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A CONTINUING BIBLIOGRAPHY WITH INDEXES

NASA SP-7037 (263)

March 1991

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES



National Aeronautics and Space Administration
Office of Management
Scientific and Technical Information Program
Washington, DC

1991

INTRODUCTION

This issue of *Aeronautical Engineering—A Continuing Bibliography* (NASA SP-7037) lists 517 reports, journal articles, and other documents originally announced in February 1991 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

Accession numbers cited in this issue are:

STAR (N-10000 Series) N91-11666 — N91-13398
IAA (A-10000 Series) A91-12945 — A91-16992

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 1991 will be published in early 1992.

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

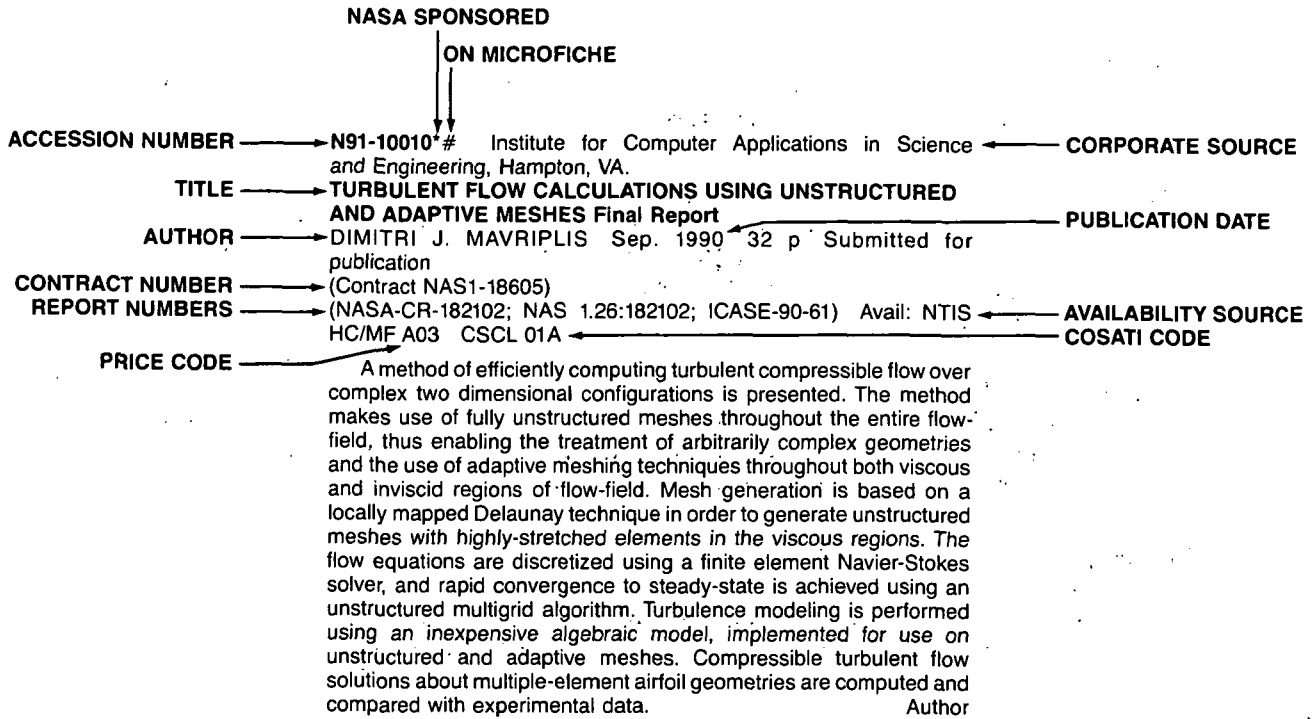
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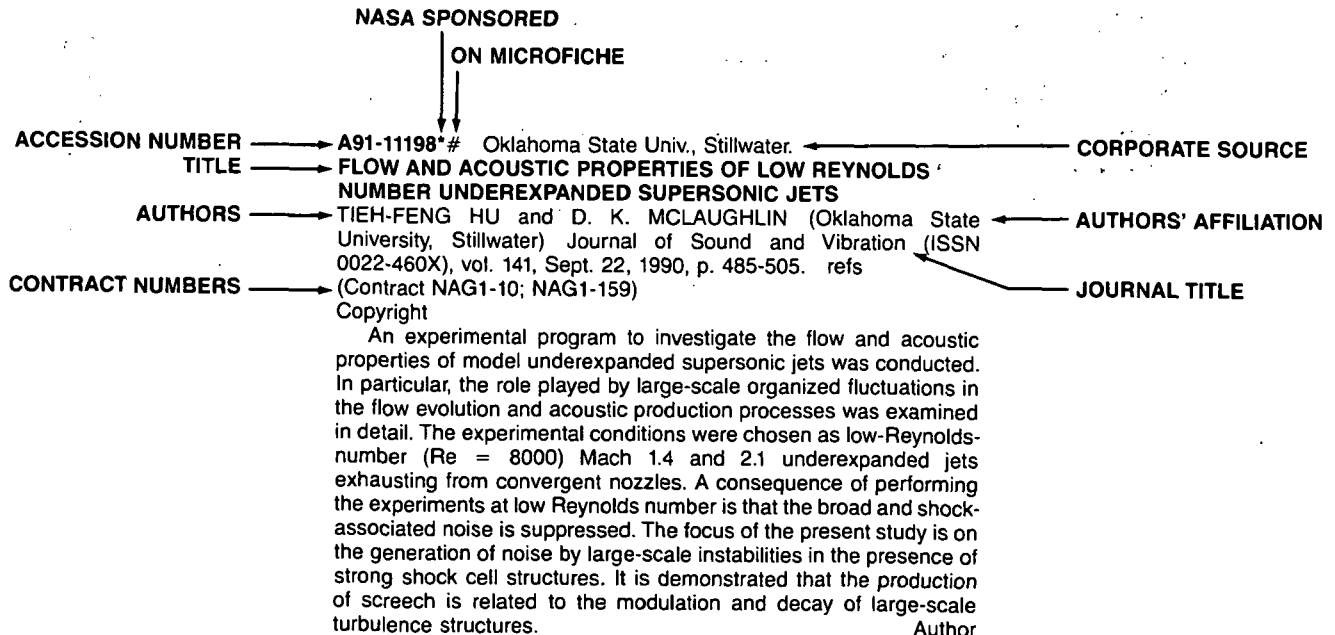
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TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT



AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 263)

MARCH 1991

01

AERONAUTICS (GENERAL)

A91-16551

FAA AGING AIRCRAFT WORKSHOP, VALLEY FORGE, PA, OCT. 9-13, 1989, PROCEEDINGS

Workshop sponsored by the American Society for Nondestructive Testing, Inc. Columbus, OH, American Society for Nondestructive Testing, Inc., 1990, 38 p. For individual items see A91-16552, A91-16553.

Copyright

The present conference discusses the nondestructive testing of aging aircraft in view both of emerging capabilities and the growing burden posed by existing airliner fleets, as well as the lessons learned by commercial air carriers concerning the use of nondestructive inspection and testing of high service-hour airframes. Also discussed are advanced methods for the nondestructive inspection of aging aircraft and a comparative study of current nondestructive airframe testing methods. O.C.

A91-16579

WING-MAN

DAVID NOLAND Air and Space (ISSN 0886-2257), vol. 5, Dec. 1990-Jan. 1991, p. 34-40.

Copyright

The summary of an aerodynamicist's work on advanced aircraft designs is presented. John Roncz has been involved in computational fluid dynamics since 1975 when he first became interested in the computerized study of liquids and gases in motion that has streamlined the design process of airfoils and propellers. Some of the revolutionary aircraft designs that he has worked on include the Rutan Voyager, the Beech Starship, the Solitaire powered glider, and, most recently, the Triumph Model 143. One outstanding example of Roncz's many accomplishments is that the airfoil in Voyager's canard had a lift-to-drag ratio of 132/1 compared to the standard airfoil L/D of 110/1. In addition, he designed new shapes for Voyager's metal propellers that increased efficiency by four percent. R.E.P.

A91-16680#

VALIDATION TESTING - THE DRIVER FOR PRODUCT QUALITY

JOHN F. SARNICOLA (Link Miles Corp., Binghamton, NY) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 27-34. refs

(AIAA PAPER 90-3123) Copyright

Probably the single largest influential set of constraints that affect the quality of advanced simulation devices is contained within the FAA regulations in force during the design period. Validation and verification testing is a necessary and essential part of establishing and maintaining quality training devices. The setting of tolerances associated with necessary validation testing is of critical importance in establishing the quality level of the device

and its purchase and operating cost. Accurate and high-resolution data are necessary for validation purposes. It is determined that manufacturing tolerances for individual simulated systems must be more stringent than established regulations in order not to have a negative impact on the composite simulator availability.

R.E.P.

N91-11724# Deutsche Luftverkehrsgesellschaft m.b.H., Frankfurt (Germany, F.R.).

MAINTAINABILITY OF REGIONAL AIRCRAFT

W. HERGESELL /in DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 127-128 1989 Avail: NTIS HC/MF A10

The influences of aircraft size and technology are discussed. It is suggested that the maintainability is affected by the philosophy of the aircraft manufacturer and the design and by the following factors: size of the aircraft; technology used in the aircraft and their systems; age of the aircraft (e.g., hours since new/cycles since new); complexity of the installed engines and systems; qualification of maintenance personnel and inspectors required; special tools and their availability; sophisticated test equipment; size of hangars and other facilities; chosen maintenance systems; reliability monitoring; product and material support by manufacturers; product improvement by manufacturers; and feedback of operator's experience to manufacturers. ESA

N91-12514# National Aerospace Lab., Tokyo (Japan).

PROCEEDINGS OF THE 7TH NAL SYMPOSIUM ON AIRCRAFT COMPUTATIONAL AERODYNAMICS

1989 303 p In ENGLISH and JAPANESE Symposium held in Tokyo, Japan, 29-30 Jun. 1989 (NAL-SP-10; ISSN-0289-260X) Avail: NTIS HC/MF A14

Various topics in computational fluid dynamics are discussed. Hydrodynamics of atmospheric phenomena, turbulence models, separated flow around a wing, transonic flow over a wing, shock wave propagation, scramjet flow computation, heat transfer in a curved pipe, and numerical simulation of supersonic inlets are among the topics covered.

N91-12563# American Inst. of Aeronautics and Astronautics, New York, NY. General Aviation Systems Technical Committee.

PROCEEDINGS OF THE 1990 AIAA/FAA JOINT SYMPOSIUM ON GENERAL AVIATION SYSTEMS

AUGUSTO FERRARA, comp., DAVE LAWRENCE, comp., and JANINE BLAKE, comp. May 1990 396 p Symposium held in Ocean City, NJ, 11-12 Apr. 1990 Prepared in cooperation with FAA, Atlantic City, NJ (DOT/FAA/CT-90/11) Avail: NTIS HC/MF A17

The 1990 American Institute of Aeronautics and Astronautics (AIAA)/Federal Aviation Administration (FAA) Joint Symposium on General Aviation Systems was the result of the combined efforts of the AIAA General Aviation Systems Technical Committee and the Federal Aviation Administration Technical Center. This symposium offered the opportunity to present and review the current state of the art in research that is being conducted in support of general aviation. All told, the papers presented covered the entire spectrum of research and the participants had the opportunity to hear presentations on everything from alternate fuels to developments in air traffic control.

01 AERONAUTICS (GENERAL)

N91-12580# National Center for Advanced Technologies, Washington, DC.

THE PROSPECTS OF AERONAUTICS

J. M. SWIHART *In* AGARD, Seminar on the Structure of Aeronautical R/D 24 p May 1990

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When considering aeronautical research and development it is useful to begin by reviewing the prospects of aeronautics for the next decades. As is clear from the other papers, the participation in any major development in aeronautics requires a sustained effort of many years and so major contributions are considered, nationally or internationally, which will come to fruition in the next century. The 20th century, saw the development of aeronautics on a global scale. The question is asked if this development now has levelled off and if from now on only marginal improvements and utilization will take place. It is indicated that there will be tremendous challenges and opportunities in the coming decades. The essence of the 50th Wright Brothers Lecture, first given in St. Louis, Missouri, USA on 14 September 1987 is contained. The lecture concentrated on civil aeronautics, but of course many identical technical developments apply equally to military and civil aviation. In fact the history of aeronautical development shows that there is an intimate relationship between civil and military aeronautical developments. The developments since 1987, when the paper was written, suggest that the outlook for technical aeronautical developments has not become less and, in fact, the developments may far exceed the expectations of a few years ago. Author

N91-12587# Institute for Defense Analyses, Alexandria, VA. Cost Analysis and Research Div.

TRENDS IN A SAMPLE OF DEFENSE AIRCRAFT

CONTRACTORS' COSTS Final Report, Oct. 1989 - Aug. 1990

JAMES D. MCCULLOUGH and STEPHEN J. BALUT Aug. 1990 23 p

(AD-A225663; AD-E501258; IDA-D-764; IDA/HQ-90-35426)

Avail: NTIS HC/MF A03 CSCL 05/3

This paper contains information on historical trends in direct and indirect costs for four defense aircraft contractors: General Dynamics-Fort Worth Division, Grumman Aerospace Corporation, McDonnell Aircraft Company, and Northrop Aircraft Company. The trends are presented for those four contractors in aggregate rather than individually. The paper concludes with a look at what these trends may mean in terms of future costs. GRA

02

AERODYNAMICS

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

A91-12966 **HYPERSONIC VISCOUS INTERACTION WITH STRONG BLOWING**

A. F. MESSITER and M. D. MATARRESE (Michigan, University, Ann Arbor) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 219, Oct. 1990, p. 291-311. Research supported by the U.S. Army. refs

Copyright

Solutions are obtained for hypersonic viscous interaction along a flat plate in the presence of strong boundary-layer blowing, with inverse-square-root injection velocity, for laminar flow over a cold wall and with a power-law viscosity-temperature relation. In the strong-interaction region, self-similarity is preserved if the blowing is such that the thicknesses of the inviscid shock layer, viscous shear layer, and inviscid blown layer all have the same order of magnitude. The weak-interaction region is also considered, and an approximate interpolation is used to join the solutions for the

surface pressure. Certain difficulties in asymptotic matching are discussed, and the extension to flow past a thin wedge is shown.

Author

A91-12967 **ANOMALOUS REFLECTION OF A SHOCK WAVE AT A FLUID INTERFACE**

JOHN W. GROVE (New York, State University, Stony Brook) and RALPH MENIKOFF (Los Alamos National Laboratory, NM) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 219, Oct. 1990, p. 313-336. Research supported by DOE. refs

(Contract DAAL03-89-K-0017; NSF DMS-89-01884)

Copyright

Several wave patterns can be produced by the interaction of a shock wave with a fluid interface. Regular wave patterns have previously been explained by a shock-polar analysis. An irregular wave pattern that typically occurs when a shock passes from a medium of high to low acoustic impedance is considered. Curvature of either the shock front or contact causes the flow to bifurcate from a locally self-similar quasi-stationary shock diffraction, to an unsteady anomalous reflection. The anomalous reflection wave pattern can be explained with a modified shock-polar analysis in which the geometric node velocity is replaced by a downstream boundary condition. Anomalous reflection is analogous to the transition from a regular to a Mach reflection when the reflected wave is a rarefaction instead of a shock. These bifurcations have been incorporated into a front-tracking code that provides an accurate description of wave interactions. Numerical results for two illustrative cases are described: a planar shock passing over a bubble, and an expanding shock impacting a planar contact.

Author

A91-12970 **THE RESPONSE OF A LAMINAR BOUNDARY LAYER IN SUPERSONIC FLOW TO SMALL-AMPLITUDE PROGRESSIVE WAVES**

P. W. DUCK (Manchester, Victoria University, England) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 219, Oct. 1990, p. 423-448. Research supported by Victoria University of Manchester. Previously announced in STAR as N89-21197. refs

(Contract SERC-GR/E/25702)

Copyright

The effect of a small amplitude progressive wave on the laminar boundary layer on a semi-infinite flat plate, due to a uniform supersonic freestream flow, is considered. The perturbation to the flow divides into two streamwise zones. In the first, relatively close to the leading edge of the plate, on a transverse scale comparable to the boundary layer thickness, the perturbation flow is described by a form of the unsteady linearized compressible boundary layer equations. In the freestream, this component of flow is governed by the wave equation, the solution of which provides the outer velocity conditions for the boundary layer. This system is solved numerically, and also the asymptotic structure in the far downstream limit is studied. This reveals a breakdown and a subsequent second streamwise zone, where the flow disturbance is predominantly inviscid. The two zones are shown to match in a proper asymptotic sense. Author

A91-12974 **EXPERIMENTS ON THE STABILITY OF SUPERSONIC LAMINAR BOUNDARY LAYERS**

A. D. KOSINOV, A. A. MASLOV, and S. G. SHEVELKOV. (AN SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 219, Oct. 1990, p. 621-633. refs

Copyright

The present paper reports an experimental study of the development of plane monochromatic waves in the boundary layer on a flat plate at Mach number $M = 2.0$. The wave characteristics of the plane waves are obtained. Three-dimensional disturbances with an angle of the wave vector to the flow $\chi = 50-70$ deg are found to be the most unstable. It is shown that the disturbances, consisting of vortical and compressible modes, are engendered in

a supersonic boundary layer by a local source of artificial disturbances. It is found that an increase in the bluntness of the leading edge of a plate stabilizes three-dimensional disturbances of a vortical mode. Author

A91-13040#

A SECONDARY FLOW CALCULATION METHOD FOR SINGLE-STAGE AXIAL TRANSONIC FLOW COMPRESSORS, INCLUDING SHOCK-SECONDARY FLOW INTERACTION

J. KALDELLIS, D. DOUVIKAS, K. D. PAPALIOU (Athens, National Technical University, Greece), and F. FALCHETTI (SNECMA, Villaroche, France) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 112, Oct. 1990, p. 652-668. Research supported by SNECMA. refs (ASME PAPER 89-GT-210) Copyright

The present secondary flow calculation method for solving the peripherally averaged flow equations can compute the hub and tip shear layers of transonic flow compressor blading simultaneously, and employs an approximate viscous/inviscid interaction calculation procedure which modifies the initial external meridional flowfield for the effects of blockage as the computation marches downstream. An improved two-zone model is used which introduces the peripheral blockage term. An approximate shock/shear layer interaction procedure was extended and adapted to the present method in order to compute the shock wave/secondary flow interaction case whenever it arises. The method is applied to two single-stage axial-flow compressors, one transonic and the other supersonic, for which experimental results were available. O.C.

A91-13041#

MODELING UNSTEADY TRANSITION AND ITS EFFECTS ON PROFILE LOSS

H. P. HODSON (Cambridge, University, England) (NATO, AGARD, Meeting, Luxembourg, Sept. 1989) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 112, Oct. 1990, p. 691-701. Previously announced in STAR as N90-18423. refs Copyright

The effects of wake interactions on the transition processes of turbomachinery blade boundary layers are considered. A simple model of unsteady transition is proposed which is then used to identify a relationship between a new reduced frequency parameter and the profile loss of a blade row which is subjected to unsteady inflow. The value of this parameter is also used to identify the nature of the boundary layer development on the blade surface. The influence of other parameters on the transition process is also discussed. The model is then extended to deal with the more general case. The validity of the model is demonstrated by a comparison with a correlation of the effects of wake-generated unsteadiness on profile loss which was originally proposed by Speidel. The effects of unsteady inflow on four idealized turbine blades are considered. Author

A91-13043#

AN EULER SOLUTION FOR UNSTEADY FLOWS AROUND OSCILLATING BLADES

L. HE (Cambridge, University, England) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 112, Oct. 1990, p. 714-722. Research supported by Rolls-Royce, PLC. refs (ASME PAPER 89-GT-279) Copyright

A finite-volume scheme with cell-vertex discretization in space and a two-step Runge-Kutta integration in time is the basis of the present time-marching Euler calculation for two-dimensional and quasi-three-dimensional unsteady flows in oscillating blade rows. A zonal moving-grid technique is used in which only subregions near oscillating blades are moved to fit both the moving blade boundaries and fixed regions. The unsteady pressure distribution and aerodynamic damping calculated by the present method for a turbine test case are in good agreement with corresponding experimental data. Attention is given to computation results for an oscillating biconvex cascade in transonic flow conditions exhibiting strong nonlinear behavior of shock-wave movements. O.C.

A91-13047*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

THE AERODYNAMICS OF AN OSCILLATING CASCADE IN A COMPRESSIBLE FLOW FIELD

D. H. BUFFUM (NASA, Lewis Research Center, Cleveland, OH) and S. FLEETER (Purdue University, West Lafayette, IN) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 112, Oct. 1990, p. 759-767. refs (ASME PAPER 89-GT-271) Copyright

Fundamental experiments are performed in the NASA Lewis Research Center Transonic Oscillating Cascade Facility to investigate and quantify the aerodynamics of a cascade of biconvex airfoils executing torsion mode oscillations at realistic reduced frequency values. Both steady and unsteady airfoil surface pressures are measured at two inlet Mach numbers, 0.65 and 0.80, and two incidence angles, 0 and 7 deg, with the harmonic torsional airfoil cascade oscillations at realistic high reduced frequency and unsteady data obtained at several interblade phase angle values. The time-variant pressures are analyzed by means of discrete Fourier transform techniques, with these unique data compared with predictions from a linearized unsteady cascade model. The experimental results indicate that the interblade phase angle has a major effect on the chordwise distributions of the airfoil surface unsteady pressure, with the effect of reduced frequency, incidence angle, and Mach numbers somewhat less significant. Author

A91-13251

DEVELOPMENT OF A GLOBAL MARCHING TECHNIQUE FOR PREDICTING FLOWS OVER ICED AIRFOILS

A. HALIM (USAF, Institute of Technology, Wright-Patterson AFB, OH) and L. COLEMAN IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 1. Swansea, Wales, Pineridge Press, 1989, p. 761-772. refs Copyright

A code is developed based on the approximate Navier Stokes equations in the vorticity stream function delta form. The code can be used to predict unsteady turbulent flow over iced airfoils. The merits of the present formulation will be evaluated by comparing its numerical performance with the solutions obtained by Coleman (1988) using the full Navier-Stokes equations for flow at a free stream Mach number of 0.12 and a Reynolds number based on chord of 1.41×10^6 to the 6th for angles of attack of 2, 4, 6, and 8 deg. Results are compared to the experimental data of Bragg (1986). The agreement is reasonable. Author

A91-13252

A DESIGN OPTIMIZATION METHOD USING THE EULER EQUATIONS

K. D. LEE and P. H. LIU (Illinois, University, Urbana) IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 1. Swansea, Wales, Pineridge Press, 1989, p. 773-782. refs Copyright

A design procedure is presented which is based on the Euler equations and a least-square optimization to find the airfoil geometry for a specified surface pressure distribution. In the approach, the geometry of a baseline airfoil is modified iteratively by adding perturbations defined as a linear superposition of base functions. The method is tested at subsonic and transonic speeds, using known airfoil sections as the target and the baseline airfoils. Author

A91-13253

INVISCID FLOW MODELS FOR PREDICTION OF THE WAKE OF AN AIRFOIL IN ROTARY MOTION

P. FRAUNIE (Aix-Marseille II, Universite, Marseille, France) and S. HUBERSON (CNRS, Laboratoire d'Informatique pour la Mecanique et les Sciences de l'Ingenieur, Orsay, France) IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989.

02 AERODYNAMICS

Volume 6, Part 1. Swansea, Wales, Pineridge Press, 1989, p. 783-792. refs

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Two unsteady inviscid flow calculations are compared on the basis of experimental visualizations of the wake developing behind an airfoil in circular complex motion. The first method is a classical two-dimensional panel scheme using a vortex sheet concept whereas the second one is the three-dimensional Rehbach's scheme which considers discrete vortex points governed by the Helmholtz equation in a Lagrangian frame. The smoothing law usually introduced for the velocity induced by the wake on the airfoil is studied for the particular considered motion. A generally good agreement is observed for the wake kinematics whose importance is pointed out in the concept of 'kinematics of stall' effects. Inviscid flow models are discussed from physical limitations in unsteady aerodynamics applications. Author

A91-13256

A NUMERICAL METHOD FOR THE COMPUTATION OF LOW MACH NUMBER REACTIVE FLOWS

G. FERNANDEZ and H. GUILLARD (INRIA, Valbonne, France)

IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 1. Swansea, Wales, Pineridge Press, 1989, p. 815-825. refs

Copyright

A numerical method for the computation of low-Mach-number, laminar, reactive flows is presented. The large discrepancy that exists in this type of flows between the speed of propagation of the material waves and the sound velocity is addressed by splitting the hyperbolic fluxes into a slow convective part and a fast acoustic part. The latter is discretized by an implicit first-order upwind scheme, while the remaining terms of the equations are discretized by a combination of explicit and implicit second-order accurate schemes. The spatial approximation uses a mixed finite volume/finite element method and the MUSCL technique of van Leer (1983) to reach second-order spatial accuracy. Numerical tests illustrating the efficiency of the method are presented. Author

A91-13260

NUMERICAL SOLUTION OF 3-D LAMINAR COMPRESSIBLE SUBSONIC FLOWS IN DUCTS

A. R. ASLAN (Institut von Karman de Dynamique des Fluides, Rhode-Saint-Genese, Belgium) IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 1. Swansea, Wales, Pineridge Press, 1989, p. 857-867. refs (Contract BMVG-T/RF-42/G-022/G-1412)

Copyright

The laminar three-dimensional flow in ducts is analyzed for a viscous compressible fluid. The flow field is modeled using the Parabolized Navier-Stokes equations. This model enables a marching procedure in the main stream direction to be used, which means less computer memory and time than solving the full Navier-Stokes equations. Approximations are applied to the Navier-Stokes equations written in general curvilinear coordinates. An a priori determined inviscid pressure field is correlated in the main stream direction and in the cross plane for viscous effects. Three momentum equations, the equations for cross-flow velocity correction and pressure field, and the energy equation have been solved numerically using the line successive over relaxation method applied to the finite differences. The density is computed from the state equation. Computations are presented for developing laminar flow in straight and S-shaped ducts of square cross-section for various Reynolds numbers and inlet Mach numbers. The velocity, pressure, and temperature fields are examined. Author

A91-13261

CELL-VERTEX ALGORITHM FOR TURBULENT TRANSONIC FLOW

K. P. DIMITRIADIS and M. A. LESCHZINER (University of Manchester Institute of Science and Technology, England) IN:

Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 1. Swansea, Wales, Pineridge Press, 1989, p. 869-880. Research supported by the Ministry of Defence of England. refs

Copyright

A cell-vertex algorithm, previously available for inviscid flow only, has been extended to viscous- and turbulent-flow conditions. The algorithm combines cell-vertex storage with an explicit Lax-Wendroff time-marching scheme, multilevel convergence acceleration, and a two-equation low-Reynolds-number (k-epsilon) transport model of turbulence. The paper focuses primarily on numerical details of the algorithm, and conveys the principal characteristics of the method through test calculations for inviscid, laminar-subsonic, laminar-transonic, and turbulent-transonic conditions. Author

A91-13262

SIMULATION OF TRANSONIC FLOW PAST AXI-SYMMETRIC BODIES AT ANGLE OF ATTACK USING THIN LAYER NAVIER-STOKES EQUATIONS

N. S. MADHAVAN and V. SWAMINATHAN (ISRO, Vikram Sarabhai Space Centre, Trivandrum, India) IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 1. Swansea, Wales, Pineridge Press, 1989, p. 881-891. refs

Copyright

A91-13263

A TIME-ACCURATE INTERACTIVE METHOD FOR COMPUTING TRANSONIC AIRFOIL FLOW

K. DAU, U. R. MUELLER, and H. HENKE (MBB GmbH, Bremen, Federal Republic of Germany) IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 1. Swansea, Wales, Pineridge Press, 1989, p. 893-903. refs

Copyright

A91-13264

NUMERICAL OPTIMIZATION DESIGN OF TRANSONIC AIRFOILS

MUH-SHENG CHEN (Aeronautical Research Laboratory, Taichung, Republic of China) and CHUEN-YEN CHOW (Colorado, University, Boulder) IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 1. Swansea, Wales, Pineridge Press, 1989, p. 905-915. refs

Copyright

A computationally efficient and versatile procedure has been developed for optimum design of transonic airfoils, which can generate an airfoil shape having lowest drag at a desired lift coefficient when flying at a specified Mach number. The design tool is constructed by coupling a reliable transonic airfoil code with an unconstrained numerical optimization algorithm. Results of design cases indicate that the conventional low-speed airfoils can be modified to become supercritical airfoils having much lower drag at transonic speeds, and the performance of existing supercritical airfoils can be improved further by modification of their profiles using this tool. The time required to complete a typical design case is of order of one hour on a CYBER 205 supercomputer, which makes this design procedure attractive for practical engineering applications. Author

A91-13265

AN ENGINEERING APPROACH TO SIMULATE SHOCK INDUCED SEPARATION IN TRANSONIC POTENTIAL FLOW

JAI MOHAN (Aeronautical Development Agency, Bangalore, India) IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 1. Swansea, Wales, Pineridge Press, 1989, p. 917-926. refs

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This paper presents an approach to simulate shock induced

separation in axisymmetric transonic flow computation. The outer inviscid flow (given by full potential equation) is coupled with the viscous flow close to the body (given by integral boundary layer method), including separated region, in an iterative manner to obtain the complete flow field solution. An improved algebraic model, named 'axisymmetric viscous bump model', describing the shape of discriminating streamline, is superpositioned at the shock foot to simulate post shock flow. Local flow conditions, upstream of the shock, are used to formulate the model. Computed results for various configurations and free-stream conditions are in good agreement with the experiment. The shock location and the separation point are predicted within a computational accuracy.

