions of this work toward maintaining United States leadership in aeronautics and space research. Author

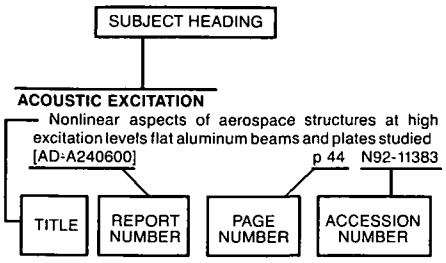
N92-30768# Aeronautical Research Labs., Melbourne (Australia).
ACTIVITIES OF THE AERONAUTICAL RESEARCH LABORATORY Annual Report, 1990-1991
1991 60 p Original contains color illustrations
Avail: CASI HC A04/MF A01; 35 functional color pages

The annual report of the Aeronautical Research Laboratory (Australia) is given. Topics covered include research in flight mechanics, propulsion, aircraft materials, aircraft structures, aircraft systems, and corporate services. Author

N92-31852*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NAS (NUMERICAL AERODYNAMIC SIMULATION PROGRAM) TECHNICAL SUMMARIES, MARCH 1989 - FEBRUARY 1990
Feb. 1990 221 p Original contains color illustrations
(NASA-TM-107960; NAS 1.15:107960) Avail: CASI HC A10/MF A03; 125 functional color pages

Given here are selected scientific results from the Numerical Aerodynamic Simulation (NAS) Program's third year of operation. During this year, the scientific community was given access to a Cray-2 and a Cray Y-MP supercomputer. Topics covered include flow field analysis of fighter wing configurations, large-scale ocean modeling, the Space Shuttle flow field, advanced computational fluid dynamics (CFD) codes for rotary-wing airloads and performance prediction, turbulence modeling of separated flows, airloads and acoustics of rotorcraft, vortex-induced nonlinearities on submarines, and standing oblique detonation waves. Author

Typical Subject Index Listing



The subject heading is a key to the subject content of the document. The title is used to provide a description of the subject matter. When the title is insufficiently descriptive of document content, a title extension is added, separated from the title by three hyphens. The accession number and the page number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document. Under any one subject heading, the accession numbers are arranged in sequence.

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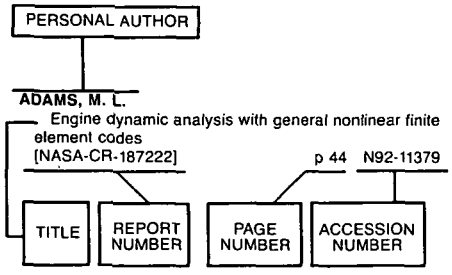
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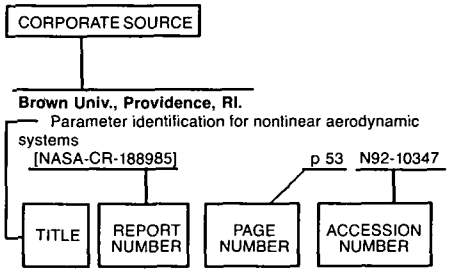
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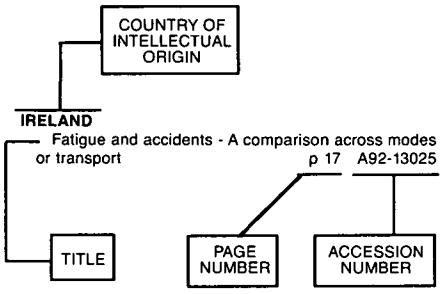
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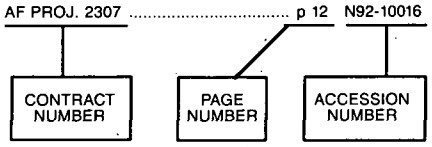
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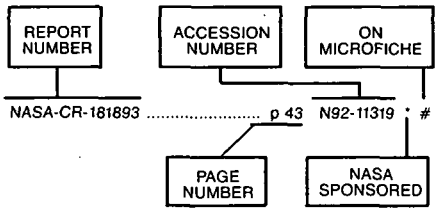
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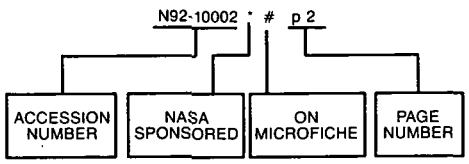
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