Author

A91-13266

ON THE DEVELOPMENT OF A NUMERICAL PREDICTION PROCEDURE FOR COMPRESSIBLE FLOWS

Z. Y. YANG, J. SWITHENBANK, and S. B. CHIN (Sheffield, University, England) IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 1. Swansea, Wales, Pineridge Press, 1989, p. 927-937. refs
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The present modification of an iterative prediction method for handling steady compressible flows encompassing both subsonic and supersonic regimes is tested for several cases. The results obtained confirm that the prediction procedure can not only handle quasi-one-dimensional transonic flow, but also predicts two-dimensional transonic and supersonic channel flows. It is also found to be suitable for the even more complex supersonic flow behind a rearward-facing step with an embedded subsonic recirculating region. The procedure is not, however, able to give a good resolution of shock waves.

O.C.

A91-13267* Boeing Co., Seattle, WA.

LOCAL GRID REFINEMENT FOR TRANSONIC FLOW PROBLEMS

ROBIN G. MELVIN, MICHAEL B. BIETERMAN, DAVID P. YOUNG, FORRESTER T. JOHNSON, SATISH S. SAMANT (Boeing Co., Seattle, WA) et al. IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 1. Swansea, Wales, Pineridge Press, 1989, p. 939-949. refs
(Contract NAS2-12513)

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The present use of locally refined Cartesian grids to solve transonic flow problems about three-dimensional aircraft configurations obviates surface-conforming grid generation through an embedding of surface-geometry paneling in the grid. Accurate resolution of flow close to the boundary, and in regions with strong velocity gradients, is achieved via hierarchical local refinement which subdivides a given grid cell into eight cells. Fast and reliable convergence is obtained by combining several preconditioners and damping strategies. Methods are suggested for preclusion of global convergence problems.

O.C.

A91-13268

OVEREXPANDED SUPERSONIC JET IMPINGEMENT ON DOUBLE WEDGE DEFLECTOR

J. K. PRASAD, R. C. MEHTA (ISRO, Vikram Sarabhai Space Centre, Trivandrum, India), and A. K. SREEKANTH (Indian Institute of Technology, Madras, India) IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 1. Swansea, Wales, Pineridge Press, 1989, p. 951-958. refs
Copyright

The pressure distribution on a double-wedge deflector due to overexpanded supersonic jet impingement has been obtained. This indicated the presence of separation shock, which is supported by schlieren and oil flow visualization. The diverted wall jet develops linearly but gradually and its height is less than the jet diameter. Compressible turbulent boundary layer equation in an arbitrary

pressure gradient is solved by employing Sasman and Cresci (1966) scheme. The principal boundary layer parameters are calculated as a function of the body-surface coordinate.

Author

A91-13286

THE VISCOUS EFFECTS ON THE AERODYNAMIC CHARACTERISTICS OF MULTISTAGE COMPRESSORS

LAI-CHEN CHIEN (Academia Sinica, Institute of Physics, Taipei, Republic of China), HUNG-WU HAN, and CHIH-HSIUNG CHEN IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 2. Swansea, Wales, Pineridge Press, 1989, p. 1277-1287. refs

Copyright

The aerodynamic characteristics of a multistage axial-flow compressor are investigated by solving steady axisymmetric compressible flow, with the viscous effects and the streamline curvature incorporated into the analysis. A simple and reliable program is developed for obtaining an initial solution for the compressor design. The efficiency of the program is demonstrated by using it to redesign an existing 5-stage axial-flow compressor.

V.L.

A91-13287

THE MOMENT FUNCTION FORMULATION OF INVERSE AND HYBRID PROBLEMS FOR BLADE-TO-BLADE COMPRESSIBLE VISCOUS FLOW ALONG AXISYMMETRIC STREAM SHEET

GAO-LIAN LIU and DAO FANG ZHANG (Shanghai Institute of Mechanical Engineering, People's Republic of China) IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 2. Swansea, Wales, Pineridge Press, 1989, p. 1289-1299. refs

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A new moment function for inviscid and viscous compressible flow along an arbitrary rotating stream sheet of revolution is introduced. It possesses some remarkable features which make it particularly suitable for solving inverse and hybrid problems and for application to transonic flow. By means of this function, the Kutta lift theorem for two-dimensional flow is extended to the cascade flow along a general streamsheet of revolution, and a method for solving inverse and hybrid problems of cascade flow is suggested. The method is validated by numerical solutions to the inverse problem of cascade flow along a conical stream sheet.

Author

A91-13288

A VARIATIONAL FINITE ELEMENT METHOD WITH VARIANT DOMAIN FOR SOLVING FULLY 3-D FLOW IN TURBOMACHINE

KANG-MIN CHEN, YU-LIN CHEN, and HONG-XING QIN (Shanghai Institute of Mechanical Engineering, People's Republic of China) IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 2. Swansea, Wales, Pineridge Press, 1989, p. 1301-1310. refs

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A variational finite element method based on variational principle with variant domain for fully three-dimensional incompressible flow in axial impellers is suggested. Modified variational principles are discretized by 27-node isoparametric finite elements. Two systems of nonlinear equation about the potential of all flow field and the location of free trailing vortex sheets are solved by an iterated method. The velocity of all flow fields and the location of free trailing sheets are given. The computational results using an annular turbine nozzle guide vane are in agreement with experimental results.

Author

A91-13289

METHODS FOR THE EFFICIENT COMPUTATION OF THE COMPRESSIBLE NAVIER-STOKES EQUATIONS FOR TURBULENT FLOWS

G. CAPDEVILLE (Ecole Nationale Supérieure de Mécanique,

02 AERODYNAMICS

Nantes, France) IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 2. Swansea, Wales, Pineridge Press, 1989, p. 1311-1320. refs
(Contract DRET-86-107)
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The resolution of the compressible Navier-Stokes equation still requires a large computing time even on supercomputers, unless acceleration techniques are used. In this work several implicit methods are tested on several two-dimensional configurations. For the turbomachinery blade-to-blade flow, the use of implicit methods is demonstrated to lead to efficient steady state computations. Several characteristics of the separated turbulent flow resulting from a shock-boundary layer interaction on the bump are studied. The capabilities of the implicit method to describe a blade-to-blade turbulent flow are discussed. Author

A91-13294

NUMERICAL STUDY OF THREE-DIMENSIONAL TURBULENT FLOW THROUGH A RECTANGULAR-ROUND S-SHAPED DIFFUSER

R. W. GUO and Q. LIN (Nanjing Aeronautical Institute, People's Republic of China) IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 2. Swansea, Wales, Pineridge Press, 1989, p. 1367-1376. Research supported by NNSFC. refs
Copyright

Three-dimensional incompressible turbulent flow through an S-shaped diffuser, with a shape change from rectangular at the inlet to circular at the outlet, is investigated numerically. The partially parabolic governing equations derived from the generalized form of the Navier-Stokes equation are solved by the finite difference method using a boundary-conforming grid system. The computed static pressure distribution along the walls, main flow velocity profiles, total pressure isobars, and cross-flow velocity vectors at the outlet are found to be in good agreement with experimental data. V.L.

A91-13295

COMPUTATIONAL THREE-DIMENSIONAL TURBULENT FLOW IN S-SHAPED DUCTS

CHAIN-NAN YUNG, THEO G. KEITH, and KENNETH J. DE WITT (Toledo, University, OH) IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 2. Swansea, Wales, Pineridge Press, 1989, p. 1377-1387. refs
Copyright

A numerical method to calculate steady state three-dimensional, incompressible, turbulent flow in S-shaped diffusers is presented. The full Navier-Stokes equations and the k-epsilon turbulence model are used to describe the flow. The diffuser considered is a rectangular cross-section S-shaped duct with an exit/inlet area ratio of 1.55. The inlet Mach number is 0.3 and the Reynolds number is 3.42×10^5 to the 5th. The computed velocity and pressure distributions are presented in graphical form. No flow separation is found in this diffuser; however, boundary layers start to form from the downstream bend and become thicker on the outside wall in the rear part of the diffuser. Author

A91-13296

HIGH MACH NUMBER IMPINGING JETS IN CROSS-FLOW - COMPARISON OF COMPUTATION WITH EXPERIMENT

K. KNOWLES and D. BRAY (Royal Military College of Science, Shrivenham, England) IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 2. Swansea, Wales, Pineridge Press, 1989, p. 1389-1398. refs
Copyright

The PHOENICS code has been used to model the flow field surrounding subsonic and under-expanded jets impinging on a ground plane in the presence of a cross-flow, for cases with both a fixed ground plane and a 'rolling-road'. The standard k-epsilon

turbulence model is used without correction factors. It is confirmed that this overpredicts the free-jet entrainment rate; the wall-jet spreading rate is slightly underpredicted but the initial thickness is too high. The ground vortex formed in cross-flow is shown to move with varying effective velocity ratio and with rolling-road operation in the same manner as experimentally observed. Author

A91-13297

APPLICATION OF AN IMPLICIT NUMERICAL METHOD TO THE COMPUTATION OF LAMINAR AND TURBULENT NOZZLE FLOWS

A. NEBBACHÉ and D. ZEITOUN (Aix-Marseille I, Université, Marseille, France) IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 2. Swansea, Wales, Pineridge Press, 1989, p. 1399-1409. refs
Copyright

The present work is a numerical analysis of the laminar and turbulent flows in a convergent-divergent nozzle. Navier-Stokes equations which describe the turbulent flow are closed by a model derived from that of Baldwin and Lomax. In solving this equation system, the implicit MacCormack numerical method is used. Author

A91-13319

CALCULATION AND MEASUREMENT OF TURBULENT JET IMPINGEMENT IN A CROSSFLOW. I, II

G. D. CATALANO, K. CHANG, and J. A. MATHIS (Louisiana State University, Baton Rouge) IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 2. Swansea, Wales, Pineridge Press, 1989, p. 1883-1906. Research supported by USAF. refs
Copyright

Calculations for the flow of a turbulent jet discharging into a confined cross flow are presented. Mean velocity ratios of jet/cross flow of 2.0, 4.0, and 6.0 are investigated. Calculated results were obtained by solving the steady three-dimensional elliptic forms of the Reynolds equations coupled with the two-equation k-epsilon model of turbulence. The mean velocity ratio is shown to determine the existence and location of impingement as well as the acceleration experienced by the cross flow as it proceeds past the jet field. The calculated results are compared with experimental data obtained using laser velocimetry. Relatively poor agreement between calculated and measured results near the jet exit suggests the anisotropic nature of this portion of the flow field. B.J.

A91-13322

THE INFLUENCE OF THE LATERAL WALLS ON VORTEX SHEDDING CHARACTERISTICS

J. LI, J. SUN, R. MARTIN, and J. PANTALONI (Aix-Marseille I, Université, Marseille, France) IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 2. Swansea, Wales, Pineridge Press, 1989, p. 1955-1962. refs
Copyright

The influence of solid walls on the vortex street behind a circular cylinder was studied. The two-dimensional, viscous and incompressible Navier-Stokes equations were solved using the finite element method for the velocity-pressure formulation and the Crank-Nicolson time integration scheme. Physical parameters such as drag and lift coefficients and the Strouhal number were evaluated with relation to the aspect ratio. Author

A91-13325

MODELING HYPERSONIC FLOW WITH NONEQUILIBRIUM CHEMISTRY EFFECTS

J. HAEUSER, A. VINCKIER (ESTEC, Noordwijk, Netherlands), and H. G. PAAP (Bayreuth, Universitaet, Federal Republic of Germany) IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea,

Wales, July 11-15, 1989. Volume 6, Part 2. Swansea, Wales, Pineridge Press, 1989, p. 1988-1999. refs
Copyright

This paper deals with the physical equations needed to describe hypersonic phenomena in thermochemical nonequilibrium and outlines a numerical solution technique for the resulting stiff system of coupled nonlinear partial differential equations, using multiblock grids with slope continuity. The main hypersonic projects in Europe are briefly outlined, and the aerodynamic and aerothermodynamic challenges of the design and the development for hypersonic vehicles are addressed. In addition, the requirements resulting from the hypersonic flight regime to obtain validated computer codes are specified. The discussion also covers the corresponding submodels for viscosity (laminar flow), diffusion velocities, and heat of formation. Author

A91-13358
COMPRESSIBLE FLOW INDUCED BY THE TRANSIENT MOTION OF A WAVEMAKER

I. FRANKEL (Technion - Israel Institute of Technology, Haifa) Zeitschrift fuer angewandte Mathematik und Physik (ISSN 0044-2275), vol. 41, Sept. 1990, p. 628-655. Research supported by the Technion - Israel Institute of Technology. refs
Copyright

An analysis is made of the effect of fluid compressibility on the evolution of pressure distribution and free surface elevation following the initiation of the horizontal motion of a vertical wavemaker. The initial- and boundary-value problems for the velocity potential are formulated and simplified through the substitution of an asymptotic expansion for small Mach numbers. A solution for the leading order is obtained by means of an appropriate distribution of supersonic sources. The long-time behavior of the solution is found to be similar to that of the short-time incompressible flow. V.L.

A91-13374
STUDY OF THREE DIMENSIONAL SEPARATED FLOWS, RELATION BETWEEN INDUCED DRAG AND VORTEX DRAG

F. CHOMETON and J. LAURENT (Conservatoire National des Arts et Metiers, Saint-Cyr-l'Ecole, France) European Journal of Mechanics, B/Fluids (ISSN 0997-7546), vol. 9, no. 5, 1990, p. 437-455. refs
Copyright

The concept of 'vortex drag', defined primarily for the purposes of drag analysis for low aspect ratio bodies, is presently shown to be analytically tractable through experimentation on a finite aspect-ratio wing, which then allows the vortex-drag concept to be compared with Prandtl's concept of 'induced drag'. For the wing tested, with an aspect ratio of 4, the vortex drag value is about half that of the induced drag. It is hypothesized that the induced drag includes a viscous term, due to the production and dissipation of the rolling vortex system of the wing. It is shown that the induced drag of a wing may be modeled through experimental analysis of its downstream velocity field. O.C.

A91-13383
THE WAVE DRAG OF DELTA WINGS AT SUPERSONIC SPEEDS: A RECENT STUDY - 30TH LANCHESTER MEMORIAL LECTURE

G. DROUGGE (Flygtekniska Forsoksanstalten, Bromma, Sweden) Aeronautical Journal (ISSN 0001-9240), vol. 94, Aug.-Sept. 1990, p. 225-230. Research sponsored by the Forsvarets Materielverk. refs

Copyright

After treating the influence of delta wing geometry on supersonic wave drag for a given planform, attention is given to the influence of airfoil profile nose radius with spanwise profile variations. It is established that larger nose radii than commonly supposed may be employed, especially on the outboard sections of delta wings. Since spanwise profile variations of this kind would delay the onset of vortex roll-up for high angles of attack, advantageous leading edge thrust could be generated during subsonic maneuvering; a

compromise delta wing geometry is therefore obtainable which yields low supersonic drag at cruise and low subsonic maneuvering drag. O.C.

A91-13546
POSSIBILITY OF MODELING THERMAL AND FORCE LOADING OF THE LATERAL SURFACE OF A BODY IN THE PATH OF A HIGH-VELOCITY GAS FLOW [K VOZMOZHNOСТИ MODELIROVANIIA TEPLOSILOVOGO VOZDEISTVIA NA BOKOVUII POVERKHNOST' TELA, OBTEKAEMOGO VYSOKOSKOROSTNYM POTOKOM GAZA]
N. M. GAVRILOVA, N. V. MEDVETSKAIA, and I. V. POLEZHAEV (AN SSSR, Institut Vysokikh Temperatur, Moscow, USSR) Teplofizika Vysokikh Temperatur, (ISSN 0040-3644), vol. 28, July-Aug. 1990, p. 728-735. In Russian. refs
Copyright

A new modeling-channel testing scheme is proposed which makes it possible to reproduce flow past the lateral surface of a body at supersonic Mach and high Reynolds numbers, corresponding to turbulent flow in a boundary layer. Supersonic channel profiles are calculated in such a way as to produce a specified flow parameter distribution on the body surface. Results of calculations are presented. V.L.

A91-13547
SELECTION OF OPTIMAL CONDITIONS IN GASDYNAMIC METHODS FOR DETERMINING THE POSSIBILITY OF HETEROGENEOUS ATOMIC RECOMBINATION [O VYBORE OPTIMAL'NYKH USLOVII V GAZODINAMICHESKIKH METODAKH OPREDELENIIA VEROIATNOSTI GETEROGENNOI REKOMBINATSII ATOMOV]

V. M. DOROSHENKO, N. N. KUDRIAVTSEV, and N. V. SMIRNOV (Moskovskii Fiziko-Tekhnicheskii Institut, Moscow, USSR) Teplofizika Vysokikh Temperatur (ISSN 0040-3644), vol. 28, July-Aug. 1990, p. 736-741. In Russian. refs
Copyright

The problem of experimental condition optimization in gasdynamic methods for determining the possibility of heterogeneous atomic recombination on weakly catalytic surfaces is investigated analytically. Schemes with flow past models in the form of blunt bodies and flat plates are examined. A comparative analysis is made of the capabilities of apparatus with subsonic and supersonic motion of a dissociated gas. V.L.

A91-13594
AERODYNAMIC SHAPE OPTIMIZATION BY THE METHOD OF INVERSE BOUNDARY VALUE PROBLEMS [OPTIMIZATSIIA AERODINAMICHESKIKH FORM METODOM OBRATNYKH KRAEVYKH ZADACH]

A. M. ELIZAROV and E. V. FEDOROV (Prikladnaia Matematika i Mekhanika (ISSN 0032-8235), vol. 54, July-Aug. 1990, p. 571-580. In Russian. refs
Copyright

Solutions are presented for variational problems concerning the shape of wing profiles with maximum lifting force, minimum drag, and maximum aerodynamic quality. Functionals are obtained whose minimization is equivalent to the optimization of the above parameters. The existence and uniqueness of the extreme points are analyzed, and examples of optimized profiles are presented. V.L.

A91-13659
NON-NAVIER-STOKES MODELS IN PROBLEMS OF SUPER- AND HYPERSONIC FLOW OF A VISCOUS GAS PAST BODIES [NENAV'E-STOKSOVSKIE MODELI V ZADACHAKH SVERKH- I GIPERZVUKOVOGO OBTEKANIIA TEL VIAZKIM GAZOM]

G. A. TIRSKII IN: Contemporary mathematical problems of mechanics and their applications. Moscow, Izdatel'stvo Nauka, 1989, p. 74-84. In Russian. refs
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The objective of the study was to evaluate errors associated with the modeling of super- and hypersonic flow problems using various types of simplified Navier-Stokes equations. In particular,

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a comparison is made between four approximate models derived from the full system of Navier-Stokes equations: parabolized Navier-Stokes equations, full equations of a viscous shock layer, equations of a thin (hypersonic) viscous shock layer, and equations of a thin viscous shock layer with a more accurately specified position of the head shock. The discussion covers applications of the equations, accuracy of the results, and simplicity of algorithms for calculating flows past spheres, hyperboloids, and blunt cones.

V.L.

A91-13669

SUPERSONIC FLOW PAST A BODY WITH HEAT INPUT AHEAD OF IT [SVERKHZVUKOVOE OBTEKANIE TELA PRI PODVODE TEPLA PERED NIM]

P. I. U. GEORGIEVSKII and V. A. LEVIN IN: Contemporary mathematical problems of mechanics and their applications. Moscow, Izdatel'stvo Nauka, 1989, p. 197-202. In Russian. refs
Copyright

The problem of supersonic flow past a body in the presence of a three-dimensionally distributed heat source ahead of the body is investigated analytically. Heat input ahead of the body is shown to have a strong effect on the flow structure. Intense gas heating within the heat spot leads to a significant reduction in gas density, an increase in local sound velocity, a decrease in Mach number, and a reduction in drag.

V.L.

A91-14315

AN EXPERIMENTAL STUDY OF ROTOR AERODYNAMICS IN GROUND EFFECT AT LOW SPEEDS

MAO SUN (Beijing University of Aeronautics and Astronautics, People's Republic of China) and HOWARD C. CURTISS, JR. (Princeton University, NJ) Chinese Journal of Aeronautics (ISSN 1000-9361), vol. 3, May 1990, p. 79-87.
Copyright

Results of an experimental study of the aerodynamics of a helicopter rotor in ground effect at low speeds are presented. Experiments of rotor wake flow visualization and induced velocity measurement near the rotor disk were conducted. At some advance ratio, the forward part of the rotor wake, after impinging on the ground, rolls up and recirculates near the rotor leading edge and large increase in induced velocity appears near the rotor leading edge. When the advance ratio increases, the rolled-up wake develops into a concentrated vortex, ground vortex, under the rotor, and the induced velocity near the rotor leading edge becomes much smaller. The ground vortex diminishes as the advance ratio further increases. Recirculation and ground vortex occur in a very narrow region of the advance ratio. These results explain the irregular variations of rotor forces and moments with advance ratio reported in previous works.

Author

A91-14319

THE APPLICATION OF DYNAMIC SCHLIEREN-PHOTON CORRELATION TECHNIQUE TO A SUPERSONIC SHEAR LAYER

LIPING XU (Beijing University of Aeronautics and Astronautics, People's Republic of China) Chinese Journal of Aeronautics (ISSN 1000-9361), vol. 3, May 1990, p. 115-122. refs
Copyright

By applying the dynamic schlieren-photon correlation technique to a two-dimensional separated supersonic shear layer, the convection velocity of large eddies inside the shear layer and the frequency of the self-sustaining oscillation of the shear layer induced by the shedding of large eddies have been obtained. The distribution of the turbulence intensity inside the shear layer can also be estimated. It is shown that the method has its promising potentials in the measurement of high speed complex flows.

Author

A91-14377

ON THE VON NEUMANN PARADOX OF WEAK MACH REFLECTION

AKIRA SAKURAI (Tokyo University of Electrical Engineering, Hatoyama, Japan), L. F. HENDERSON (Sydney, University,

Australia), KAZUYOSHI TAKAYAMA (Tohoku University, Sendai, Japan), ZBIGNIEW WALENTA (Polska Akademia Nauk, Instytut Podstawowych Problemow Techniki, Warsaw, Poland), and PHILIP COLELLA (Lawrence Livermore National Laboratory, Livermore, CA) Fluid Dynamics Research (ISSN 0169-5983), vol. 4, Feb. 1989, p. 333-345. refs

Copyright

Recent experimental and numerical studies of weak Mach reflections are examined. It is shown that the fundamental reason for the von Neumann paradox is that his theory of Mach reflection is based on the assumption that the flow downstream of the reflected wave and the Mach shock near the wave triple point is uniform. The assumption is shown to be valid for strong Mach reflection which agrees with experiment, but invalid for weak Mach reflection which does not agree with experiment. It is also shown that viscous effects are dominant when the incident shock is within about 100 mean free path lengths of the corner, but not otherwise. The analytical theory of the entire subsonic region supports these conclusions.

Author

A91-14381

INTERACTING LAMINAR BOUNDARY LAYERS IN QUASI-TWO-DIMENSIONAL FLOW

PH. GITTLER and A. KLUWICK (Wien, Technische Universitaet, Vienna, Austria) Fluid Dynamics Research (ISSN 0169-5983), vol. 5, June 1989, p. 29-47. refs

Copyright

The interaction between laminar boundary layers on swept wings and inviscid external flow is investigated in the limit of large Reynolds numbers using the method of matched asymptotic expansions. It is assumed that the direction of the free stream velocity and the normal to the leading edge include a finite sweep angle and, furthermore, that the disturbances causing the interaction process are either independent of or slowly varying with the lateral coordinate. The resulting triple-deck equations are solved numerically for the cases of supersonic flow past a swept compressions ramp and a swept indentation the depth of which is slowly increasing in the lateral direction.

Author

A91-14382

VORTEX SHEDDING MECHANISM FROM A TRIANGULAR PRISM IN A SUBSONIC FLOW

TAKEO NAKAGAWA (Max-Planck-Institut fuer Stroemungsforschung, Goettingen, Federal Republic of Germany) Fluid Dynamics Research (ISSN 0169-5983), vol. 5, July 1989, p. 69-81. refs

Copyright

Alternate periodic vortices shed from a triangular prism arranged as either a wedge or a reversed wedge are studied experimentally at a Mach number of 0.377 and at a Reynolds number of 173,000 (based on the prism height). It is found that the flow around the triangular prism arranged as a wedge separates at the sharp trailing edges, and the main vortices are generated immediately after the separation; no secondary vortex is generated. However, the flow around the other triangular prism arranged as a reversed wedge separates at the sharp leading edges. The main vortices are not formed immediately after the separation; rather, their formation is finished either over or under the trailing edge. In this case, strong secondary vortices on and beneath the trailing edge are generated by the upper and lower main vortices, respectively.

Author

A91-14387

COMPUTATIONAL STUDY OF THE SHOCK-WAVE/BOUNDARY-LAYER INTERACTION IN A DUCT

ITARU HATAUE (Tokyo, University, Japan) Fluid Dynamics Research (ISSN 0169-5983), vol. 5, Dec. 1989, p. 217-234. refs

Copyright

The compressible flow in the interior of a duct has been calculated by using the shock capturing method (Harten-type second-order TVD scheme) with LU factorization based on the two- and three-dimensional Navier-Stokes equations. The influences of some parameters contributing to the shock-wave/boundary-layer interaction are discussed. Some un-

steady mechanisms of the interaction have been clarified and the computed results have made it possible to elucidate the details of the experimental observations. Author

A91-14429*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

3D COMPUTATION OF HYPERSONIC NOZZLE

H. T. LAI (NASA, Lewis Research Center; Sverdrup Technology, Inc., Cleveland, OH) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 23 p. refs (Contract NAS3-24105; NAS3-25266) (AIAA PAPER 90-5203)

Numerical results of a NASP-like nozzle configuration are presented. The nozzle has characteristically a very large area ratio designed to operate in the hypersonic regime. The overall flowfield consists of the internal expansion from a stagnation reservoir and the external exhaust plume in a quiescent environment. The solutions were obtained for two experimental conditions at an underexpanded pressure ratio of 44000 and an overexpanded pressure ratio of 2495. These conditions produce flows expanding to high Mach numbers in the hypersonic range. At the nozzle entrance, the flow has a supersonic Mach number of 4.3 in the inviscid region. In the external expansion and exhaust regions, the flow expands to a maximum Mach number of 12.3 for the case of high pressure ratio, whereas a shock wave exists for the low pressure ratio case. The solutions from these three-dimensional calculations were compared to the experimental data for pressure distributions. Author

A91-14431#

AIR INTAKE INTEGRATION BY CFD AT HIGH MACH NUMBER
V. MAUDET and P. PERRIER (Dassault Aviation, Saint-Cloud, France) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 10 p. refs (AIAA PAPER 90-5205) Copyright

To bring down the cost of the STAR-H hypersonic aircraft design, propulsion integration of the STAR-H family which combines theoretical computational fluid dynamics (CFD) and experimental issues with a check-point method is proposed. The check-point method is based on levels of software and levels of validation of design codes and includes evaluation and analysis of the problems. It is considered that such an approach will be instrumental in sharing the responsibilities and clarifying the interface problems between the companies in charge of the different subsystems of the vehicle. The selection of the best air intakes is considered to be not an easy task since the design has to cover many targets in performance and margins in the flight envelope. The performance of the air intakes is accessible using flow field quality predictions and supercritical-flow effects. At higher Mach numbers, the use of CFD is found to be especially beneficial since it enables an integration of flying qualities, thermal design, and flow stability at a reasonable cost. B.P.

A91-14448#
HYPERSONIC AERODYNAMICS CONSIDERATIONS AND CHALLENGES

DENNIS B. FINLEY (General Dynamics Corp., Fort Worth, TX) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 15 p. refs (AIAA PAPER 90-5222) Copyright

Aerodynamic analysis of aerospace planes requires substantially greater reliance on analytical procedures than conventional vehicles. A statistical technique is presented which quantifies the confidence level in computational fluid dynamics predictions. Drag uncertainty for all elements of hypersonic aerodynamic prediction are shown to highlight the diverse considerations for drag prediction of these vehicles. The statistical method provides a systematic means of monitoring the uncertainty during configuration development. The significance of aerodynamic drag to the size of accelerator vehicles is used to illustrate the impact of uncertainties. Author

A91-14457*# Comlere, Inc., Palo Alto, CA.

TRANSITION AND TURBULENCE MEASUREMENTS IN HYPERSONIC FLOWS

F. K. OWEN (Comlere, Inc., Palo Alto, CA) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 21 p. refs

(Contract F33615-88-C-3014; NAS2-12853) (AIAA PAPER 90-5231) Copyright

This paper reviews techniques for transitional- and turbulent-flow measurements and describes current research in support of turbulence modeling. Special attention is given to the potential of applying hot wire and laser velocimeter to measuring turbulent fluctuations in hypersonic flow fields. The results of recent experiments conducted in two hypersonic wind tunnels are presented and compared with previous hot-wire turbulence measurements. I.S.

A91-14458*# High Technology Corp., Hampton, VA.

BOUNDARY LAYER TRANSITION IN HYPERSONIC FLOWS

M. R. MALIK (High Technology Corp., Hampton, VA), T. A. ZANG, and D. M. BUSHNELL (NASA, Langley Research Center, Hampton, VA) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 22 p. refs

(Contract NAS1-18240)

(AIAA PAPER 90-5232) Copyright

This paper summarizes some of the recent progress made at NASA Langley Research Center in the understanding, prediction and modeling of high speed boundary-layer transition. Linear and nonlinear theories together with large-eddy and direct numerical simulations have been used to understand various aspects of the transition problem while low disturbance 'quiet' tunnels provide means for validating the theoretical results. Author

A91-14459#

STABILITY STUDIES OF PLANAR TRANSITION IN SUPERSONIC FLOWS

THOMAS I. ELIAS and EDWARD A. EISWIRTH (McDonnell Douglas Corp., Saint Louis, MO) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 6 p. refs

(AIAA PAPER 90-5233) Copyright

Linear stability predictions and quiet tunnel transition tests are used to study laminar boundary layer transition in two-dimensional high speed flows, with special emphasis on NASP-type geometries. The transition predictions are in agreement with quiet tunnel test results and the work of previous researchers. Conclusions and recommendations for further work in high speed transition prediction are presented. Author

A91-14460#

NUMERICAL SIMULATION OF SWEPT SHOCK/BOUNDARY-LAYER INTERACTIONS

S. V. RAMAKRISHNAN and U. C. GOLDBERG (Rockwell International Science Center, Thousand Oaks, CA) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 11 p. refs

(AIAA PAPER 90-5234) Copyright

In this paper the results obtained from a numerical simulation of the three dimensional interaction between a flat-plate turbulent boundary-layer and a swept, planar oblique shock wave generated by an upright, sharp-leading-edged fin at an angle of attack is presented. A modified Baldwin-Lomax zero-equation turbulence model with Goldberg's backflow model in the separated flow regions is employed. Reynolds averaged Navier-Stokes (RANS) equations are solved using a high accuracy total variation diminishing (TVD) formulation based on a finite volume approach. Roe's Riemann solver is used to capture shocks accurately and efficiently. Detailed comparisons of the computed results with measurements and other calculations are presented to demonstrate the accuracy of the numerical simulation. Author

A91-14464*# National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

SHOCK INTERFERENCE HEATING IN SCRAMJET ENGINES
ALLAN R. WIETING (NASA, Langley Research Center, Hampton, VA) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 8 p. refs
(AIAA PAPER 90-5238) Copyright

Experimental and analytical research sponsored by the NASA Langley Research center and the NASP Structures Technology Maturation Program to define critical aerothermal loads for the NASP engine is summarized. Presented is a review of (1) shock-shock interaction on the engine cowl leading edge that results in a supersonic jet impinging on the leading edge surface and causes the heat transfer rate to be amplified by a factor of 30 or more over the undisturbed (no shock interaction) flow stagnation point heat transfer rate, (2) the effectiveness of supersonic film cooling with and without the effects of an impinging oblique shock wave, and (3) oblique shock impingement in an axial compression corner. Author

A91-14468#

CORRELATION OF MEASURED AND THEORETICAL HEAT TRANSFER AND SKIN FRICTION AT HYPERSONIC SPEEDS, INCLUDING REYNOLDS ANALOGY

PERRY A. WOODEN and GENE H. HULL (General Dynamics Corp., Fort Worth, TX) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 15 p. refs
(AIAA PAPER 90-5244) Copyright

Predicted heat transfer and skin friction coefficients from a Parabolized Navier-Stokes code are compared with measured levels at Mach 12 and Mach 18. The test article was a forebody model that was tested in June 1987 in the Calspan Hypersonic Shock Tunnel. Although heat transfer and skin friction results compared well with theory, some skin friction measurements exhibited data scatter. The relationship between heat transfer and skin friction, Reynolds analogy, provides an alternative method for obtaining experimental skin friction levels on a tested configuration. It is shown for this configuration that the use of Colburn's Reynolds analogy with the measured heat transfer rate provides good agreement with CFD predicted skin friction, thus extending the validity of Reynolds analogy to hypersonic speeds. Author

A91-14483* National Aeronautics and Space Administration, Ames Research Center, Moffett Field, CA.

NONEQUILIBRIUM HYPERSONIC AEROTHERMODYNAMICS
CHUL PARK (NASA, Ames Research Center, Moffett Field; Stanford University, CA) New York, John Wiley & Sons, 1989, 372 p. refs
Copyright

Nonequilibrium phenomena in hypersonic flows are examined on the basis of theoretical models and selected experimental data, in an introduction intended for second-year graduate students of aerospace engineering. Chapters are devoted to the physical nature of gas atoms and molecules, transitions of internal states, the formulation of the master equation of aerothermodynamics, the conservation equations, chemical reactions in CFD, the behavior of air flows in nonequilibrium, experimental aspects of nonequilibrium flow, a review of experimental results, and gas-solid interaction. Diagrams, graphs, and tables of numerical data are provided. T.K.

A91-14569#

COMPARISON BETWEEN FINITE DIFFERENCE AND FINITE ELEMENT METHODS FOR SOLUTION OF AXISYMMETRIC TRANSONIC FLOW

R. C. MEHTA, KISHORI LAL, and T. JAYACHANDRAN (ISRO, Vikram Sarabhai Space Centre, Trivandrum, India) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 42, Aug. 1990, p. 197-202. refs

The effect of the choice of calculation parameters on numerical solutions of the full potential equation is studied for two different types of numerical methods. One is solving the nonconservative form of the equation by finite-difference method and the other is

the conservative form of the finite-element technique. In finite difference scheme, body-normal coordinates are used in nose-cone region and sheared cylindrical coordinates are employed on the afterbody to accommodate cylinder and boattail portion of a typical launch-vehicle heat shield. A mesh of triangular finite elements is chosen to solve the full potential equation over a bulbous payload shroud. The effects of mesh topology, artificial viscosity model, and extent of computational domain are investigated for transonic flow. Author

A91-14572#

OPTIMISATION OF THE K-EPSILON MODEL FOR A TURBULENT FAR-WAKE

E. G. TULAPURKARA (Indian Institute of Technology, Madras, India), R. A. ANTONIA, and L. W. B. BROWNE (Newcastle, University, Australia) (National Conference on Aerodynamics, 5th, Poona, India, May 1990) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 42, Aug. 1990, p. 221-228. Research supported by the Australian Research Council. refs

In the zonal modeling approach to the problem of turbulence closure, the k-epsilon model of Launder and Spalding (1974) with five model constants is generally chosen as the standard model. Different sets of constants are determined to correctly reproduce the experimental data in certain basic flows. In a complex flow, appropriate sets of constants obtained for basic flows are used in different zones. The far wake is an important basic flow in zonal modeling. The determination of constants has been relatively unsatisfactory in the past mainly due to the lack of reliable data on the average rate of dissipation of turbulent kinetic energy. The recent availability of such data in the far wake has made it possible to determine the constants by balancing equations for momentum, turbulent kinetic energy k, and rate of dissipation epsilon. It is verified that calculations, based on the new constants, of the mean velocity, k, and epsilon are in better agreement with experiment than those obtained with the standard constants. Author

A91-14574#

EFFECT OF INLET FLOW DISTORTION ON THE PERFORMANCE OF VORTEX CONTROLLED AND HYBRID DIFFUSERS

R. K. SULLEREY, V. ASHOK (Indian Institute of Technology, Kanpur, India), and K. V. SHANTHARAM (ISRO, Vikram Sarabhai Space Centre, Trivandrum, India) (National Conference on Aerodynamics, 5th, Poona, India, May 1990) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 42, Aug. 1990, p. 239-247. Research supported by the Aeronautical Development Agency of India. refs

The present experimental investigations are concerned with diffusers employing the concept of vortex control to achieve high pressure recovery in a short length. Two types of two-dimensional diffusers have been studied; namely, vortex-controlled and hybrid diffusers with symmetrically and asymmetrically distorted inlet velocity profiles for area ratios 2.0 and 2.5 and divergence angle of 30 and 45 deg at bleed rates up to 7 percent. The measurements were carried out at a Reynolds number of 100,000. The performance was evaluated in terms of diffuser effectiveness, vortex chamber depression and nature of exit velocity profiles. The diffuser effectiveness improved with bleed-off. However, optimum bleed-off rate was lower for the hybrid diffuser. The optimum effectiveness was obtained for a particular combination of fence subtended and divergence angles. It was observed that the nature of exit velocity profiles could be controlled by differential bleed. Author

A91-14759* Virginia Polytechnic Inst. and State Univ., Blacksburg.

A PATCHED-GRID ALGORITHM FOR COMPLEX AIRCRAFT CONFIGURATIONS

ROBERT W. WALTERS (Virginia Polytechnic Institute and State University, Blacksburg) and JAMES L. THOMAS (NASA, Langley Research Center, Hampton, VA) IN: International Symposium on Domain Decomposition Methods for Partial Differential Equations,

3rd, Houston, TX, Mar. 20-22, 1989, Proceedings. Philadelphia, PA, Society for Industrial and Applied Mathematics, 1990, p. 397-409. refs

Copyright

A patched-grid algorithm for the analysis of complex configurations with an implicit, upwind-biased Navier-Stokes solver is presented. Through the use of a generalized coordinate transformation at the zonal interface between two or more blocks, the algorithm can be applied to highly stretched viscous grids and to arbitrarily-shaped patch boundaries. Applications are made to the SR71 reconnaissance aircraft in a high-altitude environment at a supersonic speed and to the F/A-18 forebody-strake configuration at subsonic, high-alpha conditions, in support of the NASA High-Alpha Research Program. Author

A91-14760

APPLICATION OF DOMAIN DECOMPOSITION TO THE ANALYSIS OF COMPLEX AERODYNAMIC CONFIGURATIONS

W. E. DIETZ, J. L. JACOBS, and J. H. FOX (Calspan Corp., Buffalo, NY) IN: International Symposium on Domain Decomposition. Methods for Partial Differential Equations, 3rd, Houston, TX, Mar. 20-22, 1989, Proceedings. Philadelphia, PA, Society for Industrial and Applied Mathematics, 1990, p. 428-450. refs

Copyright

An application of domain decomposition to the analysis of aerodynamic configurations is presented. An aerodynamic configuration is discussed which consists of approximately 40 interacting meshes, modeling an aircraft fuselage, an attached wing, pylons attached to the wing and fuselage, stores attached to the pylons, and inlet walls. The method used to analyze this configuration employs two computer codes. The first calculates interpolation information among interacting meshes; the second solves the Euler equations for the entire configuration, using the interpolation information generated by the first code. Issues related to mesh interactions, modeling complex geometries, and computational accuracy are discussed. Author

A91-14937#

COMPUTATION OF TRANSONIC VISCOUS FLOW IN NOZZLE

XIAO HOU, HONGQING HE, TIMIN CAI, and XINPING WU (Northwestern Polytechnical University, Xian, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), Oct. 1990, p. 11-16. In Chinese, with abstract in English. refs

Compressible laminar thin-layer N-S equations for inviscid transonic flow in a nozzle are solved in conservation form adopting an implicit approximation-factorization algorithm in conjunction with generalized body-fitted coordinates. The parameters in core-flow, especially in boundary layer, are obtained through the asymptotic solution of unsteady equations after suitable long time. The computed examples are the transonic viscous flow field in two kinds of nozzles, one possessing rectangular section and the other axisymmetric. The agreement of computation results in comparison with measurements is very good for both kinds of nozzles. Author

A91-15027#

A SIMPLE UNIFIED EXPRESSION OF AIRLOAD-SINGULARITY RESULTING FROM KINKED-WING-PLATFORMS

KYOKO NITTA and SHIGENORI ANDO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 38, no. 432, Jan. 1990, p. 30-40. In Japanese, with abstract in English.

The convergence of lifting surface numerical computations with the mode method is generally deteriorated by kinks, especially on the leading edge, of wing platforms. This problem can be solved by the appropriate mode function (eigensolution) for the kinks, rather than 'rounding off' of the kink, although the latter has often been used. A new unified formula of eigensolution is developed through results of a series of numerical computations with the discrete lifting surface scheme BIS. The parameters in this formula were determined using the results of previous analytical solutions. Author

A91-15035#

FLOW PAST PERFORATED PLATE PLACED PERPENDICULARLY ON GROUND PLANE

SHIKI OKAMOTO, TADASHI SAKATSUME, and GOICHI TAKEI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 38, no. 436, 1990, p. 241-248. In Japanese, with abstract in English. refs

This paper describes the flow past a two-dimensional perforated plate placed on a ground plane. The experiment was carried out in a 40 cm x 40 cm wind-tunnel having a working section of 2 m length, at Reynolds number of 63,200. The distributions of velocity in the flowfield, the recirculation region behind the perforated plate, and the surface pressure on the ground plate were measured. The results were discussed for the various values of porosity in comparison with those of the existing investigations and the calculated value of the velocity in the mixing zone for Goertler. Consequently, the windbreak is effective for the perforated plate of porosity ratio 0.2. Author

A91-15036#

MEASUREMENTS OF SHORT BUBBLE AND LONG BUBBLE FORMED ON NACA 63-009 AIRFOIL

KENICHI RINOIE, MIKA SHINGO, and JUNZO SATO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 38, no. 436, 1990, p. 249-257. In Japanese, with abstract in English. refs

An experimental study on the structure of the short bubble and the long bubble formed on a NACA 63-009 airfoil has been made. Mean velocities, turbulent stresses and turbulent triple products were measured. Results show that the turbulent stresses attain maxima near the reattachment point for the short bubble. For the long bubble, these stresses start to increase just after the laminar separation point and attain maxima far before the flow reattaches to the airfoil surface. Turbulent energy balances were estimated from results. It is shown that the turbulent energy production term has the largest contribution to the growth of turbulent energy compared with the other terms. Author

A91-15042#

EXPERIMENTS ON TRANSITION PROCESS OF LAMINAR SEPARATION BUBBLE ON AIRFOILS

KENICHI RINOIE and JUNZO SATO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 38, no. 438, 1990, p. 352-361. In Japanese, with abstract in English. refs

Experiments have been done to investigate the transition process of the laminar separation bubble on airfoils. Measurements of the power spectrum density distribution of the streamwise velocity fluctuation were made. The frequency of the discrete spectrum was in good agreement with that predicted by the linear stability theory of the separated free shear layer. From the results, it is concluded that the velocity disturbance observed initially in the laminar separation bubble for the three airfoils shows similar characteristic to that in the separated free shear layer. For the airfoil whose design pressure recovery is minimum among three airfoils, however, another kind of the discrete spectrum was also observed. This is interpreted to be caused by the interference with the external cyclic disturbance. Author

A91-15103

COMPRESSIBLE VISCOUS FLOW CALCULATIONS USING COMPATIBLE FINITE ELEMENT APPROXIMATIONS

M. O. BRISTEAU (INRIA, Le Chesnay, France), R. GLOWINSKI (Houston, University, TX), L. DUTTO, J. PERIAUX, and G. ROGE (Dassault Aviation, Saint-Cloud, France) (International Conference on Finite Elements in Flow Problems, 7th, Huntsville, AL, Apr. 3-7, 1989) International Journal for Numerical Methods in Fluids (ISSN 0271-2091), vol. 11, Oct. 20, 1990, p. 719-749. refs (Contract DRET-88-103; NSF INT-86-12680)

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The numerical simulation of compressible viscous flows by a combination of finite element methods for the space approximation, an implicit second-order multistep scheme for the time discretization

02 AERODYNAMICS

and GMRES iterative methods for solving the nonlinear problems encountered at each time step is presented. The need, at least with the centered space approximations employed, to use different finite element approximations for velocity and density is discussed. Finally, the numerical results corresponding to flows around airfoils and aerospace vehicles show the possibilities of these methods.

R.E.P.

A91-15165* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

INTERACTION OF A STREAMWISE VORTEX WITH A TURBULENT MIXING LAYER

JAMES H. BELL (NASA, Ames Research Center, Moffett Field; Stanford University, CA) and RABINDRA D. MEHTA (Stanford University, CA) *Physics of Fluids A* (ISSN 0899-8213), vol. 2, Nov. 1990, p. 2011-2023. refs

(Contract NCC2-55)

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The interaction of a single streamwise vortex with a plane turbulent mixing layer is experimentally studied. Initially, near the mixing layer origin, the vortex rides just below the layer and only affects the mixing layer properties near the bottom side of the mixing layer. Once the vortex starts to become embedded within the mixing layer and active interaction has begun, the effect of the vortex is to grossly distort the mean velocity and turbulence contours over the whole width of the mixing layer. The induced cross-flow velocities in the mixing layer result in the production of additional normal Reynolds stresses which in turn act with mean flow gradients to generate extra shear stresses. In particular, the secondary shear stress (SSS) achieves an absolute peak value equivalent to about 40 percent of the maximum primary shear stress. The position and decay of the SSS peak are then found to be strongly correlated with those of the streamwise vortex.

C.D.

A91-16027

AEROTHERMODYNAMICS - A TUTORIAL DISCUSSION

JOHN D. ANDERSON, JR. (Maryland, University, College Park) IN: Thermal Structures Conference, 1st, Charlottesville, VA, Nov. 13-15, 1990, Proceedings. Charlottesville, VA, University of Virginia Light Thermal Structures Center, 1990, p. 1-54. refs

Copyright

The present consideration of the high temperature chemically-reacting flowfields around hypersonic bodies gives attention to both inviscid flows, in which the transport mechanisms of viscosity, thermal conduction, and mass-diffusion are neglected, and viscous flows, in which these transport phenomena are included. Emphasis is given to the distinction between equilibrium and nonequilibrium chemically-reacting flows. This tutorial treatment proceeds through a microscopic description of gases and the properties of equilibrium chemically-reacting gas, normal shock-wave flows, blunt body flows, to nonequilibrium normal shock-wave flows and blunt-body flows. The effects of catalytic walls and radiating shock layers are noted.

O.C.

A91-16052#

APPROACHES TO ANALYTICAL SOLUTIONS OF LAMINAR COMPRESSED FREE JETS

JACQUES BOREE and GEORGES CHARNAY (Toulouse, Institut de Mecanique des Fluides, France) *AIAA Journal* (ISSN 0001-1452), vol. 28, Nov. 1990, p. 1859, 1860. Research supported by CNRS.

Copyright

The effects of a uniform mass density time variation on a subsonic gas jet is presently studied by generalizing the classical similarity hypothesis. Both plane and circular laminar jet evolutions are precisely established and compared. Attention is given to the laminar self-preserving region and the mixing region and potential core.

Author

A91-16053*# Pennsylvania State Univ., University Park. COMPUTATION AND TURBULENCE MODELING FOR THREE-DIMENSIONAL BOUNDARY LAYERS INCLUDING TURBOMACHINERY ROTOR FLOWS

J. ZHANG and B. LAKSHMINARAYANA (Pennsylvania State University, University Park) *AIAA Journal* (ISSN 0001-1452), vol. 28, Nov. 1990, p. 1861-1869. refs

(Contract NSG-3266)

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A method is developed for predicting the behavior of three-dimensional, turbulent boundary layers occurring in internal flows, including those on turbomachinery rotor blades. These boundary layers are complex, turbulent, and subject to Coriolis and centrifugal forces. The major thrust of this paper is the development and use of an algebraic Reynolds stress model (ARSM) that captures the changes in turbulent flow structure arising from curvature, rotation, and three dimensionality. The prediction of pressure-driven secondary flow agrees well with the measured data, and all three turbulence models (k-epsilon, algebraic eddy viscosity, and ARSM) show the same level of agreement. The prediction of boundary-layer development on rotor blades shows much better agreement with measurements with the ARSM. It is essential to employ higher-order turbulence models to capture the effects of rotation, curvature, and three dimensionality on boundary layers in turbomachinery.

Author

A91-16056#

EFFECTS OF A BASE CAVITY ON SUBSONIC NEAR-WAKE FLOW

R. W. KRUISWYK and J. C. DUTTON (Illinois, University, Urbana) *AIAA Journal* (ISSN 0001-1452), vol. 28, Nov. 1990, p. 1885-1893. Previously cited in issue 09, p. 1275, Accession no. A89-25184.

refs

(Contract DAAL03-87-K-0010)

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A91-16059#

CONTROL OF FLOW SEPARATION BY ACOUSTIC EXCITATION

M. NISHIOKA, M. ASAI (Osaka Prefecture, University, Sakai, Japan), and S. YOSHIDA *AIAA Journal* (ISSN 0001-1452), vol. 28, Nov. 1990, p. 1909-1915. Previously cited in issue 11, p. 1591, Accession no. A89-30487. refs

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A91-16060*#

Virginia Polytechnic Inst. and State Univ., Blacksburg.

EFFECT OF SUCTION ON THE STABILITY OF SUBSONIC FLOWS OVER SMOOTH BACKWARD-FACING STEPS

AYMAN A. AL-MAAITAH, ALI H. NAYFEH, and SAAD A. RAGAB (Virginia Polytechnic Institute and State University, Blacksburg) *AIAA Journal* (ISSN 0001-1452), vol. 28, Nov. 1990, p. 1916-1924. Previously cited in issue 11, p. 1591, Accession no. A89-30495.

refs

(Contract N00014-85-K-0011; NAG1-714)

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A91-16061*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

VORTEX-DOMINATED CONICAL-FLOW COMPUTATIONS USING UNSTRUCTURED ADAPTIVELY-REFINED MESHES

JOHN T. BATINA (NASA, Langley Research Center, Hampton, VA) *AIAA Journal* (ISSN 0001-1452), vol. 28, Nov. 1990, p. 1925-1932. Previously cited in issue 18, p. 2754, Accession no. A89-42046. refs

Copyright

A91-16064#

COMPUTATIONAL AND EXPERIMENTAL STUDY OF STALL PROPAGATION IN AXIAL COMPRESSORS

S. JONNAVITHULA, S. THANGAM, and F. SISTO (Stevens Institute of Technology, Hoboken, NJ) *AIAA Journal* (ISSN 0001-1452), vol. 28, Nov. 1990, p. 1945-1952. Previously cited in issue 20, p.

3082, Accession no. A89-46842. refs
(Contract N00014-86-K-0315; N62271-87-M-0204)
Copyright

A91-16074*# National Aeronautics and Space Administration.
Ames Research Center, Moffett Field, CA.

**IMPROVEMENTS TO A NONEQUILIBRIUM ALGEBRAIC
TURBULENCE MODEL**

D. A. JOHNSON and T. J. COAKLEY (NASA, Ames Research
Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol.
28, Nov. 1990, p. 2000-2003. refs
Copyright

It has been noted that while the nonequilibrium turbulence model
of Johnson and King (1985, 1987) performed significantly better
than alternative methods, differences between predicted and
observed shock locations for certain weak interactions are
produced due to a deficiency in the model's inner eddy viscosity
formulation. A novel formulation for the model is presented which
removes this deficiency, while satisfying the law of the wall for
adverse pressure-gradient conditions better than either the original
formulation or mixing-length theory. O.C.

A91-16277#
**AN EULER ZONAL METHOD USING COMPOSITE
STRUCTURED AND UNSTRUCTURED MESHES**

H. HEFAZI (California State University, Long Beach), L. T. CHEN
(Douglas Aircraft Co., Long Beach, CA), and V. CHIN AIAA,
Applied Aerodynamics Conference, 8th, Portland, OR, Aug. 20-22,
1990. 9 p. refs

(AIAA PAPER 90-3050) Copyright

A two-dimensional, zonal, interactive scheme based on Euler
equations has been developed for computing transonic flow about
complex geometries. The finite-volume Euler method has been
modified to couple zones with structured and unstructured grids.
Transonic airfoil calculations and solution for flow about a
multielement airfoil are given as examples of the application of
the scheme. The zonal interference scheme and accuracy and
efficiency of the solutions are discussed. Author

A91-16278#
CFD-BASED 3D TURBOFAN NACELLE DESIGN SYSTEM

K. UENISHI, M. S. PEARSON, T. R. LEHNIG, and R. M. LEON
(GE Aircraft Engines, Cincinnati, OH) AIAA, Applied Aerodynamics
Conference, 8th, Portland, OR, Aug. 20-22, 1990. 19 p. refs
(AIAA PAPER 90-3081) Copyright

A three-dimensional turbofan nacelle design system based on
Computational Fluid Dynamics (CFD) was developed at General
Electric Aircraft Engines. This system was created to assist nacelle
designers in the efficient assessment, modification, and
improvement of their design concepts. A reliable CFD flow solver,
user-friendly grid generation, and postprocessing software are
included in the system. The system is easy to use by designers
who are not particularly familiar with CFD. Validation and
applicability studies have been performed using several different
nacelle configurations at on-design and off-design engine operating
conditions. The robustness of the CFD system is represented by
the simulation of a static engine test case with a ground plane.
This system has demonstrated that a CFD code integrated with
automatic grid generation and postprocessing can reduce the
development cycle time in the nacelle design process. Author

A91-16293
**WAVERIDER CONFIGURATIONS ACCORDING TO THIN
SHOCK-LAYER THEORY**

HAMDI T. HEMDAN (King Saud University, Riyadh, Saudi Arabia)
Acta Astronautica (ISSN 0094-5765), vol. 21, Aug. 1990, p.
571-582. refs

Copyright

This paper shows that the thin shock-layer theory can be
completed in an analytical manner when the shock wave is attached
to the leading edges of a non-planar triangular conical wing.
Discontinuities appear only in the derivatives and not in the
functions. Thus, the second derivative of each body and the shock

is discontinuous at one point, and the first derivative of the
transverse velocity components and pressure are discontinuous
at one point. Bodies for which the slope is discontinuous at one
point are also possible. A differentiable shock wave is assumed
known and the body is calculated. Thus, bodies with smooth
differentiable cross-sections in the inboard which are attached to
planar segments in the outboard are obtained while bodies having
infinite slope at the central axis are also possible. It is found that
a parabolic arc shock in the inboard cannot permit an attached
shock solution but other higher order polynomials can. Surface
pressure coefficient, coefficients of normal and axial force, and
the lift and drag forces of waveriders constructed from these bodies
are calculated in closed-form for a wide range of the flow
parameters. Author

A91-16544
**CORRELATIONS OF ROTOR WAKE/AIRFRAME
INTERACTION MEASUREMENTS WITH FLOW VISUALIZATION
DATA**

ALBERT G. BRAND (Bell Helicopter Textron, Inc., Fort Worth,
TX), HOWARD M. MCMAHON, and NARAYANAN M. KOMERATH
(Georgia Institute of Technology, Atlanta) American Helicopter
Society, Journal (ISSN 0002-8711), vol. 35, Oct. 1990, p. 4-15.
Research supported by the U.S. Army. refs
Copyright

Interaction between the aerodynamics of the rotor and the
airframe causes large unsteady pressure fluctuations on rotorcraft
airframes. A two-bladed rotor and a hemisphere-cylinder airframe
model are used to study these pressure fluctuations in a wind
tunnel, simulating low-speed forward flight conditions. Controlled
displacement of the airframe is used to obtain finely-spaced
pressure data. These are correlated with azimuth-resolved,
quantitative laser sheet visualization of the dynamics of the tip
vortices and the inboard vortex sheets from the rotor, along the
top of the airframe. Three prominent periodic interactions are
observed on the airframe surface. In order of significance, these
are: blade passage effect, tip vortex impingement, and vortex sheet
effects. These interactions determine, to a large degree, the overall
pressure distribution on the airframe surface, and hence the
airframe unsteady airloads. The pressure signatures from the blade
passage and the vortex impingement are quite different, and are
explained using two-dimensional models. Author

A91-16545
SPECIAL VORTICES AT A HELICOPTER ROTOR BLADE

REINERT H. G. MUELLER (FIBUS Research Institute, Aachen,
Federal Republic of Germany) American Helicopter Society,
Journal (ISSN 0002-8711), vol. 35, Oct. 1990, p. 16-22. refs
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Blade Vortex Interactions (BVI) are to some extent responsible
for noise emission and blade stress due to the vortex-induced
unsteady forces on the blades. To improve the aerodynamic
behavior of a helicopter rotor, it is essential to know as much as
possible about the development of the rotor wake and the rolled-up
vortices in this wake. This paper contributes some investigations
of two special vortex phenomena which strongly influence the
flow around the rotor blades. First, evidence was found for the
often postulated 'mid vortex', which results from the interference
of a tip vortex with the following rotor blade. In free wake analysis
models, usually the circulation of this 'mid vortex' is fairly well
represented by the inboard vortex sheet. However, treating the
'mid vortex' as a rolled-up vortex could give the possibility of
modeling the vortex structure and at the same time avoid the
problem of mathematical instability of the large number of free
moving vortex trailers. In the second part, some results concerning
a 'double tip vortex' are presented. This double vortex is typical
for rotor configurations with a downward-pointing winglet at the
blade tip. Due to a change in the position and the structure of
the vortex, this 'double vortex' has a decreased influence on the
following blade at a blade vortex encounter. Author

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A91-16646

HYPersonic AIRCRAFT AND INLET CONFIGURATIONS DERIVED FROM AXISYMMETRIC FLOWFIELDS

HAMDI T. HEMDAN (King Saud University, Riyadh, Saudi Arabia)
Acta Astronautica (ISSN 0094-5765), vol. 21, Sept. 1990, p. 609-616. refs
Copyright.

Waveriders and inlets derived from the stream surfaces of axisymmetric Newtonian flows past slender pointed-nose parabolic bodies at high Mach numbers are constructed. The flowfield of the waverider including pressure distribution, velocity components, and the attached shock wave are all known in closed-form. Thus, the variation of lift and drag forces with the various parameters and the mass flow rate through the inlet are found. It is shown that adding some longitudinal curvature to the surfaces of the cone-derived waverider, considerably increases the lift-to-drag ratio but decreases the lifting force. Author

A91-16735#

HYPersonic DELTA WING FLOW CALCULATIONS USING A MULTIDOMAIN MUSCL EULER SOLVER

PH. GUILLEN and M. BÖRREL (ONERA, Chatillon, France) (INRIA and Societe de Mathematiques Appliquees et Industrielles, Workshop on Hypersonic Flows for Reentry Problems, Antibes, France, Jan. 22-26, 1990) ONERA, TP no. 1990-152, 1990, 15 p. (ONERA, TP NO. 1990-152)

Euler computation results for the test case 7.1.1 from a newly developed multidomain solver (FLU3M) based on an upwind/MUSCL numerical scheme are presented. The strong influence of the grid density for an accurate prediction of the flowfield specially in the vortex region is examined through three grid refinements. Author

A91-16736#

SIMILITUDE IN HYPersonic AERODYNAMICS

H. VIVIAND (ONERA, Chatillon-sous-Bagneux, France) (INRIA and Societe de Mathematiques Appliquees et Industrielles, Workshop on Hypersonic Flows for Reentry Problems, Antibes, France, Jan. 22-26, 1990) ONERA, TP no. 1990-153, 1990, 26 p. refs
(ONERA, TP NO. 1990-153)

Computational fluid dynamics similitude for hypersonic flows is discussed in relation to fluid mechanics modeling. A mathematical model based on the steady Navier-Stokes equations is considered in order to study the dimensional similitude for calorically perfect gas flows. When the gas density is very low, the Navier-Stokes model becomes invalid and must be replaced by the Boltzmann equation. However, when rarefaction effects are just incipient, the Navier-Stokes equations remain valid but some modifications have to be applied. For inviscid hypersonic flows of a calorically perfect gas, the similitudes are associated with different models such as the Newtonian model, hypersonic small perturbation theory, and Sytchev's model for slender bodies at large incidence. For hypersonic flows involving high temperatures and real gases, whether in thermodynamic equilibrium or not, exact similitude is not possible and approximate similitude have to be used. Particular cases such as a thermally perfect gas and a simple dissociating diatomic gas are considered. B.P.

A91-16737#

EXPERIMENTS ON SHOCK-WAVE/BOUNDARY-LAYER INTERACTIONS PRODUCED BY TWO-DIMENSIONAL RAMPS AND THREE-DIMENSIONAL OBSTACLES

J. DELERY and M.-C. COET (ONERA, Chatillon-sous-Bagneux, France) (INRIA and Societe de Mathematiques Appliquees et Industrielles, Workshop on Hypersonic Flows for Reentry Problems, Antibes, France, Jan. 22-26, 1990) ONERA, TP no. 1990-155; 1990, 34 p. refs
(ONERA, TP NO. 1990-155)

An experimental study of shock-wave/boundary-layer interactions at high Mach numbers was conducted on a two-dimensional ramp at Mach numbers 10 and 5 and on a three-dimensional obstacle at Mach number 10, with the purpose of sim-

ulating strong interactions taking place at a control surface or at a wing-fuselage junction. For Mach number 5, the effect of Reynolds number was also investigated. The flow produced was visualized by schlieren photographs, surface flow visualization, thermosensitive painting, surface heat transfer, and surface pressure measurements. It was found that, for the lowest Reynolds number values, interactions at Mach numbers 10 and 5 were laminar in the region of separation, whereas interaction obtained at Mach 5 for the highest Reynolds number value was fully turbulent, with the transition taking place well upstream of the interaction region. It was also found that the 30-deg swept three-dimensional obstacles lead to very extended zones of separated flows. I.S.

A91-16743#

PREDICTING UNSTEADY AERODYNAMIC FORCES IN LINEARIZED SUPERSONIC CONDITIONS [PREVISION DES FORCES AERODYNAMIQUES INSTATIONNAIRES EN SUPERSONIQUE LINEAIRE]

A. DUGEAI (ONERA, Chatillon, France) (Colloque d'Aerodynamique Appliquee, 27th, Marseille, France, Oct. 15-17, 1990) ONERA, TP no. 1990-164, 1990, 15 p. In French. refs
(ONERA, TP NO. 1990-164)

A linear integral method is utilized to calculate the aerodynamic forces produced by supersonic aircraft. This study is directed at achieving a three-dimensional code to predict the unsteady effects on the aircraft. The lifting-surface problem is examined, and an integral equation is obtained relating the potential harmonic gradient of the velocity to the wall displacement. The validity of this method is shown by comparing various numerical or analytical results with experimental results. R.E.P.

A91-16745#

INTERACTION BETWEEN AN OBLIQUE SHOCK WAVE AND A TURBULENT BOUNDARY LAYER DEVELOPING ON A HEATED WALL [INTERACTION ENTRE UNE ONDE DE CHOC OBLIQUE ET UNE COUCHE LIMITE TURBULENTE SE DEVELOPPANT SUR UNE PAROI CHAUFFEE]

R. BENAY (ONERA, Chatillon-sous-Bagneux, France) (Colloque d'Aerodynamique Appliquee, 27th, Marseille, France, Oct. 15-17, 1990) ONERA, TP no. 1990-166, 1990, 44 p. In French. refs
(ONERA, TP NO. 1990-166)

Wind tunnel experiments were performed to determine the interaction between an oblique shock wave and a turbulent boundary layer developing on an unheated wall or a wall heated to 600 K with an exterior airflow of Mach 2.4. Classical boundary layer calculations have led to a calculation code making possible the low-cost testing of turbulence models whose complexity does not allow their easy inclusion in the Navier-Stokes code; the algebraic stress model is cited as an example. The comparison of experimental and calculated results allows a critical analysis of the turbulence models evaluated. It is shown that a detailed airflow analysis based on experimental studies of mean and turbulent fields provides justification for the theoretical approach employed. R.E.P.

N91-11669 Southampton Univ. (England).

DYNAMIC EFFECTS OF HYPersonic SEPARATED FLOW Ph.D. Thesis

TIMOTHY PETER ROBERTS 1989 227 p
Avail: Univ. Microfilms Order No. BRD-89586

The results of an investigation into the static and dynamic behavior of the hypersonic separated flow generated over a flat plate-rearward flap configuration are reported with particular emphasis on the dynamic aspects. A range of flap deflection angles up to 35 degrees were considered. For the dynamic tests, the form of the motion of the flap was such that it was rapidly driven up from an almost zero degree angle of attack, to one of about 40 degrees, and then rapidly reversed. The investigation involved some theoretical modelling, and an experimental program in which extensive static pressure measurements and flow visualization studies were made. The experimental results showed that the rapid motion of the flap introduced some unsteadiness into the

flow over the model, particularly near reattachment. In addition it was observed that the growth or decay of the separation region 'lags' behind the changing flap angle, and that the extent of this lag is to first order, proportional to the flap angular velocity. Using this linear relationship, the experimental data were interpreted to obtain the difference in flap angles at which a given position of separation would be obtained, between that for the flap rising and that for the flap falling, both with a flap angular velocity of 51 rad/s. The experimental results have shown that the overall force and moment coefficients on the model, for the flap angular velocity range of -51 to +51 rad/s, differ by no more than -3.8 percent of the quasi-steady value. Dissert. Abstr.

N91-11670 Notre Dame Univ., IN.
**COMPRESSIBLE FLOWS WITH PERIODIC VORTICAL
 DISTURBANCES AROUND LIFTING AIRFOILS Ph.D. Thesis**
 JAMES RUSSELL SCOTT 1990 232 p
 Avail: Univ. Microfilms Order No. DA9023948

A numerical method is developed for solving periodic, three-dimensional, vortical flows around lifting airfoils in subsonic flow. This first-order method fully accounts for the distortion effects of the nonuniform mean flow on the convected upstream vortical disturbances. The unsteady velocity is split into a vortical component and an irrotational field whose potential satisfies a nonconstant-coefficient, inhomogeneous, and convective wave equation. Using an elliptic coordinate transformation, the unsteady boundary value problem is solved in the frequency domain on grids. In general, the agreement between the numerical and analytical results is very good for reduced frequencies ranging from 0 to 4, and for Mach numbers ranging from .1 to .8. Numerical results are also presented for a wide variety of flow configurations to determine the effects of airfoil thickness, angle of attack, camber, and Mach number on the unsteady lift and moment of airfoils subjected to periodic vortical gusts. Each of these parameters can have a significant effect on the unsteady airfoil response to the incident disturbances, and the effect depends strongly upon the reduced frequency and the dimensionality of the gust. For a one-dimensional or two-dimensional gust, the results indicate that airfoil thickness increases the unsteady lift and moment at the low reduced frequencies but decreases it at the high reduced frequencies. It is shown that mean airfoil loading leads to a significant reduction in the unsteady lift and moment for the low reduced frequencies, but a significant decrease for the high reduced frequencies. Dissert. Abstr.

N91-11671 Georgia Inst. of Tech., Atlanta.
**UNSTEADY VORTEX LATTICE AERODYNAMICS FOR ROTOR
 AEROELASTICITY IN HOVER AND IN FORWARD FLIGHT
 Ph.D. Thesis**
 KYUNG MIN YOO 1990 223 p
 Avail: Univ. Microfilms Order No. DA9023837

An unsteady vortex lattice method was applied and was shown to be an improvement over the classical two-dimensional quasi-steady aerodynamics. A number of code validation studies were carried out including comparison of the present method with experimental data and other methods. To develop a computational model of the rotor and its wake, a thin lifting surface and wake were discretized into bound, shed, and trailing vortex filaments fixed in a prescribed wake geometry. Also, to consider the unsteady wake aeromechanism among the blades, each blade's motion and deformation were treated. The unsteady induced inflow was calculated and compared with experiment and other inflow models. The results for a two-bladed hovering rotor clearly show the effects of the three-dimensional tip-relief effect and the unsteady wake dynamics effect of the near and returning wake undergoing various unsteady motions. The present thin lifting surface theory was also applied to a coupled flap-lag-torsion stability analysis for the hovering flight condition. The perturbed time histories of coupled flap-lag-torsional motions were analyzed by Fourier analyses to predict the damping and frequencies of particular modes. The overprediction of lead-lag damping by the two-dimensional quasi-steady aerodynamics is shown to be due to a lack of both three-dimensional tip-relief effects and unsteady wake dynamics

of the near and returning wake. In forward flight, the present method is applied to aeroelastic response predictions for both low and high advance ratios. In low speed flight, there exists a strong blade-wake interaction which is diminished in high speed flight. Dissert. Abstr.

N91-11672 Purdue Univ., West Lafayette, IN.
**THREE-DIMENSIONAL FULL POTENTIAL METHOD FOR THE
 AEROELASTIC MODELING OF PROPFANS Ph.D. Thesis**
 CHIEH-CHANG KU 1989 132 p
 Avail: Univ. Microfilms Order No. DA9018856

Three dimensional, unsteady, subsonic, and transonic flow through a single rotation propeller is studied. The unsteady loads on the blades are obtained by solving the full potential equations using an implicit time marching scheme. The purpose of the code is to provide a capability of doing propfan aeroelastic analysis in the nonlinear transonic regime. Results are shown for steady state aerodynamic loading, unsteady aerodynamic response to forced aeroelastic deformations, and free aeroelastic response. The aerodynamic analysis is based on a finite volume discretization of the potential equations. The scheme is fully implicit, with the resulting nonlinear algebraic equations being solved in conservation form by an approximately factored quasi-Newton iteration at each time step. The blade dynamics are based on the in vacuum modes and frequencies. The scheme uses a moving grid that conforms instantaneously to the deforming blade shape. Grids are generated, a priori, for the undeformed blade and for unit deformations in each of the in vacuum modes. Dynamic grids are then set by linear superposition based on the current state vector of the blade. The aeroelastic analysis of propfans was addressed in two ways: frequency domain analysis and time domain simulation. The frequency domain solution uses the generalized forces that are obtained from transfer function analysis. The results are compared directly to a linear panel method in terms of damping coefficients. Dissert. Abstr.

N91-11674*# National Aeronautics and Space Administration.
 Langley Research Center, Hampton, VA.
**THREE-DIMENSIONAL FLUX-SPLIT EULER SCHEMES
 INVOLVING UNSTRUCTURED DYNAMIC MESHES**
 JOHN T. BATINA Nov. 1990 9 p Presented at the 21st
 AIAA Fluid Dynamics, Plasma Dynamics and Lasers Conference,
 Seattle, WA, 18-20 Jun. 1990 Previously announced in IAA as
 A90-38777.
 (NASA-TM-102731; NAS 1.15:102731; AIAA-90-1649) Avail:
 NTIS HC/MF A02 CSCL 01A

Improved algorithms for the solution of the 3-D time dependent Euler equations are presented for aerodynamic analysis involving unstructured dynamic meshes. The improvements were developed recently to the spatial and temporal discretizations used by unstructured grid flow solvers. The spatial discretization involves a flux split approach which is naturally dissipative and captures shock waves sharply with at most one grid point within the shock structure. The temporal discretization involves either an explicit time integration scheme using a multistage Runge-Kutta procedure or an implicit time integration scheme using a Gauss-Seidel relaxation procedure which is computationally efficient for either steady or unsteady flow problems. With the implicit Gauss-Seidel procedure, very large time steps may be used for rapid convergence to steady state, and the step size for unsteady cases may be selected for temporal accuracy rather than for numerical stability. Steady flow results are presented for both the NACA 0012 airfoil and the ONERA M6 wing to demonstrate applications of the new Euler solvers. A description of the Euler solvers is presented along with results and comparisons which assess the capability. Author

N91-11675*# National Aeronautics and Space Administration.
 Lewis Research Center, Cleveland, OH.
**EFFECT OF ACOUSTIC EXCITATION ON STALLED FLOWS
 OVER AN AIRFOIL**
 K. B. M. Q. ZAMAN Oct. 1990 14 p Presented at the 13th
 Aeroacoustics Conference, Tallahassee, FL, 22-24 Oct. 1990;

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sponsored in part by AIAA
(NASA-TM-103183; E-5563; NAS 1.15:103183; AIAA-90-4010)
Avail: NTIS HC/MF A03 CSCL 01A

The effect of acoustic excitation on post-stalled flows over an airfoil, i.e., flows that are fully separated from near the leading edge, is investigated. The excitation results in a tendency towards reattachment, which is accompanied by an increased lift and reduced drag, although the flow may still remain fully separated. It is found that with increasing excitation amplitude, the effect becomes more pronounced but shifts to a Strouhal number which is much lower than that expected from linear, inviscid instability of the separated shear layer. Author

N91-11678# Michigan Univ., Ann. Arbor. Dept. of Aerospace Engineering.

HYPERSONIC AERODYNAMICS AND CONTROL Final Report, 4 Apr. 1988 - 3 Jun. 1990

T. C. ADAMSON, JR., R. M. HOWE, E. G. GILBERT, N. X. VINH, A. F. MESSITER, and B. VANLEER 6 Jun. 1990 295 p
(Contract DASG60-88-C-0037)
(AD-A225058) Avail: NTIS HC/MF A13 CSCL 16/2

The use is discussed of gas injection from the surface of a hypervelocity vehicle such that the effective shape of the body is changed to obtain desired aerodynamic forces and thus desired vehicle control; this type of aerodynamic control represents a gas injection scheme which might possibly be used for control both inside and outside the atmosphere. Optimal trajectories and control were determined for trajectories and control multi-stage surface launched interceptors with ranges of several thousand miles and flight times of a few minutes; both propulsive and aerodynamic controls were considered, and trajectory optimization was based on minimizing the total interceptor mass ratio. In the aerodynamic control work, studies were made of gas injection into the boundary layer on one side of a thin wedge in steady hypersonic flow. To ascertain the magnitudes of the largest force changes available with blowing, gas injection rates large enough to cause the boundary layer to be blown off the body were considered. Conditions for the desired flight envelope are such that laminar flows could be considered. A fundamental conclusion reached is that relatively large aerodynamic force changes can be obtained with relatively small rates of gas injection. GRA

N91-11679# National Aeronautical Establishment, Ottawa (Ontario).

A SUMMARY OF TRANSONIC NATURAL LAMINAR FLOW AIRFOIL DEVELOPMENT AT NAE Aeronautical Note

M. KHALID and D. J. JONES May 1990 136 p
(AD-A225102; NAE-AN-65; NRC-31608) Avail: NTIS HC/MF A07 CSCL 01/1

This report contains an analysis of the experimental results obtained from four supercritical natural laminar flow airfoils investigated in the NAE High Reynolds Number Test Facility. The airfoils have maximum thickness to chord ratios of 0.10, 0.13, 0.16 and 0.21 and were designed for a lift coefficient of 0.6. Their design Mach numbers were 0.8, 0.76, 0.72 and 0.68 respectively and the design chord Reynolds number was 12.5 million. It was found that all the airfoils showed the presence of a drag bucket close to design conditions and long lengths (in some cases about 70 percent) of natural laminar flow at Reynolds number 6.7 million. The minimum drag for the airfoils was found to range from 0.0045 to 0.0051, representing far lower levels than any airfoil dominated by turbulent boundary layer. It is also indicated that, with transition fixed at about 10 percent chord, the drag levels were similar to other airfoils with turbulent boundary layers. GRA

N91-11680# European Space Agency, Paris (France).

HALF-MODEL TESTS ON AN ONERA CALIBRATION MODEL IN THE TRANSONIC WIND TUNNEL, GOETTINGEN (FEDERAL REPUBLIC OF GERMANY)

WOLFGANG LORENZ-MEYER (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen, Germany, F.R.) Aug. 1990 43 p Transl. into ENGLISH of Halbmodellmessungen an einem ONERA-Eichmodell im

Transsonischen Windkanal Goettingen (Goettingen, Fed. Republic of Germany, DFLR), May 1989 44 p Original language document was announced as N90-18370

(ESA-TT-1195; DLR-MITT-89-20; ETN-90-98009) Avail: NTIS HC/MF A03; original German version available from DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58; 5000 Cologne, Fed. Republic of Germany, 18.50 Deutsche marks

Force and pressure distribution measurements were carried out at three wing sections on a calibration model in a 1m by 1m transonic wind tunnel. The model was mounted on the half model balance without a splitter plate but with a 5 mm thick boundary layer trap. The results are compared with complete model tests. The coefficients cannot be adequately corrected by the use of linear correction rules. Some oil film photographs were prepared for flow visualization purposes. ESA

N91-11681# Naval Postgraduate School, Monterey, CA. **MAPPING THE AIRWAKE OF A MODEL DD-963 ALONG SPECIFIC HELICOPTER FLIGHT PATHS M.S. Thesis**

GUSTAV A. ANDERSON Dec. 1989 93 p
(AD-A225327) Avail: NTIS HC/MF A05 CSCL 01/1

A continuation was made of flow visualization studies done in the NPS low speed environmental wind tunnel. The long term goal is to map the airwake around a ship model and scale to full size for the purpose of determining safe operating envelopes on non-aviation ships. This project used hot wire and hot film anemometry to establish a data base for helicopter approach paths at 0 deg, 30 deg port, and 30 deg starboard ship yaw angles. Calibration of the wind tunnel revealed that some turbulence generators, used in two previous studies, created excessive turbulence intensity levels and were subsequently removed. Analysis along the flight paths was done with and without the model in place. The comparison showed that turbulence intensity levels of up to 50 percent were experienced in the proximity of the flight deck. These levels fell by 40 to 50 percent within 1/4 ship length along all approach paths. The starboard yaw approach path contained the greatest turbulence magnitudes and the 0 deg yaw contained the least. GRA

N91-11727# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Inst. fuer Entwurfsaerodynamik.

LAMINAR FLOW WING

G. REDEKER /n DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 137-145 1989
Avail: NTIS HC/MF A10

Laminar flow technology is one of the promising means to improve the performance of aircraft. With long laminar boundary layers on wing surfaces and on other aircraft components, the skin friction and thereby the drag is reduced considerably. The state of the art of designing laminar flow airfoils and wings for higher Reynolds numbers, applicable to commuter or transport aircraft is described and an indication of the drag reduction by applying this technology is given. ESA

N91-12517# Kyushu Univ., Fukuoka (Japan). Dept. of Aeronautical Engineering.

NUMERICAL CALCULATIONS OF SEPARATED FLOWS AROUND A WING SECTION AT UNSTEADY MOTION BY A DISCRETE VORTEX METHOD

SHIGERU ASO, ATSUSHI FUJIMOTO, NAOKI FUTATSUDERA, and MASANORI HAYASHI (Nippon Inst. of Tech., Japan) /n NAL, Proceedings of the 7th NAL Symposium on Aircraft Computational Aerodynamics p 27-32 1989 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A14

Separated flows around a wing section at unsteady motion are simulated numerically by a discrete vortex method combined with a panel method. The potential flows around wing sections are expressed by vortex sheets, and separated shear layers are expressed by discrete vortices. In the calculation, a separation point is determined by solving the boundary layer equation. The strength of shed vortex is estimated using local velocity near

separation point. Also, modifications for the estimation of pressure coefficients around wing section are proposed. The estimated pressure distributions show good agreements with experimental results. At first, calculations are carried out for a wing section at fixed angle of attack. The results show excellent agreements with experiments. Secondly, separated flows around pitching airfoils are simulated. A hysteresis of the lift of an airfoil at dynamic stall is obtained in the calculation. Those results suggest that the present method is quite useful to simulate separated flows around a wing section both at steady and unsteady motions. Author

N91-12518# Institute of Computational Fluid Dynamics, Tokyo (Japan).

UNSTEADY CALCULATION OF THE TRANSONIC FLOW OVER ONERA-M6 WING WITH A SIDE WALL

TAKUYA SAKURAGI and KEISUKE KAMO (Fuji Heavy Industries Ltd., Utsunomiya, Japan) *In* NAL Proceedings of the 7th NAL Symposium on Aircraft Computational Aerodynamics p 33-37 1989 In JAPANESE; ENGLISH summary

Avail: NTIS HC/MF A14

The major portion of the flow field at high Reynolds number will be unsteady, so turbulent eddy viscosity models are used in simulating such high Reynolds number flow. The steady flow fields obtained by using the turbulent eddy viscosity model is expected to be the time-averaged solutions. In this study, researchers investigated the unsteady solution of the flow over the wing with a side wall. For this purpose, they calculated the time-average of the unsteady flow field without using any turbulent eddy viscosity models. As the number of grid points gets large, the CP curves of the time-average will become close to the results of the experiment. Author

N91-12519# National Aerospace Lab., Tokyo (Japan).

TURBULENCE MODELS FOR TRANSONIC FLOWS WITH SEPARATION

YOKO TAKAKURA, SATORU OGAWA, and TOMIKO ISHIGURO *In its* Proceedings of the 7th NAL Symposium on Aircraft Computational Aerodynamics p 39-44 1989 In JAPANESE; ENGLISH summary Prepared in cooperation with Fujitsu Ltd., Tokyo, Japan

Avail: NTIS HC/MF A14

Computation of 3-D transonic viscous flows around the ONERA-M6 wing is performed by using several turbulence models with an improved Harten-Yee Total Variation Diminishing (TVD) scheme. The models used here are the Baldwin-Lomax model, Subgrid-Scale (SGS) model and Jones-Lauder (k-epsilon)-model, and the test condition is a flow with the interaction of shock wave and boundary layer under the large separation. As the result, it is concluded that the SGS and (k-epsilon) models work well compared with the Baldwin-Lomax model, and that the physical phenomena such as the interaction of shock wave and boundary layer numerically captured are qualitatively correct when the pressure distributions agree with experimental ones. Author

N91-12535# National Aerospace Lab., Tokyo (Japan).

A NUMERICAL SIMULATION FOR SUPERSONIC INTAKE

JUNGI SHIGEMATSU, KUZUOMI YAMAMOTO, and ATSUSHIGE TANAKA (Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo, Japan) *In its* Proceedings of the 7th NAL Symposium on Aircraft Computational Aerodynamics p 135-139 1989 In JAPANESE; ENGLISH summary

Avail: NTIS HC/MF A14

A supersonic inlet flow with strong viscous effect was numerically simulated by solving two-dimensional Navier-Stokes equations. In this simulation, the Harten-Yee's Total Variation Diminishing (TVD) scheme is employed for sharp shock resolution and numerical stability. Numerical results successfully simulate strong viscous effects similar to those of wind tunnel tests. Author

N91-12544# National Aerospace Lab., Tokyo (Japan).

NUMERICAL SIMULATION OF FLOW FIELDS AROUND AN AIRPLANE OF COMPLEX GEOMETRIES

MASAKAZU TACHIBANA and SUSUMU TAKANASHI *In its* Proceedings of the 7th NAL Symposium on Aircraft Computational Aerodynamics p 195-199 1989 In JAPANESE; ENGLISH summary

Avail: NTIS HC/MF A14

A numerical aerodynamic simulation system applicable to various complex geometries was developed. Researchers use an O-O type of grid in order to concentrate grid points in wall boundary layers effectively and to implement wall and outer boundary conditions easily. In addition, on the body surface, the grid is divided into several blocks which have common points at each interface. By doing so, a finite volume algorithm can be applied easily and the Navier-Stokes code using this grid became adaptable to various kinds of airplanes. As a first example, we tried to compute the flowfield around a practical aircraft configuration, and also compared the solution with the wind tunnel test data. Author

N91-12548# National Aerospace Lab., Tokyo (Japan).

RAREFIED GAS NUMERICAL WIND TUNNEL. 5: VORTEX SHEDDING BEHIND AN INCLINED FLAT PLATE

KATSUHISA KOURA and EMI KANEMATSU (Fujitsu Ltd., Tokyo, Japan) *In its* Proceedings of the 7th NAL Symposium on Aircraft Computational Aerodynamics p 221-224 1989 In JAPANESE; ENGLISH summary

Avail: NTIS HC/MF A14

The rarefied gas numerical wind tunnel with the universal code described using the null-collision direct-simulation Monte Carlo method is used for the simulation of the vortex shedding in dilute gas flows past an inclined flat plate at the incidence angle 45 deg. The results obtained for the freestream Mach number $M(\infty) = 0.7$ and Knudsen numbers $Kn(\infty) = 1/60$ and $1/200$, for which the freestream Reynolds numbers $Re(\infty) = 69$ and 230 , respectively, clearly show the vortex shedding in the wake region of the plate. The Strouhal number is about 0.2, which is rather larger than about 0.15 under continuum (incompressible) flow conditions. It is also found that the well-defined vortex structure disappears at rather small Knudsen number $K(\infty)$ approx. greater than 0.1 for $M(\infty) = 0.7$ or at rather small Mach number $M(\infty)$ approx. greater than 2 for $K(\infty) = 1/60$. Author

N91-12550# National Aerospace Lab., Tokyo (Japan).

COMPARATIVE STUDY ON WING PRESSURE DISTRIBUTION OF HIGH SPEED JET AIRPLANE BETWEEN NUMERICAL SIMULATION AND FLIGHT TEST

JUNICHI MIYAKAWA (Mitsubishi Heavy-Industries Ltd., Tokyo, Japan) and SUSUMU TAKANASHI *In its* Proceedings of the 7th NAL Symposium on Aircraft Computational Aerodynamics p 231-236 1989 In JAPANESE; ENGLISH summary

Avail: NTIS HC/MF A14

Computational aerodynamics has evolved to be a practical design tool comparable to wind tunnel testing, and it has played an important role in actual aircraft design stages. There have been intensive works already done for code validation to support the accuracy of the computation. The code accuracy based upon comparison between numerical simulation and actual flight test is discussed for the first time. Author

N91-12551# National Aerospace Lab., Tokyo (Japan).

NUMERICAL SIMULATION OF TRANSONIC FLOWS OVER BOEING-747 AND ITS VALIDATION BY COMPARISON WITH EXPERIMENTAL DATA

RYOZO ITO, SUSUMU TAKANASHI, KISA MATSUSHIMA, MOTOMU SATO, KOZO FUJII, and EDWARD N. TINOCO (Boeing Commercial Airplane Co., Seattle, WA.) *In its* Proceedings of the 7th NAL Symposium on Aircraft Computational Aerodynamics p 237-241 1989 In JAPANESE; ENGLISH summary

Avail: NTIS HC/MF A14

The viscous transonic flow simulations over a B747 wing-fuselage combination were carried out using the three-dimensional Reynolds-averaged thin-layer Navier-Stokes equations. The single grid system in C-O topology is used for

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these computations, and it has 1.1 million grid-points. Computed results such as total lift and pressure distributions on the wing are in good agreement with the wind tunnel test data. Author

N91-12552# Tottori Univ. (Japan). Dept. of Applied Mathematics and Physics.

NUMERICAL SIMULATION OF WING IN GRAND EFFECT 2

T. KAWAMURA and SHOZO KUBO *In* NAL, Proceedings of the 7th NAL Symposium on Aircraft Computational Aerodynamics p 243-247 1989 *In* JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A14

Flow around a wing in ground effect is studied by solving both the incompressible and compressible Navier-Stokes equations numerically. A standard marker-and-cell (MAC) method with third order upwind difference for the non-linear term is used to calculate incompressible flow. For compressible flow, a new numerical scheme is developed. Both schemes run well and researchers can investigate numerically the effect of the distance from the ground, that of attack angle and that of the oscillation of the wing on the flow field and the force acting on the body. Author

N91-12553# National Aerospace Lab., Tokyo (Japan).

EFFECTS OF BLADE TIP PLANFORMS ON ROTOR PERFORMANCE IN HOVER

TAKASHI AOYAMA, KEIJI KAWACHI (Tokyo Univ., Japan), and SHIGERU SAITO *In* its Proceedings of the 7th NAL Symposium on Aircraft Computational Aerodynamics p 249-254 1989 *In* JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A14

A calculation method is developed to analyze the flow around a helicopter blade in hover. Aerodynamic loads generated by a blade are calculated by solving the three-dimensional Euler equations in a rotating coordinate system on body-conforming curvilinear grids around a blade. These equations are solved by employing a Beam-Warming scheme. A Total Variation Diminishing (TVD) scheme is used in order to capture the accurate shock wave. The local induced velocity generated by the rotor-wake is taken into the calculation by subtracting the equivalent angle of attack along the blade from the geometrical one. This equivalent angle of attack is calculated by using prescribed-wake vortex theory. The ability of the present method is verified in comparison with the results of the experiment and the analytical method. In addition, the effects of the planforms of a blade tip on the performance of a helicopter rotor and on the flow around a blade in hover are analyzed. The comparison among swept-back, tapered and swept-back tapered tips is presented. As a result, one tip planform, which has sweep-back angle and inverse-taper, is found to improve the performance of the rotor. Author

N91-12555# National Aerospace Lab., Tokyo (Japan).

TRANSONIC AERODYNAMICS ANALYSES OF UNCONVENTIONAL WING CONFIGURATIONS BY 3D-EULER CODE

MASAKATA HASHIMOTO (Mitsui Engineering and Shipbuilding Co. Ltd., Tokyo, Japan), NAOKI HIROSE, and TAKESHI OHNUKI *In* its Proceedings of the 7th NAL Symposium on Aircraft Computational Aerodynamics p 265-271 1989 *In* JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A14

New wing configurations such as a forward-swept-wing and a joined-wing recently attracted attention and are studied with expectations for higher lift-to-drag ratio, wider range of aileron effectiveness, or higher drag divergence Mach number than the conventional ones. Here, a computational code especially developed for analyzing the transonic aerodynamics of the new wing configurations is presented. The code is based on a system of Euler equations which are solved by the time-split MacCormack's scheme. Computational results of lift, drag and pressure distribution characteristics of the forward-swept-wing and the joined-wing configurations are shown and discussed in comparison with those of the conventional aft-swept wing. Author

N91-12556# National Aerospace Lab., Tokyo (Japan). Computational Aerodynamic Section.

AERODYNAMIC SIMULATION OF FLOWS ABOUT A SPACE-PLANE 3

KISA MATSUSHIMA, SUSUMU TAKANASHI, and KOZO FUJII (Tokyo Univ., Japan) *In* its Proceedings of the 7th NAL Symposium on Aircraft Computational Aerodynamics p 273-278 1989 *In* JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A14

Three dimensional flowfields about a winged space vehicle at supersonic speed were numerically simulated using Navier-Stokes equations. The present model of the vehicle is under study at the National Aerospace Laboratory as a candidate Japanese future aerospace vehicle. Here, interest is concentrated on the understanding of the effect of the tail wing on the shape of the vehicle. So, two different simulations were conducted; one is for the flowfields about a whole configuration model (WBT Model) and the other is about a wing-body combination model (WB Model). The vortical flow phenomena due to high angle of attack are so complicated that a more careful consideration is necessary. The numerical results show the difference clearly between those two flowfields. The aerodynamic forces and coefficients computed from the simulation results are in good agreement with experimental data. Author

N91-12572# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AN AIRFOIL FOR GENERAL AVIATION APPLICATIONS

MICHAEL S. SELIG, MARK D. MAUGHMER (Pennsylvania State Univ., University Park.), and DAN M. SOMERS *In* AIAA, Proceedings of the 1990 AIAA/FAA Joint Symposium on General Aviation Systems p 280-291 May 1990
(Contract NGT-50341)

Avail: NTIS HC/MF A17 CSCL 01/1

A new airfoil, the NLF(1)-0115, has been recently designed at the NASA Langley Research Center for use in general-aviation applications. During the development of this airfoil, special emphasis was placed on experiences and observations gleaned from other successful general-aviation airfoils. For example, the flight lift-coefficient range is the same as that of the turbulent-flow NACA 23015 airfoil. Also, although beneficial for reducing drag and having large amounts of lift, the NLF(1)-0115 avoids the use of aft loading which can lead to large stick forces if utilized on portions of the wing having ailerons. Furthermore, not using aft loading eliminates the concern that the high pitching-moment coefficient generated by such airfoils can result in large trim drags if cruise flaps are not employed. The NASA NLF(1)-0115 has a thickness of 15 percent. It is designed primarily for general-aviation aircraft with wing loadings of 718 to 958 N/sq m (15 to 20 lb/sq ft). Low profile drag as a result of laminar flow is obtained over the range from $c_{sub l} = 0.1$ and $R = 9 \times 10^6$ (the cruise condition) to $c_{sub l} = 0.6$ and $R = 4 \times 10^6$ (the climb condition). While this airfoil can be used with flaps, it is designed to achieve $c_{sub l, max} = 1.5$ at $R = 2.6 \times 10^6$ without flaps. The zero-lift pitching moment is held at $c_{sub m, sub o} = 0.055$. The hinge moment for a .20c aileron is fixed at a value equal to that of the NACA 63 sub 2-215 airfoil, $c_{sub h} = 0.00216$. The loss in $c_{sub l, max}$ due to leading edge roughness, rain, or insects at $R = 2.6 \times 10^6$ is 11 percent as compared with 14 percent for the NACA 23015. Author

N91-12591# National Aerospace Lab., Tokyo (Japan).

PROCEEDINGS OF THE 6TH NAL SYMPOSIUM ON AIRCRAFT COMPUTATIONAL AERODYNAMICS

Dec. 1988 251 p *In* ENGLISH and JAPANESE Symposium held in Tokyo, Japan, 16-17 Jun. 1988

(DE89-910195; NAL-SP-9; ISSN-0289-260X; JTN-90-80118)

Avail: NTIS HC/MF A12

The following topics were discussed: computational fluid dynamics, numerical flow visualization, numerical analysis, computerized simulation, difference schemes, the total variation diminishing, the implicit method, grid generation, the Navier-Stokes equation, computerized simulation, three dimensional flow, high

Reynolds number flow, viscous flow, shock waves, the finite element method, the finite volume method, the alternating direction implicit method, transonic flow, supersonic flow, hypersonic flow, and airfoils.

N91-12596# National Aerospace Lab., Tokyo (Japan).
NUMERICAL CALCULATION OF CHEMICALLY REACTING COMPRESSIBLE FLOW

TOMIKO ISHIGURO, SATORU OGAWA, and YASUHIRO WADA
In its Proceedings of the 6th NAL Symposium on Aircraft Computational Aerodynamics p 27-35 Dec. 1988 In JAPANESE; ENGLISH summary
 Avail: NTIS HC/MF A12

A summary of a solver-code which is being developed for the purpose of numerically analyzing chemically reacting compressible flows is presented. The code solves the two or three-dimensional Reynolds time average complete Navier-Stokes equations including species transport equations, and has two strong points. The first point is that the system of governing equations for the flow computation contains a total mass conservation equation and transport equations of all species taking account of total mass conservation and impartial numerical treatment of every chemical species. Therefore, the correction of mass ratios of all species is made so that the summation of them is equal to one after every time step integration. The second point is that the total variation diminishing (TVD) difference scheme is used in order to capture strong discontinuous surfaces clearly and efficiently which are apt to appear in supersonic flow fields. Applying this solver, shock-induced chemically reacting flows and flow fields for the case of transverse sonic injection of H sub 2 fuel into a supersonic airstream are analyzed numerically. Author (NASDA)

N91-12611# Fuji Heavy Industries Ltd., Utsunomiya (Japan).
NAVIER-STOKES SIMULATION OF TRANSONIC FLOW AROUND VENTILATED AIRFOILS

KEISUKE KAMO, YASUHIRO TANI, and KANICHI AMANO (Japan Aircraft Development Corp., Tokyo.) *In* NAL, Proceedings of the 6th NAL Symposium on Aircraft Computational Aerodynamics p 133-140 Dec. 1988 In JAPANESE; ENGLISH summary
 Avail: NTIS HC/MF A12

A ventilated airfoil, which has porous areas or slits on its surface to generate passive ventilation, is expected to improve the lift-to-drag ratio in the transonic flow region. The flow characteristics of ventilated airfoils are simulated numerically using an improved two-dimensional compressible Navier-Stokes analysis code with the boundary condition modified for ventilation. Author (NASDA)

N91-12612# Mitsubishi Heavy-Industries Ltd., Tokyo (Japan).
COMPARISON WITH COMPUTATION USING PANEL METHOD AND WIND TUNNEL TEST AROUND TRANSONIC COMPLETE AIRCRAFT

TAKESHI KAIDEN, JUNICHI MIYAKAWA, MITSUNORI YANAGISAWA, and KANICHI AMANO (Japan Aircraft Development Corp., Tokyo.) *In* NAL, Proceedings of the 6th NAL Symposium on Aircraft Computational Aerodynamics p 141-149 Dec. 1988 In JAPANESE; ENGLISH summary
 Avail: NTIS HC/MF A12

The rapid progress of computational aerodynamics enables us to analyze airflow with viscous calculation instead of with an inviscid one. In two-dimensional application, the effectiveness in comparison with wind tunnel testing has already been validated and put into a practical stage. In three-dimensional applications, the wing-body configuration has been done. Presented here is a discussion of the panel method concerned with the analysis of the complete aircraft, including the calculation of the string interference, which is indispensable to wind tunnel testing. Results indicate that the panel method is valid in the subsonic region and that the sting makes up wash flow. Author (NASDA)

N91-12613# Nagoya Univ. (Japan). Dept. of Aeronautical Engineering.
CALCULATION OF HIGH SPEED FLOW ABOUT WINGED BODY

MICHIRU YASUHARA, YOSHIKI NAKAMURA, and SHINJI INAGAKI *In* NAL, Proceedings of the 6th NAL Symposium on Aircraft Computational Aerodynamics p 151-158 Dec. 1988 In JAPANESE; ENGLISH summary
 Avail: NTIS HC/MF A12

The objective of the present study is to numerically calculate the flow about the fundamental configuration for a flying vehicle in supersonic and hypersonic regimes. Two kinds of body configurations were chosen: a hemisphere-cylinder and a shuttle-like body. In the present study three numerical schemes are employed to compare each result: the Beam-Warming method, the Yee-Harten total variation diminishing (TVD) method and the MacCormack TVD method. Furthermore, those results are compared with an experiment which was conducted by the shock tunnel at Nagoya University at M=eight. Reasonable agreement was obtained between them for the location of bow shock waves which validate the present simulation. Author (NASDA)

N91-12615# National Aerospace Lab., Tokyo (Japan).
NAVIER-STOKES SIMULATIONS OF A WINGED VEHICLE USING UPWIND SCHEME

MASAKAZU TACHIBANA and SUSUMU TAKANASHI *In its* Proceedings of the 6th NAL Symposium on Aircraft Computational Aerodynamics p 163-165 Dec. 1988 In JAPANESE; ENGLISH summary
 Avail: NTIS HC/MF A12

Supersonic flow about a winged vehicle is investigated. An upwind scheme based on a total variation diminishing (TVD) formulation is used to solve the thin layer Navier-Stokes equations. The result for alpha=20 deg shows three kinds of separation line on the upper surface. Author (NASDA)

N91-12617# National Aerospace Lab., Tokyo (Japan).
NUMERICAL SIMULATION OF HYPERSONIC FLOW AROUND A SPACE PLANE

YUKIMITSU YAMAMOTO and SHIN KUBO (Total System, Inc., Tokyo, Japan) *In its* Proceedings of the 6th NAL Symposium on Aircraft Computational Aerodynamics p 175-181 Dec. 1988 In JAPANESE; ENGLISH summary
 Avail: NTIS HC/MF A12

Thomas and Van Leer's flux-split upwind total variation diminishing (TVD) scheme was applied to the hypersonic flow around a space plane proposed by the National Aerospace Laboratory (NAL). Thin-layer Navier-Stokes equations in a finite volume formulation are solved by using an implicit approximately factored alternating direction implicit (ADI) algorithm. Numerical computations are performed for the conditions of Mach number 7.0 and Reynolds number 4.4 times ten to the 6th power at angles of attack up 50 degrees. Numerical results are compared with experimental data obtained from the hypersonic wind tunnel tests at NAL. Through these comparisons, it is demonstrated that the present TVD Navier-Stokes code has excellent capabilities for evaluating total aerodynamic performance and the severe aerodynamic heating, which are of great significance in the design of a space plane configuration. In the present analysis, a modified Yee-Harten's TVD scheme is developed and applied. Numerical calculations were carried out by using these two schemes for M sub infinity = 10.0 at alpha = 0 deg, and almost the same pressure contours are obtained. Author (NASDA)

N91-12618# National Aerospace Lab., Tokyo (Japan).
RAREFIED GAS NUMERICAL WIND TUNNEL Report No. 4
 KATSUHISA KOURA, KINUYO NAKAMURA, and TOSHIYUKI SHIMOJI (Facom Hitac Co. Ltd., Japan) *In its* Proceedings of the 6th NAL Symposium on Aircraft Computational Aerodynamics p 183-186 Dec. 1988
 Avail: NTIS HC/MF A12

The rarefied gas numerical wind tunnel (RGNWT) for simulation of rarefied gas flows around three-dimensional space vehicles is under construction. The RGNWT consists of the universal code described using the null-collision (NC) direct-simulation Monte Carlo Method and the software for the grid generation and graphic display. In order to ascertain the feasibility of the RGNWT,

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quantitative comparisons between the NC and time-counter (TC) direct-simulation Monte Carlo Methods are made for the shock wave structure and leading-edge flow. It is shown in the leading-edge flow that the NC method is stronger for the small number of simulation molecules than the TC method; the lower limit of the number of simulation molecules for the NC method is less than one third of that for the TC method. The computation time for the NC method is comparable to that for the TC method for the same number of simulation molecules. Author (NASDA)

N91-12622# National Aerospace Lab., Tokyo (Japan). Structural Mechanics Div.

NUMERICAL SIMULATION OF UNSTEADY AERODYNAMICS AROUND AN OSCILLATING WING IN ELASTIC MODES

JIRO NAKAMICHI *In its* Proceedings of the 6th NAL Symposium on Aircraft Computational Aerodynamics p 205-214 Dec. 1988 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A12

Unsteady Navier-Stokes calculations around airfoil/wing configurations are demonstrated. Two D (two dimensional) transonic flutter simulations are performed about a NACA 64A010 airfoil using not only a diagonal form of Beam-Warming scheme but also a non-diagonal one. The effects of time accuracy of the algorithms on the flutter boundaries are checked by comparing two results. Three D (three dimensional) unsteady computation around an oscillating wing in elastic motion are carried out and obtained results are compared with experimental data. It is found that the diagonal form of Beam-Warming scheme is efficient for predicting the flutter boundaries of airfoils in cases where the flow is not separated. It is also demonstrated that the present three D code gives results in agreements with experimental data. It can be used for three D flutter simulation programs in a similar manner to two D cases. Author (NASDA)

N91-12623# Fujitsu Ltd., Tokyo (Japan).

ON THE COMPUTATION OF VISCOUS FLOWS AROUND A THREE-DIMENSIONAL WING

YOKO TAKAKURA, SATORU OGAWA, and TOMIKO ISHIGURO (National Aerospace Lab., Tokyo, Japan) *In* NAL, Proceedings of the 6th NAL Symposium on Aircraft Computational Aerodynamics p 215-221 Dec. 1988 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A12

The applicability of our modified total variation diminishing (TVD) schemes (Harten-Yee and Chakavarthy Osher numerical fluxes) to the viscous flow problems is examined. At the same time, the improvements of the left-hand-side operators to reach steady states and the turbulent model of large eddy simulation (LES) are presented. The computation of viscous flows around the ONERA-M6 wing indicate that the improved left-hand-side operators have a better convergence rate than the original one, that the improved turbulent model of LES works well even in the high attack-angle problem, and that these TVD schemes are applicable to the viscous flow problems. Author (NASDA)

N91-12624# Tottori Univ. (Japan). Dept. of Applied Mathematics and Physics.

NUMERICAL SIMULATION OF FLOW AROUND THE AIRCRAFT DESIGNED TO UTILIZE GROUND EFFECT

T. KAWAMURA and SHOZO KUBO *In* NAL, Proceedings of the 6th NAL Symposium on Aircraft Computational Aerodynamics p 223-227 Dec. 1988 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A12

Flow around an aircraft spatially designed to take advantage of ground effect effectively is studied by using the incompressible Navier-Stokes equations. A third-order upwind difference scheme is used to solve the equations. Calculations are carried out under many conditions, i.e., the distance from the body to the ground, the angle of attack and the Reynolds number, etc. are changed systematically in order to investigate these effects on the flow field and forces acting on the body. Author (NASDA)

N91-12625# National Aerospace Lab., Tokyo (Japan).

VERIFICATION OF 2D-VISCOUS FLOW SIMULATION CODES USING AIRFOIL WITH VERY SMALL LEADING EDGE RADIUS
MASAHIRO FUKUDA, KAZUHIRO NAKAHASHI, NAOKI HIROSE, NOBUHIRO KAWAI, and EIJI KIKUNO (Sumitomo Precision Products Co. Ltd., Japan) *In its* Proceedings of the 6th NAL Symposium on Aircraft Computational Aerodynamics p 229-234 Dec. 1988 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A12

In recent years, numerical simulation methods based on viscous equations have been widely applied to aerodynamic research and development in airfoils, wings, fuselages, etc. It has proved powerful, and the application of this method to propeller blades research and development, especially for the ATP (advanced turboprop)-blades, is natural. While many experiences with two-dimensional viscous simulation for thick airfoils are accumulated, experience with thin airfoils with very sharp leading edges has been scant. The verification of two-dimensional viscous simulation codes, NSFOIL and NS2D applied to one of those airfoils, NACA 16-204 airfoil which was tested in the two-dimensional wind tunnel at the National Aerospace Laboratory last year, is the main object of the present report. Mach number sweeps at low angles of attack and angle of attack sweeps at $M=0.6$ and 0.85 were made. The comparison of the computed aerodynamic characteristics with the wind tunnel data assure us that the method is useful in this field, although some improvements in the codes are to be desired. Author (NASDA)

N91-12626# Tokyo Univ. (Japan).

THREE-DIMENSIONAL NAVIER-STOKES SIMULATION OF FLOW AROUND ATP

YUICHI MATSUO, CHUICHI ARAKAWA, SHIGERU SAITO, and HIROSHI KOBAYASHI (National Aerospace Lab., Tokyo, Japan) *In* NAL, Proceedings of the 6th NAL Symposium on Aircraft Computational Aerodynamics p 235-241 Dec. 1988 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A12

Viscous transonic rotational flows around a single rotation advanced turboprop (ATP) at cruise conditions were simulated using three-dimensional Navier-Stokes equations. An implicit finite difference method based on a total variation diminishing (TVD) formulation and a Baldwin-Lomax model of turbulence were used for the solution procedure. The numerical results were successful in capturing viscous flow features such as shock boundary layer interaction and boundary layer separation. The predicted aerodynamic performances showed good agreement with experimental data. Author (NASDA)

N91-12627# Mitsubishi Heavy-Industries Ltd., Tokyo (Japan).

NUMERICAL SIMULATIONS OF FLOW AROUND ATP ENGINE

MASAHIRO NAKAO and JUNICHI MIYAKAWA *In* NAL, Proceedings of the 6th NAL Symposium on Aircraft Computational Aerodynamics p 243-248 Dec. 1988 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A12

Flow fields around the advanced turboprop (ATP) engine with counter-rotating propellers are simulated numerically by solving three-dimensional unsteady Euler equations. The numerical method is implicit approximate factorization developed by Beam and Warming. The calculation model is for an unducted fan style engine with eight times eight SR-3 propellers. The distribution of pressure on the blade surfaces, the propeller efficiencies, and the velocity vectors downstream of propellers are obtained. The relation of propeller efficiencies and velocity vectors downstream of rear propellers shows the features of counter-rotating propellers. Author (NASDA)

N91-12631 ESDU International Ltd., London (England).

INTRODUCTION TO TRANSONIC AERODYNAMICS OF AEROFOILS AND WINGS Abstract Only

Apr. 1990 43 p
(ESDU-90008; ISBN-0-86579-734-0; ISSN-0141-4356) Avail: ESDU

The flow phenomena that occur in steady high subsonic flow over airfoils and wings, and the prediction of the initial stages of shock-induced separation are discussed. The development of regions of supersonic flow on an airfoil is first considered, at constant angle of attack as Mach number increases and at constant Mach number as angle of attack increases. The influence of various features of the flow, illustrated by visualization photographs, on the airfoil aerodynamic characteristics is shown graphically. The interaction in attached flow of the shock with a turbulent boundary layer is considered and a correlation shows the effect of the upstream boundary layer conditions on the length of the interaction region. Shock-induced separation is then discussed, also illustrated with graphs of the Mach number contours in the vicinity of the shock and corresponding flow visualization pictures, and the types of separation met are explained. A broad criterion for separation is suggested and a correlation of separation bubble length in terms of the upstream boundary layer parameters is included. A correlation of conditions for flow breakdown is also given. There is a brief discussion of the occurrence of transonic conditions on high lift devices, where supersonic flow can exist at free stream Mach numbers as slow as 0.2. Finally, three-dimensional effects are considered, initially in terms of the infinite yawed wing, and then in terms of the tip effects introduced with finite aspect ratio.

ESDU

N91-12632 Bradford Univ. (England).

SEPARATED FLOW ON A HIGH LIFT WING: A STUDY OF THE TURBULENT CHARACTERISTICS OF THE SEPARATED FLOW REGION ON A HIGH LIFT WING UNDER NORMAL AND WING BODY CONDITIONS BY MEANS OF A FLYING HOT-WIRE TECHNIQUE Ph.D. Thesis

HUSSAIN HAMMOD AL-KAYIEM 1989 457 p
Avail: Univ. Microfilms Order No. BRD-89961

The large separation of turbulent wall shear layer from high lift wings is discussed. An experimental investigation was carried out measuring the flow field, including large separation region, over a high lift wing model having an NACA 4412 aerofoil section. A new procedure was developed to design and manufacture the wing model using computer aided design-manufacturing (CAD-CAM) facilities. The investigation contains a comparison of two wing configurations: (1) Clean wing, (2) Wing/Body interference. The main measuring instrumentation was the flying hot-wire (FHW). The related kinematic, electronic, and operating software of the FHW system are discussed, as well as the transformation of the FHW signals into useful information of the flow field. The development and testing of new calibration of the X hot-wire probe is presented. The developed procedure increases the accuracy of measurement in highly turbulent flow. To implement this method, an in-situ calibration of the X FHW was adopted. The data acquisition (system and procedure) was implemented digitally using a minicomputer interfaced to various electronic circuits. Suitable software was developed and used for sampling, digitizing and on-line analysis of the FHW signals. The developed analysis enabled transformations of the FHW signals into mean velocity components and turbulence statistical quantities. The FHW system was found to give accurate results both in reverse, as well as in the streamwise flow field. The results obtained were presented in the format of profiles, velocity vectors fields, contour plots, colored shadings, and probability distributions to characterize both the mean flow and the associated turbulence. Dissert. Abstr.

N91-12633# Office National d'Etudes et de Recherches Aérospatiales, Paris (France).

COMPUTATION OF UNSTEADY TRANSONIC FLOWS USING AN IMPLICIT CENTERED EULER SOLVER WITHOUT ARTIFICIAL VISCOSITY Ph.D. Thesis - Paris VI Univ.

ANNE-MARIE SENS Sep. 1990 98 p In FRENCH; ENGLISH summary Report will also be announced as translation (ESA-TT-1235) Original contains color illustrations (ONERA-NT-1990-8; ISSN-0078-3781; ETN-90-98023) Avail: NTIS HC/MF A05

The numerical simulation of unsteady transonic flows are studied. The Euler equations are solved using an extension of

Lerat's centered scheme. This scheme is able to work without artificial viscosity. The aim is to extend this property to real unsteady problems. Two approaches are developed in the 1-D case. In the first one, nonlinearities are taken into account in the construction of the scheme but oscillations in the numerical structure of moving shock waves are not avoided. The second approach leads to a modification of the second order terms in the implicit scheme allowing a better control of the numerical dissipation. A local time step is introduced in addition to the uniform time step. The two time step scheme is extended in 2-D using the approach developed by Lerat and Sides in the steady case. A stability result is given in the scalar case. The method is applied to the unsteady transonic flow calculation around an airfoil in rigid body motion. The two time step method is validated in 3-D case for the problem of a swept wing oscillating in translation between parallel walls. ESA

N91-12634# Fluid Physics, Inc., Encinitas, CA.

SIMULANT GAS TEST TECHNIQUE FEASIBILITY Final Report, Dec. 1988 - Jan. 1990

RICHARD M. TRACI May 1990 85 p
(Contract F33615-88-C-3011)

(AD-A224878; R90-09-03; WRDC-TR-90-3023) Avail: NTIS HC/MF A05 CSDL 20/4

The uncertainty engendered by non-equilibrium air effects on hypersonic vehicle aerodynamics and heat transfer is compounded by the fact that such effects are difficult to validate in ground test facilities. Laboratory quality ground test data on air chemistry effects are clearly needed to investigate the rich parametric effects of scale, complex geometry, turbulence coupling, and altitude/Mach number flight regime. Moreover, data is needed for numerical model validation purposes. A proposed concept for such a test, referred to as the Simulant Gas shock tunnel test, is investigated. The approach is based on the use of simulant gas mixtures in a shock tunnel operating in the nonreflected shock mode. Simulant gases are sought which react at lower temperatures than oxygen and which have a relatively well defined ignition temperature. They thereby provide the possibility of remaining unreacted in the freestream of the expanded shock tunnel flow while reacting at representative and controllable rates in the shock layer of a test model. The test concept, if feasible, would provide a laboratory quality experimental simulation technique which possesses reactive flow similitude relative to oxygen dissociation at hypersonic flight conditions. The feasibility of the simulant gas test concept was evaluated by performing reactive flow scaling and reactive streamline flow analyses for a limited range of combustible gas mixtures. The method is illustrated for air by defining flight regimes and baseline shock tunnel test regimes for which nonequilibrium oxygen dissociation is operative in the vehicle/model shock layer.

GRA

N91-12635# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Hubschrauber und Flugzeuge.

CALCULATION OF NONSTATIONARY TWO AND THREE DIMENSIONAL FLOWS AROUND A CARRYING WING USING AN IMPLICIT RELAXATION PROCESS, IN ORDER TO SOLVE THE EULER EQUATIONS Thesis - Univ. der Bundeswehr Neubiberg [BERECHNUNG INSTATIONAERER ZWEIG- UND DREIDIMENSIONALER STROEMUNGEN AM TRAGFLUEGEL MITTELS EINES IMPLIZITEN RELAXATIONSVERFAHRENS ZUR LOESUNG DER EULERGLEICHUNGEN]

ALFRED BRENNEIS 12 Mar. 1990 236 p In GERMAN (MBB/FE122/S/PUB/394; ETN-90-97843) Copyright Avail: NTIS HC/MF A11

A calculation process is developed in order to solve the nonfactorized, implicit Euler equations using a relaxation process. The starting point is a stationary finite volume Euler process, which is first extended to the non stationary parts, for temporarily modified boundary conditions. In order to reduce the total calculation time, the solution of the implicit Euler equations through an explicit process was not taken into account. The first time use of a relaxation process for nonstationary flow calculation represented the center point of the work. The decisive point was the use of a nonlinear Newton method, which by means of a Punkt-Gauss-Seidel

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algorithm is resolved with an iteration. Detailed 2-D and 3-D test calculations with parameter variations were carried out at harmonic pitching carrying wings. The accelerating factor in relation to the explicit version is dependent of the network fineness, the reduced frequency, and the CFL number between 5 and 300, and is independent of it, if a 2-D or 3-D problem is involved. ESA

N91-12639# Universal Energy Systems, Inc., Dayton, OH.
RESEARCH IN FLIGHT DYNAMICS Final Report, May 1986 - May 1989

GARY D. STREBY Jun. 1990 28 p
(Contract F33615-86-D-3800)
(AD-A226123; WRDC-TR-90-3040) Avail: NTIS HC/MF A03
CSCD 01/1

The Research in Flight Dynamics Program provided the resources and specialized personnel to conduct multidiscipline research studies and investigations to support the efforts of the Air Force Flight Dynamics Laboratory. These studies involved advanced technology areas that may be implemented in advanced Air Force weapon systems. Technical disciplines that were investigated included such areas as vehicle dynamics, flight control, mechanical subsystem, DBMS software development, numerical simulations of complex aerodynamic problems, aerodynamics, and data analysis. Management of this program required the definition of individual tasks, providing in-house expertise or obtaining specialized expertise to conduct the assigned tasks, and management of funding and scheduling of all efforts. GRA

N91-12645# Karlsruhe Univ. (Germany, F.R.). Inst. fuer Stroemungslehre und Stroemungsmaschinen.

CALCULATION OF TRANSONIC, FRICTION BETWEEN AFFECTED CHANNELS AND PROFILE FLOWS WITH PASSIVE INFLUENCE Ph.D. Thesis [BERECHNUNG TRANSSONISCHER, REIBUNGSBEHAFTETER KANAL- UND PROFILSTROEMUNGEN MIT PASSIVER BEEINFLUSSUNG]
THOMAS BREITLING 1989 94 p In GERMAN
(ETN-90-98192) Avail: NTIS HC/MF A05

A multicomponent process is described, which allows calculation of ventilated and non-ventilated transonic tunnel flows. A new process for producing a contour matched orthogonal calculation net with controllable line density in tunnels is presented. The further development of the model for the description of the interference range is emphasized. Sensitivity examinations for the extension of the interference zone are conducted. The flow volume in the interference zone and in the tunnel are represented in diagrams. The boundary layer measures confirm the models used. The implementation of the interface model and of the chamber calculation in an already existing program for the calculation of airfoils is described. It is shown that the process used here with the implemented interference model is in good agreement with pressure and boundary layer measures. ESA

N91-12646# Universitaet der Bundeswehr Muenchen, Neubiberg (Germany, F.R.). Inst. fuer Luftfahrttechnik und Leichtbau.

A VORTEX LATTICE METHOD FOR THE CALCULATION OF INTERFERENCE EFFECTS BETWEEN WINGS AND FREE VORTEX SHEETS IN SUBSONIC FLOW Ph.D. Thesis [EIN WIRBELGITTERVERFAHREN ZUR BERECHNUNG VON INTERFERENZEFFEKTEN SWISCHEN TRAGFLAECHEEN UND FREIEN WIRBELSCHICHTEN BEI UNTERSCHALLSTROEMUNG]
CHRISTINE URBAN 1988 155 p In GERMAN; ENGLISH summary
(Contract DFG-WA-424/3)

(ETN-90-98196) Avail: NTIS HC/MF A08

A time dependent zero order singularity method was developed to gain a simple and appropriate mathematical method for the calculation of the basis interference effects between wings and free vortex sheets. The method is suited for plane thin wings and subsonic flow conditions. The discontinuity surfaces are represented by a discrete vortex lattice. Thanks to the vortex lattice method, the mathematical and numerical advantages of a zero order potential method are combined with an increased

accuracy of the velocity field, which represents an essential precondition for the calculation of interfering wings with vortex separation. The simulation of unsteady incompressible processes is possible. The vortex lattice method provides a reliable tool for the layout process, for experimental investigations, and for more detailed theoretical studies. ESA

N91-13330*# Rice Univ., Houston, TX. Dept. of Mechanical Engineering and Materials Science.

THE SEMIDISCRETE GALERKIN FINITE ELEMENT MODELING OF COMPRESSIBLE VISCOUS FLOW PAST AN AIRFOIL
ANDREW J. MEADE In Hampton Univ., NASA/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1990 p 86-87 Sep. 1990
Avail: NTIS HC/MF A07 CSCD 01/1

The primary project was the numerical simulation, by a finite element/finite difference method, of the viscous flow about an airfoil. The secondary project involved the numerical simulation of the three-dimensional separated and vortex-dominated flow about a hemispherically capped cylinder in the transonic regime. Preliminary calculations were started for the hemisphere-cylinder at 0 and 5 degree angle of attack. The solution of the flow field about airfoils and wings is required to determine the important parameters of lift, moment, and drag. Viscous effects must be accounted for if the drag is to be accurately calculated. At present there are basically two approaches to the numerical simulation of the flow field, the use of fully viscous models and the inviscid/viscous models. The fully viscous models require the solution of an approximation of the Navier-Stokes equations and therefore should simulate most of the physical mechanisms. A fast, accurate, and computationally efficient inviscid flow solver was recently developed by Hartwich. It is thought that Hartwich's program coupled to a fast, accurate, and computationally efficient boundary layer code, will make an excellent tool for airfoil design. The purpose of the primary project was to develop a compressible boundary layer code using the semidiscrete Galerkin finite element method. The numerical scheme employed used the combination of a Dorodnitsyn formulation of the boundary layer equations, with a finite difference/finite element procedure (semidiscrete Galerkin method), in the solution of the compressible two-dimensional boundary layer equations. A laminar compressible boundary layer code was developed and tested for a NACA 0012 airfoil at a Mach number of 0.5, a Reynolds number of 5000, and zero angle of attack. At present the boundary layer program solves up to, but not beyond, separation. Author

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AIR TRANSPORTATION AND SAFETY

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

A91-16299
KEEPING BOMBS OFF AIRCRAFT

ROBERT J. PIRIH, ANDREAS F. KOTOWSKI, and STEPHEN T. SCHWARZMANN (EG&G Astrophysics Research Corp., Long Beach, CA) ICAO Journal (ISSN 0018-8778), vol. 45; June 1990, p. 12-16.
Copyright

Technical approaches to the concealed bomb problem include exposing the bag to some type of penetrating radiation and extracting some of the explosive material from the bag as vapor and doing a chemical analysis. Penetrating ionizing radiation techniques includes X-ray scanners, neutron scanners, thermal neutron activation (TNA), fast neutron analysis, neutron techniques with improved spatial resolution, and gamma-ray techniques. Penetrating electromagnetic radiation includes nuclear magnetic resonance and microwave techniques. Vapor detection techniques to date are summarized and detection strategy including the use

of X-ray scanners and the improvement of X-ray systems is discussed and it is recommended that TNA be further developed.
L.K.S.

A91-16300**DETECTION OF CONCEALED EXPLOSIVES AND NARCOTICS USING ION MOBILITY SPECTROMETRY**

JAMES B. SCHULTZ ICAO Journal (ISSN 0018-8778), vol. 45, June 1990, p. 19, 20.

Copyright

The Ionscan ion mobility spectrometer, designed to detect all known military and commercial explosives including Semtex and C-4 plastic, regardless of the concealment method or packaging information, is studied. The device is capable of detecting minute amounts of these explosives and of narcotics with no false alarms and minimal operator intervention. Interchangeable sampling nozzles allow for inobtrusive sampling and an air pump is used to draw the air and particles on or near a package, luggage, or person through the probe to the detector unit. Sampling rates of 10 bags or passengers per minute have been achieved. Several criteria are listed which an effective explosive detection system must meet, including: automated operation and detection, ability to detect minute amounts of all known military and civilian explosives, and safe and reliable operation at an affordable cost.

L.K.S.

A91-16687#**ADVERSE WEATHER SIMULATION CONCEPTS FOR SAFETY OF FLIGHT TRAINING**

BRUCE MONTAG (Southwest Research Institute, San Antonio, TX) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 86-96. refs (AIAA PAPER 90-3132) Copyright

An overview is presented of weather sensor systems, flight training, adverse weather training and simulation requirements, current weather simulation approaches, and a new concept for a modular, adverse weather simulation system. This modular concept provides a multisensor, correlated weather environment for advanced flight safety training applications and a means for controlling and correlating out the window visual weather scenes, aircraft handling qualities, and weather processing sensor avionics displays. The proposed weather concept provides a standard for the simulation of weather and offers a consistent means of presenting weather cues to the flight crew.

R.E.P.

A91-16740#**ICE ACCUMULATION ON INTAKE GUIDE VANES [CAPTION DE GLACE SUR UNE AUBE DE PREROTATION D'ENTREE D'AIR]**

R. HENRY and D. GUFFOND (ONERA, Chatillon-sous-Bagneux, France) (Reunion du Panel de Propulsion et Energetique, 76th, Brussels, Belgium, Oct. 8-12, 1990) ONERA, TP no. 1990-161, 1990, 8 p. In French. (ONERA, TP NO. 1990-161)

The severity of ice formation, as well as the amount of ice to be dislodged on intake guide vanes during engine idling, must be known in order to properly manage the flow and intensity of deicing heat needed to protect the blades. Modeling the path of supercooled droplets, first in a two-dimensional axisymmetric field, then along a flow path close to the vane, allows the calculation of the extent and intensity of the accumulation. Finally a heat-balance on the vane wall permits an evaluation of the type of ice removed.

R.E.P.

N91-11682*# National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

AIRBORNE WIND SHEAR DETECTION AND WARNING SYSTEMS. SECOND COMBINED MANUFACTURERS' AND TECHNOLOGISTS' CONFERENCE, PART 1

AMOS A. SPADY, JR., comp., ROLAND L. BOWLES, comp., and HERBERT SCHLICKENMAIER, comp. (Federal Aviation

Administration, Washington, DC.) Jul. 1990 347 p Conference held in Williamsburg, VA, 18-20 Oct. 1988 (NASA-CP-10050-PT-1; NAS 1.55:10050-PT-1) Avail: NTIS HC/MF A15 CSCL 01/3

The Second Combined Manufacturers' and Technologists' Conference hosted jointly by NASA Langley (LaRC) and the Federal Aviation Administration (FAA) was held in Williamsburg, Virginia, on October 18 to 20, 1988. The purpose of the meeting was to transfer significant, ongoing results gained during the second year of the joint NASA/FAA Airborne Wind Shear Program to the technical industry and to pose problems of current concern to the combined group. It also provided a forum for manufacturers to review forward-look technology concepts and for technologists to gain an understanding of the problems encountered by the manufacturers during the development of airborne equipment and the FAA certification requirements.

N91-11683*# American Airlines, Inc., Fort Worth, TX.

TOOLS FOR THE TRADE

WALLACE M. GILLMAN In NASA, Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 1 p 11-21 Jul. 1990

Avail: NTIS HC/MF A15 CSCL 01/3

A brief review is given of daily operations in the airline business, with emphasis on the decisions made by pilots and the information used to make those decisions. Various wind shears are discussed as they affect daily operations. The discussion of tools focuses on airborne reactive and predictive systems. The escape maneuver used to fly out of a severe windshear is from a pilot's point of view.

Author

N91-11684*# Honeywell, Inc., Phoenix, AZ. Sperry Commercial Flight Systems Group.

FLIGHT EXPERIENCE WITH WINDSHEAR DETECTION

TERRY ZWEIFEL In NASA, Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 1 p 59-70 Jul. 1990

Avail: NTIS HC/MF A15 CSCL 01/3

Windshear alerts resulting from the Honeywell Windshear Detection and Guidance System are presented based on data from approximately 248,000 revenue flights at Piedmont Airlines. The data indicate that the detection system provides a significant benefit to the flight crew of the aircraft. In addition, nuisance and false alerts were found to occur at an acceptably low rate to maintain flight crew confidence in the system. Data from a digital flight recorder is also presented which shows the maximum and minimum windshear magnitudes recorded for a representative number of flights in February, 1987. The effect of the boundary layer of a steady state wind is also discussed.

Author

N91-11685*# Honeywell, Inc., Phoenix, AZ. Sperry Commercial Flight Systems Group.

INTERFACE STANDARDS FOR INTEGRATED FORWARD-LOOKING/PREDICTIVE/REACTIVE WINDSHEAR SYSTEMS

MARK M. MCGLINCHEY In NASA, Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 1 p 73-81 Jul. 1990

Avail: NTIS HC/MF A15 CSCL 01/3

Forward-looking windshear systems are developing to a point (particularly the infrared sensors) where their interface with the cockpit and reactive windshear systems needs to be defined. As airlines retrofit their aircraft with reactive windshear systems, it is important to recognize that onboard windshear systems of the future will be a combination of both forward-looking and reactive elements. Today's reactive systems need to be built with the capability to interface with the forward-looking systems of tomorrow. This presentation is a first step at looking at the requirements and defining interface standards for integrated forward-looking and

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reactive windshear systems. Undoubtedly the requirements for interfacing these types of windshear systems will change as the technology changes. Author

N91-11686*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

HEAVY RAIN EFFECTS ON AIRPLANE PERFORMANCE

R. E. DUNHAM, JR., G. M. BEZOS, B. A. CAMPBELL, W. D. MACE, JR., and W. E. MELSON, JR. (National Aeronautics and Space Administration. Wallops Flight Facility, Wallops Island, VA.) *In its* Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 1 p 85-101 Jul. 1990

Avail: NTIS HC/MF A15 CSCL 01/3

The objective is to determine if the aerodynamic characteristics of an airplane are altered while flying in the rain. Wind-tunnel tests conducted at the NASA Langley Research Center (LaRC) have shown losses in maximum lift, reduction in stall angle, and increases in drag when a wing is placed in a simulated rain spray. For these tests the water spray concentration used represented a very heavy rainfall. A lack of definition of the scaling laws for aerodynamic testing in a two-phase, two-component flow makes interpolation of the wind-tunnel test uncertain. Tests of a large-scale wing are to be conducted at the LaRC. The large-scale wing is mounted on top of the Aircraft Landing Dynamics Facility (ALDF) carriage. This carriage (which is 70-foot long, 30-foot wide, and 30-foot high) is propelled with the wing model attached down a 3000-foot long test track by a water jet at speeds of up to 170 knots. A simulated rain spray system has been installed along 500 feet of the test track and can simulate rain falls from 2 to 40 inches/hour. Operational checks are underway and the initial tests should be completed by the Fall of 1989. Author

N91-11687*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

A PROPOSED DEFINITION FOR A PITCH ATTITUDE TARGET FOR THE MICROBURST ESCAPE MANEUVER

RICHARD S. BRAY *In* NASA, Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 1 p 105-121 Jul. 1990

Avail: NTIS HC/MF A15 CSCL 01/3

The Windshear Training Aid promulgated by the Federal Aviation Administration (FAA) defines the practical recovery maneuver following a microburst encounter as application of maximum thrust accompanied by rotation to an aircraft-specific target pitch attitude. In search of a simple method of determining this target, appropriate to a variety of aircraft types, a computer simulation was used to explore the suitability of a pitch target equal in numerical value to that of the angle of attack associated with stall warning. For the configurations and critical microburst shears simulated, this pitch target was demonstrated to be close to optimum. Author

N91-11688*# United Air Lines, Inc., Denver, CO.

THE 11 JULY 1988 DENVER WINDSHEAR ENCOUNTERS

ROBERT L. IRELAND *In* NASA, Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 1 p 179-187 Jul. 1990

Avail: NTIS HC/MF A15 CSCL 01/3

On July 11, 1988, between 2207 and 2213 UTC (16:07 to 16:13 MDT), four successive United flights had inadvertent encounters with microburst windshear conditions while on final approach to Denver Stapleton Airport (DEN), each resulting in a missed approach, subsequent delay, and uneventful arrival. A fifth flight executed a missed approach without encountering the phenomena. There was no damage to aircraft and no passenger injuries were incurred. The term inadvertent is used within United Airlines' windshear training materials and the Federal Aviation Administration (FAA) Windshear Training Aid to connote an encounter with windshear after vigilance and cautionary practices fail to identify and afford complete avoidance of the hazardous area. No crew culpability is implied. A comprehensive investigation

for scientific purposes in the study of windshear phenomenon is being conducted separately under the guidance of the FAA with involvement and cooperation from United, the National Transportation Safety Board (NTSB), National Center for Atmospheric Research (NCAR), Boeing, Douglas, NASA, and others. Author

N91-11689*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AIRBORNE DOPPLER RADAR DETECTION OF LOW ALTITUDE WINDSHEAR

EMEDIO M. BRACALENTE, WILLIAM R. JONES, and CHARLES L. BRITT (Research Triangle Inst., Hampton, VA.) *In its* Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 1 p 211-224 Jul. 1990 Presented at the AIAA Conference on Sensor and Measurement Techniques for Aeronautical Application, Atlanta, GA, 7-9 Sep. 1988 Previously announced in IAA as A90-23284

Avail: NTIS HC/MF A15 CSCL 01/3

As part of an integrated windshear program, the Federal Aviation Administration, jointly with NASA, is sponsoring a research effort to develop airborne sensor technology for the detection of low altitude windshear during aircraft take-off and landing. One sensor being considered is microwave Doppler radar operating at X-band or above. Using a Microburst/Clutter/Radar simulation program, a preliminary feasibility study was conducted to assess the performance of Doppler radars for this application. Preliminary results from this study are presented. Analysis show, that using bin-to-bin Automatic Gain Control (AGC), clutter filtering, limited detection range, and suitable antenna tilt management, windshear from a wet microburst can be accurately detected 10 to 65 seconds (.75 to 5 km) in front of the aircraft. Although a performance improvement can be obtained at higher frequency, the baseline X-band system that was simulated detected the presence of a windshear hazard for the dry microburst. Although this study indicates the feasibility of using an airborne Doppler radar to detect low altitude microburst windshear, further detailed studies, including future flight experiments, will be required to completely characterize the capabilities and limitations. Author

N91-11690*# Clemson Univ., SC.

CLUTTER FILTER DESIGN CONSIDERATIONS FOR AIRBORNE DOPPLER RADAR DETECTION OF WINDSHEAR

ERNEST G. BAXA, JR. *In* NASA, Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 1 p 281-294 Jul. 1990

Avail: NTIS HC/MF A15 CSCL 01/3

The problem of clutter rejection when processing down-looking Doppler radar returns from a low altitude airborne platform is a paramount problem. With radar as a remote sensor for detecting and predicting windshear in the vicinity of an urban airport, dynamic range requirements can exceed 50 dB because of high clutter to signal ratios. This presentation describes signal processing considerations in the presence of distributed and/or discrete clutter interference. Previous analyses have considered conventional range cell processing of radar returns from a rigidly mounted radar platform using either the Fourier or the pulse-pair method to estimate average windspeed and windspeed variation within a cell. Clutter rejection has been based largely upon analyzing a particular environment in the vicinity of the radar and employing a variety of techniques to reduce interference effects including notch filtering, Fourier domain line editing, and use of clutter maps. For the airborne environment the clutter characteristics may be somewhat different. Conventional clutter rejection methods may have to be changed and new methods will probably be required to provide useful signal to noise ratios. Various considerations are described. A major thrust has been to evaluate the effect of clutter rejection filtering upon the ability to derive useful information from the post-filter radar data. This analysis software is briefly described. Finally, some ideas for future analysis are considered including the use of adaptive filtering for clutter rejection and the estimation

of windspeed spatial gradient directly from radar returns as a means of reducing the effects of clutter on the determination of a windshear hazard. Author

N91-11691*# Turbulence Prediction Systems, Boulder, CO.
RAMIFICATIONS OF THE RECENT FAA RULE FOR WINDSHEAR SYSTEMS ON THE DEVELOPMENT OF FORWARD-LOOKING SYSTEMS

H. PATRICK ADAMSON *In* NASA, Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 1 p 313-323 Jul. 1990
 Avail: NTIS HC/MF A15 CSCL 01/3

The recent Federal Aviation Administration (FAA) rule requiring windshear systems with flight guidance may have severe ramifications for the development of infrared and other forward-looking systems. The industry needs to have and can have a more cost effective option through the use of a forward-looking system with a reactive backup instead of a reactive system with flight guidance. However, because of the short time for compliance with the new FAA rule, it is possible that existing transport aircraft will be in full compliance before a comprehensive investigation of all forward-looking systems can be completed. If this occurs, it is possible that the market for forward-looking systems will be severely reduced, thereby eliminating the economic incentive to develop these much needed systems. Thus, to assure that this option is available for the airlines, it behooves the industry to immediately support an in-service evaluation of all available forward-looking systems. Author

N91-11692*# Delco Systems Operations, Milwaukee, WI.
STATUS OF THE DELCO SYSTEMS OPERATIONS FORWARD LOOKING WINDSHEAR DETECTION PROGRAM

BRIAN J. GALLAGHER *In* NASA, Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 1 p 331-348 Jul. 1990
 Avail: NTIS HC/MF A15 CSCL 01/3

Delco Systems Operations, a division of General Motors Hughes Electronics Corporation, is developing a Forward Looking Windshear Detection System based on the integration of infrared remote sensing and accelerometer reactive sensing technologies. The infrared sensor is a multi-spectral, scanning radiometer operating in the 8 to 14 micron region. A 2 x 5 detector array with parallel-serial scanning produces 60 degrees horizontal and 10 degrees vertical-fields of view. Using multiple wavelength signals, azimuth temperature gradients are analyzed for characteristic signatures of thermally induced windshear phenomena. Elevation temperature gradients are processed through an atmosphere model to continuously compute a stability index for arming microburst detection criteria. The atmosphere model and proprietary computer processing algorithms combine to generate coarse estimates of disturbance ranges based on multiple wavelength radiance data with different extinction coefficients. Computer outputs of atmospheric stability, disturbance intensity, and azimuth and range information provide a situation display capability. A ground operated, experimental radiometer has been developed and is being used to verify the detection and discrimination concepts at an atmospheric and simulated rain test facility in Milwaukee. A prototype airborne radiometer is being developed for flight test evaluation during the summer of 1989. Author

N91-11694*# National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.
INVESTIGATION OF AIRBORNE LIDAR FOR AVOIDANCE OF WINDSHEAR HAZARDS

RUSSELL TARG (Lockheed Missiles and Space Co., Palo Alto, CA.) and ROLAND L. BOWLES *In its* Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 1 p 365-377 Jul. 1990
 Avail: NTIS HC/MF A15 CSCL 01/3

A generalized windshear hazard index is defined, which is

derived from considerations of wind conditions at the present position of an aircraft and from remotely sensed information along the extended flight path. Candidate airborne sensor technologies based on microwave Doppler radar, Doppler lidar, and infrared radiometric techniques are discussed in the context of overall system functional requirements. Initial results of a performance and technology assessment study for competing lidars are presented. Based on a systems approach to the windshear threat, lidar appears to be a viable technology for windshear detection and avoidance, even in conditions of moderately heavy precipitation. The proposed airborne CO₂ and Ho:YAG lidar windshear-detection systems analyzed here can give the pilot information about the line-of-sight component of windshear threat from his present position to a region extending 1 to 3 km in front of the aircraft. This constitutes a warning time of 15 to 45 seconds. The technology necessary to design, build, and test such a brassboard 10.6 micron CO₂ lidar is now available. However, for 2-micron systems, additional analytical and laboratory investigations are needed to arrive at optimum 2-micron rare-earth-based laser crystals. Author

N91-11695*# National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.
AIRBORNE WIND SHEAR DETECTION AND WARNING SYSTEMS. SECOND COMBINED MANUFACTURERS' AND TECHNOLOGISTS' CONFERENCE, PART 2

AMOS A. SPADY, JR., comp., ROLAND L. BOWLES, comp., and HERBERT SCHLICKENMAIER, comp. (Federal Aviation Administration, Washington, DC.) Jul. 1990 452 p Conference held in Williamsburg, VA, 18-20 Oct. 1988 (NASA-CP-10050-PT-2; NAS 1.55:10050-PT-2) Avail: NTIS HC/MF A20 CSCL 01/3

The Second Combined Manufacturers' and Technologists' Conference was hosted jointly by NASA Langley (LaRC) and the Federal Aviation Administration (FAA) in Williamsburg, Virginia, on October 18 to 20, 1988. The meeting was co-chaired by Dr. Roland Bowles of LaRC and Herbrt Schlickenmaier of the FAA. The purpose of the meeting was to transfer significant, ongoing results gained during the second year of the joint NASA/FAA Airborne Wind Shear Program to the technical industry and to pose problems of current concern to the combined group. It also provided a forum for manufacturers to review forward-look technology concepts and for technologists to gain an understanding of the problems encountered by the manufacturers during the development of airborne equipment and the FAA certification requirements.

N91-11696*# National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

FLIGHT GUIDANCE RESEARCH FOR RECOVERY FROM MICROBURST WIND SHEAR

DAVID A. HINTON *In its* Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 2 p 395-416 Jul. 1990
 Avail: NTIS HC/MF A20 CSCL 01/3

Research is in progress to develop flight strategy concepts for avoidance and recovery from microburst wind shears. The objectives of this study are to evaluate the performance of various strategies for recovery from wind shear encountered during the approach-to-landing, examine the associated piloting factors, and evaluate the payoff of forward-look sensing. Both batch and piloted simulations are utilized. The industry-recommended manual recovery technique is used as a baseline strategy. Two advanced strategies were selected for the piloted tests. The first strategy emulates the recovery characteristics shown by prior optimal trajectory analysis, by initially tracking the glideslope, then commanding a shallow climb. The second strategy generates a flight path angle schedule that is a function of airplane energy state and the instantaneous shear strength. All three strategies are tested with reactive sensing only and with forward-look sensing. Piloted simulation tests are in progress. Tentative results indicate that, using only reactive alerts, there appears to be little difference in performance between the various strategies. With forward-look

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alerts, the advanced guidance strategies appear to have advantages over the baseline strategy. Relatively short forward-look alert times, on the order of 10 or 15 seconds, produce a far greater recovery benefit than optimizing a recovery from a reactive alert. Author

N91-11697*# Honeywell, Inc., Phoenix, AZ. Sperry Commercial Flight Systems Group.

ANALYSIS OF GUIDANCE LAW PERFORMANCE USING PERSONAL COMPUTERS

J. RENE BARRIOS *In* NASA, Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 2 p 471-484 Jul. 1990

Avail: NTIS HC/MF A20 CSCL 01/3

A point mass, three-degree of freedom model is presented as a basic development tool for PC based simulation models. The model has been used in the development of guidance algorithms as well as in other applications such as performance management systems to compute optimal speeds. Its limitations and advantages are discussed with regard to the windshear environment. A method for simulating a simple autopilot is explained in detail and applied in the analysis of different guidance laws. Author

N91-11698*# Princeton Univ., NJ. Dept. of Mechanical and Aerospace Engineering.

AN EXPERT SYSTEM FOR WIND SHEAR AVOIDANCE

ROBERT F. STENGEL and D. ALEXANDER STRATTON *In* NASA, Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 2 p 515-544 Jul. 1990

Avail: NTIS HC/MF A20 CSCL 01/3

The principal objectives are to develop methods for assessing the likelihood of wind shear encounter (based on real-time information in the cockpit), for deciding what flight path to pursue (e.g., takeoff abort, landing go-around, or normal climbout or glide slope), and for using the aircraft's full potential for combating wind shear. This study requires the definition of both deterministic and statistical techniques for fusing internal and external information, for making go/no-go decisions, and for generating commands to the aircraft's autopilot and flight directors for both automatic and manually controlled flight. The expert system for pilot aiding is based on the results of the FAA Windshear Training Aids Program, a two-volume manual that presents an overview, pilot guide, training program, and substantiating data that provides guidelines for this initial development. The Windshear Safety Advisor expert system currently contains over 140 rules and is coded in the LISP programming language for implementation on a Symbolics 3670 LISP Machine. Author

N91-11699*# Honeywell, Inc., Phoenix, AZ. Sperry Commercial Flight Systems Group.

THE EFFECT OF WINDSHEAR DURING TAKEOFF ROLL ON AIRCRAFT STOPPING DISTANCE

TERRY ZWEIFEL *In* NASA, Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 2 p 547-561 Jul. 1990

Avail: NTIS HC/MF A20 CSCL 01/3

A simulation of a Boeing 727 aircraft during acceleration on the runway is used to determine the effect of windshear on stopping distance. Windshears of various magnitudes, durations, and onset times are simulated to assess the aircraft performance during an aborted takeoff on five different runway surfaces. A windshear detection system, active during the takeoff roll and similar to the Honeywell Windshear Detection System is simulated to provide a discrete system to activate aircraft braking upon shear detection. The results of the simulation indicate that several factors effect the distance required to stop the aircraft. Notable among these are gross weight, takeoff flap position, runway characteristics, and pilot reaction time. Of the windshear parameters of duration, onset and magnitude, magnitude appears to have the most significant effect. Author

N91-11700*# Direction Generale de L'Aviation Civile, Toulouse (France).

WIND SHEAR PREDICTIVE DETECTOR TECHNOLOGY STUDY STATUS

C. GANDOLFI *In* NASA, Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 2 p 592-637 Jul. 1990

Avail: NTIS HC/MF A20 CSCL 01/3

Among the different elements to be investigated when considering the Wind Shear hazard, the Aeronautical Navigation Technical Service (STNA/3E), whose task is to participate in the development of new technologies and equipments, focused its effort on airborne and ground sensors for the detection of low-level wind shear. The first task, initiated in 1986, consists in the evaluation of three candidate techniques for forward-looking sensors: lidar, sodar, and radar. No development is presently foreseen for an infrared based air turbulence advance warning system although some flight experiments took place in the 70's. A Thomson infrared radiometer was then installed on an Air France Boeing 707 to evaluate its capability of detecting clear air turbulence. The conclusion showed that this technique was apparently able to detect cloud layers but that additional experiments were needed; on the other hand, the rarity of the phenomenon and the difficulty in operating on a commercial aircraft were also mentioned. Author

N91-11701*# Massachusetts Inst. of Tech., Lexington. Lincoln Lab.

SUMMER 1988 TDWR MICROBURST ANALYSIS

MARK W. MERRITT *In* NASA, Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 2 p 740-751 Jul. 1990

Avail: NTIS HC/MF A20 CSCL 01/3

The Terminal Doppler Weather Radar (TDWR) testbed system was operated during the months of July to August 1988 in a live operational demonstration providing microburst (and related weather hazard) protection to the Stapleton International Airport in Denver, CO. During this time period, the performance of the detection system was carefully monitored in an effort to determine the reliability of the system. Initial performance analysis indicates that the microburst detection component of TDWR satisfies the basic performance goals of 90 percent probability of detection and 10 percent probability of false alarm. An in-depth study of the system performance, based on analysis of both dual-Doppler radar observations and surface mesonet measurements, is in progress to provide a detailed understanding of the observability of microbursts by the radar, the ability of the algorithms to detect microburst observed by the radar, and the timeliness and accuracy of the microburst alarms provided to operational users. Author

N91-11702*# Massachusetts Inst. of Tech., Lexington. Lincoln Lab.

AUTOMATIC DETECTION OF LOW ALTITUDE WIND SHEAR DUE TO GUST FRONTS IN THE TERMINAL DOPPLER WEATHER RADAR OPERATIONAL DEMONSTRATION

DIANA KLINGLE-WILSON *In* NASA, Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 2 p 754-770 Jul. 1990

Avail: NTIS HC/MF A20 CSCL 01/3

A gust front is the leading edge of the cold air outflow from a thunderstorm. Wind shears and turbulence along the gust front may produce potentially hazardous conditions for an aircraft on takeoff or landing such that runway operations are significantly impacted. The Federal Aviation Administration (FAA) has therefore determined that the detection of gust fronts in the terminal environment be an integral part of the Terminal Doppler Weather Radar (TDWR) system. Detection of these shears by the Gust Front Algorithm permits the generation of warnings that can be issued to pilots on approach and departure. In addition to the detection capability, the algorithm provides an estimate of the

wind speed and direction following the gust front (termed wind shift) and the forecasted location of the gust front up to 20 minutes before it impacts terminal operations. This has shown utility as a runway management tool, alerting runway supervisors to approaching wind shifts and the possible need to change runway configurations. The formation and characteristics of gust fronts and their signatures in Doppler radar data are discussed. A brief description of the algorithm and its products for use by Air Traffic Control (ATC), along with an assessment of the algorithm's performance during the 1988 Operational Test and Evaluation, is presented. Author

N91-11703*# Air Line Pilots Association, International, Washington, DC.

WIND SHEAR PROCEDURES AND THE INSTRUMENTATION

W. W. MELVIN *In* NASA, Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 2 p 798-808 Jul. 1990

Avail: NTIS HC/MF A20 CSCL 01/3

The effect of pitch rate on abort landing caused by wind shear encounters is discussed. Optimal trajectories, airspeed, and wind shear warning systems are briefly discussed. The bulk of the presentation is in viewgraph form. Author

N91-11704*# Airbus Industrie, Blagnac (France).

AIRBUS WINDSHEAR WARNING AND GUIDANCE SYSTEM

J. L. BONAFE *In* NASA, Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 2 p 811-834 Jul. 1990

Avail: NTIS HC/MF A20 CSCL 01/3

From its first designed airplane, Airbus considered mandatory a help in the crew's decision-making process to initiate an escape maneuver and help to successfully realize it. All the Airbus airplanes designed since 1975 included an alpha-floor function and a speed reference control law imbedded in the speed reference system (SRS) box for A 300 and FAC and FCC for A 310, A300/600 and the A 320. Alpha-Floor function takes into account the airplane energy situation considering angle of attack and observed longitudinal situation in order to apply immediately the full power without any pilot action. Speed reference managers control airspeed and/or ground speed in order to survive a maximum in shear situation. In order to comply with the new FAA regulation: Aerospatiale and Airbus developed more efficient systems. A comparison between 1975 and a newly developed system is given. It is explained how the new system improves the situation. Author

N91-11706# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Aerospace Medical Panel.

OCCUPANT CRASH PROTECTION IN MILITARY AIR TRANSPORT

RICHARD F. CHANDLER Aug. 1990 151 p (AGARD-AG-306; ISBN-92-835-0579-4; AD-A227647) Copyright Avail: NTIS HC/MF A08; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The progress is traced of developments in seat and restraint systems for passengers in all types of aircraft. Results of carefully directed studies from the 1940's through current times leading to today's state of the art are reported as are specifications and regulations which were developed. An extensive bibliography provides the sources of reports necessary for a reader who wishes to make an indepth study of the technology. Author

N91-11707# Deutsche Gesellschaft fuer Luft- und Raumfahrt, Bonn (Germany, F.R.).

EUROPEAN FORUM: THE EVOLUTION OF REGIONAL AIRCRAFT TECHNOLOGIES AND CERTIFICATION

1989 201 p Forum held in Friedrichshafen, Fed. Republic of Germany, 6-7 Apr. 1989; sponsored by DGLR, AAAF, and RAeS

Sponsored by BMFT (DGLR-BERICHT-89-02; ISBN-3-922010-45-8; ETN-90-97835) Avail: NTIS HC/MF A10

The evolution of aircraft technology and certification to a joint European approach was discussed. Competition with high speed railways was considered. New technologies included the use of composite materials, particularly carbon fiber reinforced plastic wings, and information systems. Noise reduction research is reported. Turbofan and propfan technologies are addressed. Passenger and airline requirements are covered.

N91-11708# European Regional Airlines Organization, Chobham (England).

REGIONAL AIR TRAFFIC AFTER 1992

MIKE A. AMBROSE *In* DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 5-8 1989 Avail: NTIS HC/MF A10

Some thoughts on regional air traffic assuming the completion of a fully liberalized air transport system by January 1993 are offered. Major factors which will influence traffic characteristics including the nature of the liberalization, airport and air traffic control infrastructure and congestion levels, advances in technology and changes in air transport economics, are reviewed. ESA

N91-11709# Bundesministerium fuer Verkehr, Bonn (Germany, F.R.).

HIGH-SPEED TRAINS IN COMPETITION WITH REGIONAL AIR TRANSPORT

PETER REINHARDT *In* DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 9-20 1989 Avail: NTIS HC/MF A10

Concepts developed to encounter loss of passengers in short and long distance railway transport are discussed. High speed railway transport in Europe, particularly France and the Federal Republic of Germany, is described. Improvements in rolling material and a list of future traveling times with time saved are given. The reasons for choice between traveling methods are outlined. ESA

N91-11710# British Aerospace Commercial Aircraft, Hatfield (England).

NEXT GENERATION OF REGIONAL AIRCRAFT

ALAN A. BLYTHE *In* DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 21-25 1989 Avail: NTIS HC/MF A10

The current situation with regard to regional airliners is reviewed, focusing on aircraft designed primarily for this market. Future market prospects, together with candidate powerplants for the next generation aircraft are considered. Objectives for the next generation regional airliners are identified. Needs with regard to safety, operating flexibility, operating costs, reliability, comfort standard, field performance and noise are discussed. Potential contenders for the next generation of regional airliners are reviewed. ESA

N91-11711# Aerospatiale, Toulouse (France).

TOWARDS A SINGLE CERTIFICATION ACTION WITHIN EUROPE

J. VIARGUES and J. JAVELLE *In* DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 27-31 1989

Avail: NTIS HC/MF A10

The airworthiness and certification concepts and the development and the objectives of the European regulations are reviewed. Examples of the application of the European regulations and the different procedures used, and the lessons to be learnt from these experiences are presented. Future developments concerning regulations and procedures are presented. ESA

N91-11712# Saab-Scania, Linkoping (Sweden). Ground and Flight Test Dept.

EXPERIENCES GAINED IN THE SF340 AIRWORTHINESS PROCESS

03 AIR TRANSPORTATION AND SAFETY

MILTON MOBARG *In* DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 33-35 1989
Avail: NTIS HC/MF A10

An introduction to the Swedish company SAAB-Scania's background as an aircraft manufacturer, commencing in the late thirties, is given. The significant stages of the SF340 program are discussed. Emphasis is given to the airworthiness and certification aspects of the program. ESA

N91-11713# Fokker B.V., Schipol-Oost (Netherlands).
FOKKER 50: TECHNOLOGY VERSUS CERTIFICATION EXPERIENCE

R. W. BISHOP *In* DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 37-46 1989
Avail: NTIS HC/MF A10

With accompanying illustrations, the Fokker 50 program is described. The Fokker 50 was awarded a type certificate on the 15th May 1987, ending a development program launched in November 1983. The aircraft, which started life as a re-engined derivative of the F27 Mk 500, evolved into a state of the art turboprop airliner making full use of current technology. A major part of the program was an update of the certification base, achieved in close cooperation with the Dutch civil aviation authority. Experience gained during the development process generally confirmed the need for direct interaction between the technology adopted and the evolving basis for certification. ESA

N91-11716# Dornier System G.m.b.H., Friedrichshafen (Germany, F.R.).

DORNIER 328: TECHNOLOGY VERSUS CERTIFICATION ASPECTS OF PROGRAM PHILOSOPHY

R. BIRRENBACH *In* DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 63-72 1989
Avail: NTIS HC/MF A10

Type certification aspects and operational effects of the Dornier 328 program are discussed. New technologies are applied where experience is available, risk affordable and attractive operating costs are shown. The application of composite material is burdened by cost and time. Aluminum-lithium sheet metal is delayed because production is not yet reasonably established. Requirements on flammability, smoke emission and toxic gas emission demands new material for cabin/cockpit interiors. Advancement in microelectronics and modern airliner in service experience prepare the way for integrated digital avionic installation in regional airlines. ESA

N91-11720# Cranfield Inst. of Tech., Bedford (England). Coll. of Aeronautics.

A PASSENGER'S VIEW OF COMMUTER AIRCRAFT

A. N. HOFTON *In* DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 105-110 1989
Avail: NTIS HC/MF A10

Passenger's views of commuter aircraft are considered. The fact that passengers seek inconsistent combinations of service features such as frequency, load factor, aircraft size and fare levels and that the task of the designer and airline manager are particularly difficult is acknowledged. The study draws on personal experience and on the results of surveys of passengers, to highlight the areas where passengers seek improvements. It is concluded that users require more space per passenger, more cabin stowage space and lower cabin noise levels. Growing congestion means that all commuter aircraft should be capable of operating from secondary runways. More customer research is suggested as being needed before new designs are frozen. ESA

N91-11735# Civil Aviation Authority, London (England).
THE EUROPEAN CERTIFICATION PROCESS

R. ASHFORD *In* DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 201-205 1989
Avail: NTIS HC/MF A10

The European certification process developed by the Joint Aviation Authorities (JAA) is described against the background of the total JAA activity. The progress from developing common

regulations in the 1970s to the present arrangements for joint certification and maintaining continued airworthiness throughout the lifetime of the aircraft is summarized. The relationship of this work to the European Civil Aviation Conference (ECAC) and the European community is discussed. It is suggested that this developing JAA certification activity meets the legitimate needs of the European and worldwide aircraft manufacturing and operating industry. ESA

N91-11736# Swedish Civil Aviation Administration, Stockholm. Flight Safety Dept.

THE CERTIFICATION OF THE SAAB 340

INGMAR HEDBLUM *In* DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 207-210 1989
Avail: NTIS HC/MF A10

The procedures used to certify the SAAB SF 340 commuter airplane are described. The certification was the first effort to jointly certify an airplane by all the Joint European Airworthiness Authorities. Examples of major issues in the process are given. ESA

N91-11737# Luftfahrt-Bundesamt, Brunswick (Germany, F.R.).
CERTIFICATION PROCESS FOR AEROPLANE TYPE DORNIER DO 328

KLAUS KOPLIN *In* DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 211-213 1989
Avail: NTIS HC/MF A10

A joint European team was set up for the first time to carry out certification of the new airplane type Do 328. This team shall determine for all of the 12 European Aviation Authorities that the requirements for certification are met. The duties of this team as well as of the other bodies involved in the joint certification process are described. ESA

N91-11738# Federal Aviation Administration, Washington, DC.

LOCATION OF COMMERCIAL AIRCRAFT

ACCIDENTS/INCIDENTS RELATIVE TO RUNWAYS Final Report

ROBERT E. DAVID 1 Jul. 1990 85 p
(AD-A225225; DOT/FAA/AOV-90-1) Avail: NTIS HC/MF A05
CSCL 01/2

The location of an aircraft involved in an accident or incident may be documented by the National Transportation Safety Board and the Federal Aviation Administration during the course of their investigation. When available, it will appear in the record of the individual investigation. However, this location information is not available from either of these agencies in a summary form. Compiled in this document is the location relative to the runway of these accidents/incidents for aircraft involved in commercial air transportation in the United States. Accidents/incidents that occurred from 1978 to 1987 were studied. Since it is intended that this information will be used mainly to make decisions on individual airports, no attempt was made to reach conclusions or make recommendations based on the data. The accidents/incidents used were categorized as undershoots, landings off the runway, veeroffs, overruns, and other in the vicinity of the airport. The aircraft location was recorded in terms of the distance along the runway centerline or extended centerline (X distance) and the perpendicular distance from the centerline or extended centerline (Y distance). GRA

N91-12571# University of Western Michigan, Kalamazoo. Dept. of Aircraft and Automotive Engineering.

PERFORMANCE INSTRUMENTATION FOR MULTIENGINE SAFETY

ARTHUR W. HOADLEY *In* AIAA, Proceedings of the 1990 AIAA/FAA Joint Symposium on General Aviation Systems p 260-279 May 1990
Avail: NTIS HC/MF A17

Many accidents in multiengine aircraft are caused by the pilot's inability to retain control and/or obtain maximum performance when an engine fails. In order to maintain control of the aircraft, the

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

A91-14392

OMEGA SYSTEM PERFORMANCE ASSESSMENT

P. B. MORRIS, R. R. GUPTA (Analytic Sciences Corp., Reading, MA), R. J. WENZEL, and H. O. SHIRER (USCG, Omega Navigation System Center, Alexandria, VA) *Navigation* (ISSN 0028-1522), vol. 36, Winter 1989-1990, p. 345-362. refs

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The development of a figure-of-merit, or performance index, for the Omega system that accounts for most of the attributes of the system, including station performance, signal coverage characteristics, receiver performance, and the geographic patterns of users/user requirements is presented. Sample calculations and results for assumed alternative station power level assignments are presented to illustrate the numerical characteristics of this index. Although the model is applied to the Omega system, the method shown is general and could be used for other radio navigation systems. R.E.P.

A91-14394

OVERDETERMINED CELESTIAL FIX BY ITERATION

ROBERT W. SEVERANCE *Navigation* (ISSN 0028-1522), vol. 36, Winter 1989-1990, p. 373-378. refs

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A celestial fix which minimizes the sum of the squares of the sextant altitude residuals is presented as an alternative to constructing lines of position (LOPs) from azimuths and altitude differences. It is especially applicable to multiple sights, from one or several celestial bodies, providing covariance estimates for the longitude and latitude and a basis for discarding wild readings. The iterative algorithm which replaces the sight reduction tables can be programmed in a high-level computer language and is very robust with respect to the observer's initially guessed position. A fix from a series of sun altitudes taken for an hour after sunrise is presented as an example. Geometry makes this particular fix highly accurate in longitude and inaccurate in latitude, while the low sun angles make it liable to refraction error. Author

A91-14395

IMPROVED ALGORITHMS FOR MINIMUM DISTANCE NAVIGATION

K. C. C. WIPPERN (USAF, Space Command, Colorado Springs, CO) *Navigation* (ISSN 0028-1522), vol. 36, Winter 1989-1990, p. 397-408. refs

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This paper presents formulas that can be used to generate the navigation parameters (e.g., true course) required for surface navigation along a spherical and oblate spheroidal geodesic (first-order perturbation) as an analytic set of functions of a single, continuous variable. It is the mathematical treatment, and the use of parametric analysis, which distinguishes the results presented in this paper from earlier work in the area of minimum distance (or geodesic) surface navigation. Author

A91-14770

THE AIRBORNE SEEKER TEST BED

CURTIS W. DAVIS, III (MIT, Lexington, MA) *The Lincoln Laboratory Journal* (ISSN 0896-4130), vol. 3, Summer 1990, p. 203-224. Research sponsored by USAF and U.S. Army.

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The Airborne Seeker Test Bed is a recently operational instrumentation system containing a closed-loop tracking, semiautonomous seeker with the capability to record high-fidelity signals pertaining to radar seeker phenomenology, target scattering characteristics, electronic countermeasures, and acquisition and tracking performance. The unique capabilities of the test bed will

pilot must not allow the aircraft to stall with the asymmetric thrust caused by a failed engine. The strong yawing moment that results, coupled with the stall, will most likely result in a spin. Several training accidents have been caused by demonstrating Vmc (minimum controllable airspeed) at a sufficiently high altitude, where the lower engine thrust causes the Vmc to be below the stall speed of the aircraft. When the aircraft stalls before Vmc is reached, an unrecoverable spin can occur. Instrumentation designed to give the pilot a continuous display of the aircraft's stall margin (the percent of lift coefficient available but not being used) allows the pilot to know where the aircraft is relative to stall, regardless of its load factor, weight, or configuration. The same technology can be used to detect the sideslip of an aircraft with asymmetric thrust. An aircraft's best single engine performance is obtained when the sideslip is zero and the stall margin for best climb is flown. During an engine out emergency, the pilot would control the stall margin with pitch changes and the sideslip by adjusting the bank angle, while using the rudder to maintain directional control. The theory and hardware necessary to provide both stall margin and sideslip indications are discussed. Author

N91-12573# Goldschmied (Fabio R.), Monroeville, PA.

AERODYNAMIC TRANSPORT EFFICIENCY OF GENERAL AVIATION: AN OVERVIEW

FABIO R. GOLDSCHMIED *In AIAA, Proceedings of the 1990 AIAA/FAA Joint Symposium on General Aviation Systems p 292-311 May 1990*

Avail: NTIS HC/MF A17

An extensive overview has been carried out on the Aerodynamic Transport Efficiency, as defined by Gabrielli and von Karman, of General Aviation aircraft, using data from many published sources, including the 1988 and 1989 Tri-aviation races and the 1970 Oshkosh Aircraft Efficiency Contest races. The best result from the races was an efficiency of 6.19 at 91 m/s (204 MPH) for a four-seat aircraft. It was also shown that an efficiency of 14.8 can be achieved with a NASA fuselage/wake-propeller configuration and 12.9 with a Navy fuselage/pressure-thrust configuration of comparable gross weight and speed. On the basis of the Kraus cruise Figure-of-merit, this would mean that new advanced aircraft would have the same merit value as used conventional aircraft, for the same purchase price; thus the buyer would be strongly motivated to buy the new aircraft, revitalizing the General Aviation industry. Author

N91-12647# Failure Analysis Associates, Inc., Westborough, MA.

FAILURE ANALYSIS TECHNIQUES FOR THE EVALUATION OF ELECTRICAL AND ELECTRONIC COMPONENTS IN AIRCRAFT ACCIDENT INVESTIGATIONS Final Report, 20 Sep. 1989 - 20 Apr. 1990

DONALD GALLER, DONALD E. ALLISON, and DAVID W. MERCALDI Aug. 1990 149 p

(Contract F33615-89-C-5647; AF PROJ. 3005)

(AD-A226381; WRDC-TR-90-4075) Avail: NTIS HC/MF A07 CSCL 09/1

Failure analysis techniques for the evaluation of electrical and electronic components are summarized for: lamps, wiring, connectors, switches, magnetic materials, printed wiring boards and microelectronic devices. Techniques using optical and scanning electron microscopy (SEM) for the analysis of these components are described. Energy Dispersive X ray analysis (EDAX) of elemental constituents, X ray radiography, and specialized electrical measurements are also described. The potential for the techniques to distinguish pre-accident conditions from post-impact damage was assessed. Data on the failure rates of aircraft electrical components was reviewed. Data from the Air Force Mishap database indicates that 36 percent of electrical failures on aircraft are caused by interconnections: wiring and connectors. Corrosion is identified as a major cause of connector problems. GRA

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be used to collect data and develop computer models for evaluating and predicting missile performance. Test bed data will be used to evaluate the susceptibility of U.S. aircraft to missile attack, and to explore new directions for future systems. The test bed is also designed to support the development of advanced seekers and new electronic countermeasure techniques, and to demonstrate their capabilities in flight. Author

A91-14773

OPTIMAL PROCESSING OF POLARIMETRIC SYNTHETIC-APERTURE RADAR IMAGERY

L. M. NOVAK, M. C. BURL, R. D. CHANEY, and G. J. OWIRKA (MIT, Lexington, MA) The Lincoln Laboratory Journal (ISSN 0896-4130), vol. 3, Summer 1990, p. 273-290. Research sponsored by DARPA. refs

(Contract F19628-90-C-0002)

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The Advanced Detection Technology Sensor can detect, discriminate, and classify stationary ground targets during the day or night even through cloud cover, fog, smoke, dust, or rain. The sensor is a coherent, fully polarimetric, 35-GHz SAR with a resolution of 1 ft x 1 ft. And, to minimize SAR speckle while preserving image resolution, it uses the polarimetric whitening filter, a recently-developed method for processing fully polarimetric data into SAR imagery. Author

A91-14904

INVERSE SCATTERING ANALYSIS OF DIFFRACTION LIMITED SAR

HANS HELLSTEN (National Defence Research Establishment, Linkoping, Sweden) IEEE Transactions on Antennas and Propagation (ISSN 0018-926X), vol. 38, Oct. 1990, p. 1517-1522. refs

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A theory of diffraction-limited SAR imagery is developed. Data are assumed to be collected by an airborne radar operating at relatively low frequencies and covering a relative bandwidth approaching unity (e.g., 10-100 MHz). The radar antenna is omnidirectional to allow a very large relative Doppler bandwidth. The inverse problem of reconstructing the ground topography from the collected data is solved analytically, with compensation for antenna effects; an interferometric antenna configuration provides discrimination between left- and right-hand side returns. The inversion leads to a two-dimensional Poisson equation for the ground surface angular height function, the source density corresponding to the SAR ground reflectivity. Because the ground is described relative to the aircraft, there is a latitude in this description which does not affect radar data. Except for this, the scheme provides a unique estimate of the ground topography at very high resolution (near 1 m for 90-MHz bandwidth). I.E.

A91-15031#

AN INVESTIGATION ON DME-BASED NAVIGATION SYSTEM

SUMIO MOTOYAMA and MORIYUKI MIZUMACHI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 38, no. 434, 1990, p. 139-147. In Japanese, with abstract in English. refs

The positional accuracies of DME-based navigation systems are studied. The LMS error criterion is used in these determinations. The horizontal dilution of precision is used as the evaluation parameter for these navigation systems. K.K.

A91-16729#

GEOSTATIONARY COMPLEMENT TO GPS - PROBLEM ANALYSIS AND MAIN RESULTS

D. FLAMENT (ONERA, Chatillon, France) and J. M. DURAND (CNES, Toulouse, France) (Institute of Navigation Satellite Division, International Technical Meeting, 3rd, Colorado Springs, CO, Sept. 19-21, 1990) ONERA, TP no. 1990-140, 1990, 8 p. refs

(ONERA, TP NO. 1990-140)

This paper discusses problems that still stand in the way of the GPS becoming a sole air navigation system for most

aeronautical flight phases and introduces an approach for correcting these problems by using an autonomous external system using one or several geostationary satellites. According to this proposal, each of these satellites would broadcast an indication of the health of the GPS constellation in order to ensure a better integrity of the system. The satellites, having the same function as a classical GPS satellite, would also improve the GPS availability. Problems involved by the use of geostationary satellites as GPS are analyzed. I.S.

A91-16911#

A KALMAN FILTER CONCEPT FOR AN AUGMENTED LOW-COST INERTIAL NAVIGATION SYSTEM BASED ON FIBER OPTIC GYROS

O. GLASER and F. KRUMM (Standard Elektrik Lorenz AG, Stuttgart, Federal Republic of Germany) IN: Symposium Gyro Technology 1989; Stuttgart, Federal Republic of Germany, Sept. 19, 20, 1989, Proceedings. Stuttgart/Duesseldorf, Universitaet Stuttgart/Deutsche Gesellschaft fuer Ortung und Navigation, 1989, p. 12.0-12.29. refs

An account is given of the characteristics required by a Kalman filter for application in an augmented inertial navigation system's fiber-optic gyro. The Kalman filter operates in conjunction with GPS data and yields optimal navigation solutions; both one- and two-filter system configurations and performance characteristics are discussed. The two-filter configuration is noted not to suffer from critical redundancy problems. Even in the case of GPS outages due to lost satellites or jamming, full navigational capability is retained, although inertial measurement unit performance accuracy will be degraded. O.C.

N91-11721# Aerospatiale, Suresnes (France).

THE EVOLUTION OF REGIONAL AIR TRAFFIC

DANIELLE KAHAN In DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 111-115 1989 Avail: NTIS HC/MF A10

Analysis of the regional market growth including historical evolution and evolving legal framework is presented. The European market characteristics regarding stage length, block time, frequency and network are described. Analysis of the possible trends taking into account the influence of airport and airline policies and passenger standpoint is carried out. Analysis shows a great potential for the European regional market in particular and indicates a wide range of requirements to meet that demand. ESA

N91-11722# Airport Authority, Munich (Germany, F.R.).

REGIONAL AIR TRAFFIC INTO INTERNATIONAL AIRPORTS: THE DEVELOPMENT IN REGIONAL AIR TRAFFIC

P. TRAUTMANN and C. PARAU In DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 117-120 1989

Avail: NTIS HC/MF A10

The development of regional air traffic, defined as the sector of aviation which increases the density of the domestic and international scheduled air traffic network with the aim of developing the area covered by the network, is described. It normally employs modern turboprop aircraft, but the jump to the jet age is already planned. It differs greatly between countries. Its main hope of survival lies in the exploitation of gaps in the market and a careful tactical approach when dealing with the large passenger airline companies. ESA

N91-11723# Eurocontrol Agency, Brussels (Belgium).

AIR TRAFFIC CONTROL ASPECTS FOR THE TIME BEYOND 1992

HANSJUERGEN VONVILLIEZ In DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 121-125 1989

Avail: NTIS HC/MF A10

Problem areas and potential solutions concerning human resources, airspace structure and complexity, air traffic control and system support are analyzed. Common Medium Term Plan of

the Eurocontrol organization is recalled. Its communal goal of harmonization of development and integration of air traffic control are emphasized. ESA

N91-11740# Technische Univ., Brunswick (Germany, F.R.). Inst. fuer Verkehr, Eisenbahnwesen und Verkehrssicherung.

UTILIZATION OF A TESTING UNIT FOR THE EXAMINATION OF SSR MODE S, FOLLOWING A TCAS PRESENTATION [EINSATZ EINER MESSANLAGE ZUR UNTERSUCHUNG VON SSR MODE S ANLAESSLICH EINER TCAS PRAESENTATION]

WOLFGANG DETLEFSEN and ROLAND MALLWITZ Apr. 1990 44 p In GERMAN (ETN-90-97891) Avail: NTIS HC/MF A03

The number of moves in air space is continually increasing. Therefore, conventional concepts of flight safety and the existing air space structures have reached their limits. New forms of guidance and supervision of the air traffic are required, such as Secondary Surveillance Radar (SSR) and the Threat Alert and Collision Avoidance Systems (TCAS). Methods are developed which, on the one hand, describe the behavior simulated board and ground appliances in real traffic sequence, and, on the other hand, allow to simulate and analyze basic functions of the system, onboard and on ground in real environment. ESA

N91-11741# Technische Univ., Brunswick (Germany, F.R.). Inst. fuer Verkehr, Eisenbahnwesen und Verkehrssicherung.

REPORT ON THE STATE OF STANDARDIZATION OF MODE S, AND MODE S APPLICATIONS [BERICHT ZUM STAND DER STANDARDISIERUNG VON MODE S UND MODE S ANWENDUNGEN]

KLAUS-PETER BERG May 1990 122 p In GERMAN (ETN-90-97892) Avail: NTIS HC/MF A06

The examinations presented are based on the analysis of recorded real traffic sequences. The exploitation of input data and the associated data preparation are illustrated. The traffic distribution is examined within the coverage of various sensors. Starting with the geographical and temporary distribution, the obstacle loads inside the radar stream are determined, so that first conclusions on the charge of future mode S sensor can be deduced. These real in-beam distributions are extracted as input data, in order to assess various processes of the roll call scheduling. After examination of basic processes an optimal algorithm is developed. The processes are evaluated and tested, using synthetic and real traffic sequences. A simulation is presented to determine the time budget required for surveillance transactions. The fixing of mode S data links in the ATN (Aeronautical Telecommunication Network) is represented. It allows the general concept to be drafted. Mode S subnetwork, and a conversion in mode S internal data formats are discussed. The efficiency reduction resulting from the ATN concept is examined. The mode S specific communication formats are stated in order to discuss the requirements for mode S duties. ESA

N91-11742# European Space Agency, Paris (France).

TESTING OF A GPS RECEIVER

KARLHEINZ HURRASS (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany, F.R.) Aug. 1990 42 p Transl. into ENGLISH of Erprobung eines GPS-Empfangers (Brunswick, Fed. Republic of Germany, DFVLR), Oct. 1988 43 p Original language document was announced as N89-25145 (ESA-TT-1146; DFVLR-MITT-88-30; ETN-90-98005) Avail: NTIS HC/MF A03

The results of the tests performed on the Global Positioning System (GPS) since the seventies are reported. In 1986, 7 satellites were available for research purposes. The accuracy of the GPS was tested. A Litton LTN-700 receiver suitable for the C/A code was used. The reference flight paths were determined by the avionics flight evaluation system. The position errors measured consisted of high frequency and low frequency noise. The standard deviation of the latter was about 30 meters. ESA

N91-11743# Federal Aviation Administration, Washington, DC. Office of Aviation Policy and Plans.

TERMINAL AREA FORECASTS: FY 1990-2005

Jul. 1990 526 p (AD-A252227; FAA-APO-90-6) Avail: NTIS HC/MF A23 CSCI 01/5

Forecasts are presented of aviation activity of 854 airports in the U.S. for fiscal years 1990 to 2005. These include 398 airports with FAA air traffic control towers and radar approach control service and 17 FAA contract towers. For each airport, detailed forecasts are made for the four major uses of the air traffic system: air carriers, air taxi/commuters general aviation, and military. Summary tables contain national, FAA regional, and State aviation data and other airport specific highlights. The forecasts were prepared to meet the budget and planning needs of the FAA and to provide airport-specific information that can be used by State and local aviation authorities, the aviation industry, and the general public. GRA

N91-12567# Wichita State Univ., KS. Inst. for Aviation Research.

THE ENHANCEMENT OF AIR TRAFFIC CONTROL SAFETY THROUGH PRE-HIRE UNIVERSITY BASED TRAINING PROGRAMS

BRENT D. BOWEN In AIAA, Proceedings of the 1990 AIAA/FAA Joint Symposium on General Aviation Systems p 82-107 May 1990

Avail: NTIS HC/MF A17

A potential means to enhance air traffic control safety through increased human performance capabilities of the nation's Air Traffic Controller Work Force is proposed. Research data was gathered from colleges and universities participating in the Federal Aviation Administration's (FAA) Airway Science Program. The Federal Aviation Administration initiated the Airway Science Program in 1983 to facilitate the development of collegiate education programs as a means of meeting future FAA manpower needs, primarily in the area of air traffic control. The FAA realized that it must update the skill level of its work force to adapt to an increasingly technical and automated environment. This is a major undertaking in that the upgrading of this work force will require the attrition of over 45,000 individuals. Currently, 32 institutions of higher education participate in the Airway Science Program. These institutions represent many established colleges and universities which offer aviation educational programs developed by the FAA. Research data gathered through this study should allow the Federal Aviation Administration to better understand the potential of the Airway Science Program to enhance air traffic safety. This program allows the availability of a means of pre-hire training through a baccalaureate degree program which stresses technical and managerial capabilities. This will provide an air traffic control work force with the increased human performance capabilities which are required to staff the increasingly difficult systems of our rapidly developing National Airspace System. Author

N91-12577# Federal Aviation Administration, Atlantic City, NJ. **GENERAL AVIATION AND TCAS**

CARL B. JEZIERSKI In AIAA, Proceedings of the 1990 AIAA/FAA Joint Symposium on General Aviation Systems p 358-363 May 1990

Avail: NTIS HC/MF A17

The amended Traffic Alert and Collision Avoidance System (TCAS) rule was published in the Federal Register on April 9, 1990. It requires TCAS-II equipage of all civil aircraft with more than 30 passenger seats operating in the United States by December 30, 1993. The same rule also requires turbine powered aircraft with 10 to 30 seats to be equipped with TCAS-I by February 9, 1995. Described here is the technical operation of the different types of TCAS and how General Aviation participates in the TCAS environment. Development efforts of a low cost airborne collision avoidance system are also addressed. Author

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

N91-12648# Mitre Corp., Bedford, MA.
**EXAMINATION OF RTCA/DO-198 POSITION
RECONSTRUCTION ALGORITHMS FOR AREA NAVIGATION
WITH THE MICROWAVE LANDING SYSTEM Final Report**
JOHN W. HALL, PATRICIA M. HATZIS, and FREDERIC D.
POWELL Jun. 1990 57 p
(Contract F19628-89-C-0001; AF PROJ. 5420)
(AD-A224804; MTR-10766; ESD-TR-90-308) Avail: NTIS HC/MF
A04 CSCL 17/7

Use of the Microwave Landing System (MLS) for area navigation and computed centerline approach requires that the MLS avionics determine the aircraft position in Cartesian coordinates relative to the runway centerline. The inputs to the avionics are the locations of the three MLS ground units and the three observations of distance, azimuth angle, and elevation angle. When the three ground units are not collocated, this process requires an iterative algorithm. A March 1988 publication of the Radio Technical Commission for Aeronautics (RTCA) presents five such algorithms. These algorithms have various problems, such as errors in the analyses and/or computer code, and divergence or false solutions, etc., within the minimum coverage area of the MLS. This report, which identifies the various problems and offers corrections, concentrates on the two algorithms that assume a conical MLS azimuth antenna, as that is likely to be the only type that will be developed. GRA

N91-12653# Mitre Corp., Bedford, MA.
**A GAUSSIAN ALGORITHM USING COORDINATE ROTATION
FOR AREA NAVIGATION OPERATIONS WITH THE
MICROWAVE LANDING SYSTEM Final Report**
JOHN W. HALL, PATRICIA M. HATZIS, and FREDERIC D.
POWELL Jun. 1990 51 p
(Contract F19628-89-C-0001; AF PROJ. 5420)
(AD-A225642; MTR-10765; ESD-TR-90-315) Avail: NTIS HC/MF
A04 CSCL 17/7

The Microwave Landing System (MLS) avionics convert the received signals of range, azimuth angle, and elevation angle to yield aircraft position in Cartesian coordinates. This enables area navigation and computed centerline approaches, including multi-leg and curved approaches. When the three MLS ground units are not collocated, this requires iteration. The speed of convergence and the size of the algorithm and its computational burden affect the MLS avionics storage and timing requirements. Gaussian algorithms tend to be relatively compact but diverge at azimuth angles within the coverage of the MLS, while Newton-Raphson algorithms require more storage and impose a greater computational burden. This report presents a Gaussian algorithm which, by rotating the coordinate system, enables fast convergence everywhere within the MLS coverage, and with a computational burden significantly less than an equivalent Newton-Raphson algorithm. GRA

N91-12655# Federal Aviation Administration, Washington, DC.
Office of Management Systems.
FAA AIR TRAFFIC ACTIVITY: FISCAL YEAR 1989
1989 213 p
(AD-A226063) Avail: NTIS HC/MF A10 CSCL 17/7

This FAA publication furnishes terminal and en route air traffic activity information of the National Airspace system. The data have been reported by the FAA-operated airport traffic control towers (ATCT's), air route traffic control centers (ARTCC's), flight service stations (FSS's), approach control facilities, and FAA contract-operated towers. These reports are used as a guide in determining the need for larger or additional facilities, and possible increases in personnel at existing facilities. Tables in chapter one show aircraft handled under instrument flight rules (IFR) at ARTCC centers by aviation category, center, and region. Chapter two includes summaries of airport operations at FAA-operated towers by type of operation, aviation category, state, and region. Instrument operations at towers and radar approach control facilities (RAPCON's and RATCC's) are also included. Chapters three and four include summaries of instrument approaches at FAA ARTCC's and approach control facilities and secondary airports. Data for

FSS's and IFSS's appear in chapter five. This information includes total flight services, IFR-DVFR and VFR aircraft contacted, IFR DVFR and VFR flight plans originated, pilot briefs, and airport advisories by facility, state, and region. Chapter six includes airport and instrument operations at FAA contract-towers by type of operation aviation category, state, and region. Rank order tables are provided to give the user a picture of the busiest facilities in the system. Historical tables are included where possible to show changes in growth. Hub designations are based on the number of enplanements within the 50 U.S. states and other U.S. areas as reported in Airport Activity Statistics of Certified Route Carriers. GRA

N91-12658# Civil Aeromedical Inst., Oklahoma City, OK.
**CORRELATES OF TWO EXPERIMENTAL TESTS WITH
PERFORMANCE IN THE FAA ACADEMY AIR TRAFFIC
CONTROL NONRADAR SCREEN PROGRAM Final Report**
DAVID J. SCHROEDER, CAROLYN S. DOLLAR, and LENDELL
G. NYE Aug. 1990 13 p Sponsored by FAA, Washington,
DC
(AD-A226419; DOT/FAA/AM-90/8) Avail: NTIS HC/MF A03
CSCL 05/9

This study was designed to determine the relationships among experimental tests, the tests currently used to select entrants into the FAA's Air Traffic Control Specialist (ATCS) Academy Nonradar Screening Program, and Academy success. A battery of paper-and-pencil tests, including the Directional Headings Test (DHT) which was developed at the Civil Aeromedical Inst., and subsequently modified for this study, and the Dial Reading Test (DRT) was administered to 1,225 students who entered in 1987. Scores on the current selection measures, the Multiplex Controller Aptitude Test (MCAT) and Abstract Reasoning Test, were obtained from the Office of Personnel Management (OPM). The pass, fail, and withdrawal rates for the sample were compared to performance levels on the experimental and OPM tests. Several Academy performance criteria and test results were intercorrelated and stepwise multiple regression analyses were conducted to predict overall Academy success and final grades. Results demonstrated that the DHT and DRT could be used to assess the potential of entrants to successfully complete the Academy Screen. Even though the current ATCS applicant group differs from those entering the Academy a decade ago on several dimensions (e.g., education and experience), the multiple correlation of the DHT, and MCAT scores with Academy success remained relatively unchanged. Results suggest there are other test measures which, when combined with the MCAT, would be better predictors than the existing battery of selection tests. GRA

N91-12660# Technische Hochschule, Aachen (Germany, F.R.).
Fakultaet fuer Bauingenieur- und Vermessungswesen.
**THE CALCULATION OF THE ULTIMATE CAPACITY OF A ONE
RUNWAY MAIN SYSTEM. A NEW ARRANGEMENT ON THE
BASIS OF A RADAR DATA EVALUATION Ph.D. Thesis [DIE
BERECHNUNG DER GRENZKAPAZITAET EINES
'ONE-RUNWAY-MAIN SYSTEM': EIN NEUER ANSATZ AUF
DER BASIS EINER RADAR DATENAUSWERTUNG]**
RALF CHAUMET 1989 192 p In GERMAN; ENGLISH
summary
(ETN-90-98189) Avail: NTIS HC/MF A09

The basis for the arrivals-only model and for the determination of time deviations from model flight arrival characteristics, is the evaluation of radar data. This data, which reveal in synchronized form all simultaneous air traffic movements in the vicinity of the airport captured by radar, are turned into individual flight profiles and flight sequences. Using algorithms, the radar signals which display location altitude and time are determined, and through the use of compensating computations, the overflight time points and speeds are extracted. The results of the radar data analysis enter into the model for estimating the ultimate capacity. In order to help in the application of this model to other runway systems, the various factors that influence the ultimate capacity are given. ESA

N91-12701*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

FLIGHT TEST RESULTS OF FAILURE DETECTION AND ISOLATION ALGORITHMS FOR A REDUNDANT STRAPDOWN INERTIAL MEASUREMENT UNIT

F. R. MORRELL, P. R. MOTYKA, and M. L. BAILEY (PRC Kentron, Inc., Hampton, VA.) In AGARD, Fault Tolerant Design Concepts for Highly Integrated Flight Critical Guidance and Control Systems 13 p Apr. 1990

Copyright Avail: NTIS HC/MF A12; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive CSCL 17/7

Flight test results for two sensor fault-tolerant algorithms developed for a redundant strapdown inertial measurement unit are presented. The inertial measurement unit (IMU) consists of four two-degrees-of-freedom gyros and accelerometers mounted on the faces of a semi-octahedron. Fault tolerance is provided by edge vector test and generalized likelihood test algorithms, each of which can provide dual fail-operational capability for the IMU. To detect the wide range of failure magnitudes in inertial sensors, which provide flight crucial information for flight control and navigation, failure detection and isolation are developed in terms of a multi level structure. Threshold compensation techniques, developed to enhance the sensitivity of the failure detection process to navigation level failures, are presented. Four flight tests were conducted in a commercial transport-type environment to compare and determine the performance of the failure detection and isolation methods. Dual flight processors enabled concurrent tests for the algorithms. Failure signals such as hard-over, null, or bias shift, were added to the sensor outputs as simple or multiple failures during the flights. Both algorithms provided timely detection and isolation of flight control level failures. The generalized likelihood test algorithm provided more timely detection of low-level sensor failures, but it produced one false isolation. Both algorithms demonstrated the capability to provide dual fail-operational performance for the skewed array of inertial sensors. Author

N91-12704# Crouzet Aerospace and Systems, Valence (France).

A HIGH INTEGRITY FLIGHT DATA SYSTEM

J. L. ROCH and J. CONDET In AGARD, Fault Tolerant Design Concepts for Highly Integrated Flight Critical Guidance and Control Systems 10 p Apr. 1990 In FRENCH

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Solutions are described for the design of a modern flight data system to be used for piloting and navigation of helicopters. The critical flight system is used in the aircraft safety cable and responds to a certain number of specific limits. First, the problems which cause the limits are examined; next, the methods and technologies are described for reaching satisfaction. Transl. by E.R.

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A91-13351

SUPREME SOVIET

Flight International (ISSN 0015-3710), vol. 138, Oct. 10, 1990, p. 36-40.

Copyright

Some performance characteristics and structural details of the MiG-29 are presented with particular reference to maneuverability at high angles of attack. The Fulcrum was flown for the first time by a Western pilot; former Harrier chief test pilot John Farley. Control of engine and airframe at alpha of 90 degrees was demonstrated during a series of airshow maneuvers. Standard

operational performance with the use of the variable-position intake doors is compared with the Sea Harrier performance under similar flight geometry. Directional control and stability at high alpha are made possible by the positioning of the twin fins and rudders to take advantage of vortex flows. As alpha varies, sophisticated use is made of the electrical bias in each of the hydraulic control-surface actuators. R.E.P.

A91-13431

FASCINATING FACETS

CHRIS POCOCK Air International (ISSN 0306-5634), vol. 39, Sept. 1990, p. 164-174.

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The USAF F-117 has been designed primarily for low observability so that it could not be successfully intercepted by existing air defense systems. The prismatic external configuration is a primary factor in this design which employs exotic materials that absorb radar energy or suppress exhaust flame. Its development was made possible by advances in such areas as FBW flight control systems, radar absorbent materials and computer-aided design. Operational status of the aircraft was kept in total secrecy for several years and many extraordinary precautions were taken to ensure minimal sighting. Information on avionics and weaponry has not yet been released. The aircraft's mission is defined as the night attack of critical, high-leverage targets with pinpoint accuracy. R.E.P.

A91-13716

METHODS OF OPTIMIZATION OF AIRCRAFT STRUCTURES [METODY OPTIMIZATSII AVIATIONNYKH KONSTRUKTSII]

NIKOLAI V. BANICHUK, VIKTOR I. BIRIUK, ALEKSANDR P. SEIRANIAN, V. M. FROLOV, and I. U. F. IAREMCHUK Moscow, Izdatel'stvo Mashinostroenie, 1989, 296 p. In Russian. refs

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Methods that are currently used for optimizing the load-bearing structures of aircraft are reviewed, and structural optimization models are examined. In particular, attention is given to the statement of optimization problems, optimization criteria, parametric analysis of the structure weight, aeroelasticity models, and constraints on the static strength, fatigue, and longevity. The discussion also covers the engineering and physical principles of flutter, control reversal, and divergence; static problems of material distribution optimization in structural elements; optimization of the dynamic layout of aircraft; and optimal design problems with several constraints. V.L.

A91-13724

MASTERFULLY DIGITAL 11

HARRY HOPKINS Flight International (ISSN 0015-3710), vol. 138, Oct. 24, 1990, p. 24-29.

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The basic characteristics of the MD-11 are listed and shown in comparison to other current commercial transports. Cockpit avionics consists primarily of six side-by-side color displays whereby each pilot has primary flight and navigation displays while the two center screens are the engine and alert display and system display. Three monochrome malfunction control and display units are located on the center pedestal, with the two at the forward end normally used for flight management system control and the rearward for engineering functions and datalink. Some interesting aspects of in-flight automation control features are cited; the air system automatically reconfigures to provide engine air when the takeoff phase is ended at reduction of flap setting; climb thrust is then set automatically or to max continuous thrust in the case of an engine failure. Several other flight details are described and a cutaway diagram of the MD-11 is presented. R.E.P.

A91-14229

OPTIMIZATION DESIGN FOR SUPPRESSING 'GROUND RESONANCE' OF THE HELICOPTER

ZHONGQUAN GU (Nanjing Aeronautical Institute, People's Republic of China) Chinese Journal of Aeronautics (ISSN

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1000-9361), vol. 3, Aug. 1990, p. 178-186.

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Concepts of pole-region placement from control and optimization theory are presently applied to the problem of helicopter 'ground resonance' suppression; a method is developed for the optimal design of system stiffness and damping parameters to specified requirements. Optimization calculation results for the reduction of landing gear stiffness and for the enhancement of blade-damper stiffness are shown to effectively suppress the ground-resonance phenomenon. The method is generalizable to 'air-resonance' suppression in helicopters employing hingeless rotors. O.C.

A91-14242#

LATERAL OSCILLATIONS OF STING-MOUNTED MODELS AT HIGH ALPHA

L. E. ERICSSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 27, Sept.-Oct. 1990, p. 508-513. Previously cited in issue 09, p. 1290, Accession no. A89-25041. refs

Copyright

A91-15033#

A STUDY ON THE HELICOPTER ROTORBLADE COATING MICRO-WAVE ABSORBER

OSAMU HASHIMOTO, OSAMU MIZOKAMI, and MAMORU SEKIGUCHI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 38, no. 434, 1990, p. 156-159. In Japanese, with abstract in English. refs

In this paper, the reduction of radar cross section of helicopter rotorblade whose front edge is coated with thin microwave absorber is discussed, both theoretically and experimentally. As a result, it is found that measured absorption values are 4-13 dB at 15 GHz and measured values show good agreement with those calculated. These results are applicable to the design and manufacturing of a stealth rotorblade having the cylinder-type absorber. Author

A91-16029

AN ASSESSMENT OF KEY AEROTHERMAL ISSUES FOR THE STRUCTURAL DESIGN OF HIGH SPEED VEHICLES

ANTHONY MARTELLUCCI and THOMAS B. HARRIS (Science Applications International Corp., Fort Washington, PA) IN: Thermal Structures Conference, 1st, Charlottesville, VA, Nov. 13-15, 1990, Proceedings. Charlottesville, VA, University of Virginia Light Thermal Structures Center, 1990, p. 69-98. Research sponsored by the USAF and U.S. Army. refs

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The next generation of flight vehicles will fly at higher speeds in the atmosphere for extended time periods resulting in increased heating and aerothermal-structural loads. This necessitates the use of coupled aerothermal and structural design methods for detailed vehicle design. The vehicle's flight envelope will define the aerodynamic heating that will be experienced, which will determine the thermal protection material, structure, and cooling concepts that are necessary. Vehicle designers can no longer use the independent methodologies coupled in a linear superposition approach for design. This paper defines some of the aerothermal, aeroacoustic and thermal management tools that are available to design engineers. Author

A91-16037* Analytical Services and Materials, Inc., Hampton, VA.

PRELIMINARY THERMAL/STRUCTURAL ANALYSIS OF A CARBON-CARBON/REFRACTORY-METAL HEAT-PIPE-COOLED WING LEADING EDGE

DAVID E. GLASS (Analytical Services and Materials, Inc., Hampton, VA) and CHARLES J. CAMARDA (NASA, Langley Research Center, Hampton, VA) IN: Thermal Structures Conference, 1st, Charlottesville, VA, Nov. 13-15, 1990, Proceedings. Charlottesville, VA, University of Virginia Light Thermal Structures Center, 1990, p. 241-257. refs

Copyright

This study presents preliminary thermal/structural analyses of

a carbon-carbon/refractory-metal heat-pipe-cooled wing leading edge concept designed for an air breathing single-stage-to-orbit hypersonic vehicle. The concept features chordwise (i.e., normal to the leading edge) and spanwise (i.e., parallel to the leading edge) refractory-metal heat pipes which are completely embedded within a carbon-carbon primary structure. Studies of the leading edge were performed using nonlinear thermal and linear structural three-dimensional finite element analyses. The concept was shown to be thermally feasible within the limits of the assumptions made in the analyses when internal radiative cooling is present during ascent, and a three-dimensional carbon-carbon architecture is used. In addition, internal radiative cooling was found not to be necessary during descent. The linear stress analysis indicated excessively large thermal stresses in the refractory metal walls of the heat pipes even though a soft layer of carbon was included between the heat pipe and the carbon-carbon structure in an attempt to reduce the thermal stresses. A nonlinear structural analysis may be necessary to properly model the response of the refractory-metal heat pipes. Author

A91-16547

VALIDATION OF ROTOR VIBRATORY AIRLOADS AND APPLICATION TO HELICOPTER RESPONSE

JING G. YEN, MITHAT YUCE, CHEN-FU CHAO, and JOHN SCHILLINGS (Bell Helicopter Textron, Inc., Fort Worth, TX) American Helicopter Society, Journal (ISSN 0002-8711), vol. 35, Oct. 1990, p. 63-71. refs

Copyright

A 1/5 Mach-scaled model of the Bell Advanced Light Rotor (ALR) with pressure-instrumented blades was recently tested at the NASA Langley 14- by 22-ft subsonic wind tunnel. The ALR is a four-bladed bearingless rotor with advanced airfoils. Ninety-two pressure transducers were installed at five spanwise locations. Experimental vibratory airloads were obtained by integrating the individual pressures. In this paper, the airloads data are presented in time histories as well as harmonic amplitude and phase angles. The data are depicted as functions of advance ratio and rotor thrust coefficient. Comparisons are made between the experimental data and analytical values. The analytical values were calculated using three rotor wake/inflow models: Drees inflow, Scully free wake, and Johnson free wake. Johnson's wake model provided the best results. Computed blade loads, pitch-link loads, and hub loads using the Johnson free wake model are compared with those measured on three different bearingless model rotors in wind tunnels and one full-scale bearingless rotor in flight. Results indicate that rotor loads prediction can be improved with the COPTER/Johnson free wake methodology and that the same methodology offers hope for calculating N/rev hub loads. Author

A91-16575

THE CONTRA-ROTATING KAMOVs

JOHN W. R. TAYLOR Air International (ISSN 0306-5634), vol. 39, Nov. 1990, p. 257-267, 303, 304.

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An overview is presented of the various contrarotating rotor helicopter models developed by Kamov from 1948 to the present. After proving the viability of the contrarotating concept, the Ka-15 was produced and demonstrated a versatility that allowed its utilization in numerous military and civilian roles. Other innovative helicopter designs include the Ka-25 (the most important Kamov product for Soviet naval use), the Ka-25 K flying crane, and the Ka-27PS for duty aboard aircraft carriers for search and rescue. Finally, the proposed development of a Ka-226 which will be powered by two 420 shp Allison 250-C20 turboshaft engines imported from the USA is described. R.E.P.

A91-16607

V-22 FSD FLIGHT TEST STATUS REPORT

TOMMY H. THOMASON (Bell Helicopter Textron, Inc., Arlington, TX) Vertiflite (ISSN 0042-4455), vol. 36, Nov.-Dec. 1990, p. 28-31, 33.

Copyright

V-22 FSD design, support and flight testing, and flight test

plans are studied. There are six V-22 FSD aircraft: the first three designed for envelope expansion and configuration development, and the remainder intended for mission evaluation. Major supporting or qualification tests accomplished in whole or in part include a wind tunnel test, simulation, fuel system bench test, transmission bench test, component static and fatigue test, ballistic test, avionics systems integration, flight control system integration, airframe static test, and ground test article. Envelope expansion to a maximum altitude of 10,000 ft and 250 KCAS with maneuvers to approximately 2 Gs was accomplished in 1989. Minor problems identified in flight test to date include engine flameout after sudden movement of the engine condition level to idle to simulate the onset of a one-engine-inoperative flight condition, uncommanded lateral stick/pilot divergent oscillation at 250 knots, and cockpit vibration. L.K.S.

A91-16612

THRUST REVERSING FIGHTERS - A LOOK BACK

WILLIAM B. BLAKE (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) Vertiflite (ISSN 0042-4455), vol. 36, Nov.-Dec. 1990, p. 61-65. Copyright

U.S. fighters thrust reverser research is reviewed from the mid-1950s to the present. The use of reverse thrust will aid in the maneuvering through rapid deceleration and precision flight path control at low speeds. Thrust reversers, however, also incur both weight and cost penalties and possible hot gas ingestion, surface heating, structural, and stability and control problems. Early efforts at such a system began with the RF-84F, the first U.S. fighter to fly with a thrust reverser. The development and testing of the Rohr Tiger F-11A is reviewed, noting that, since the F-11A program, only limited wind tunnel testing of reversers has occurred for single engine fighters (F-16 and F-20). Recent research has concentrated on twin engine installations, such as the F-15 and the F-18, and has been facilitated by the advent of nonaxisymmetric or two-dimensional, rectangular nozzles. The F-15 S/MTD program, designed to incorporate two-dimensional vectoring/reversing nozzles into an existing high performance fighter is described. L.K.S.

A91-16677#

THE COMPOSITION OF FLIGHT SIMULATION MODELS - FLIGHT TESTING VERSUS DATCOM TECHNIQUES

M. BAARSPUL and J. A. MULDER (Delft, Technische Universiteit, Netherlands) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 1-10. refs (AIAA PAPER 90-3120) Copyright

Flight test results are compared to DATCOM techniques in composing a flight simulation model. Based on this comparison, it is shown that quite acceptable a priori models can be composed using inexpensive DATCOM techniques. Thus a very cost-effective alternative to flight testing is to use DATCOM techniques for aerodynamic model building. This method may be a good approach with the important additional advantage that during the flight test program a proof of match database may be generated which is crucial in FAA Phase II/III simulator certification. R.E.P.

A91-16678*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

HOT-BENCH SIMULATION OF THE ACTIVE FLEXIBLE WING WIND-TUNNEL MODEL

CAREY S. BUTTRILL and JACOB A. HOUCK (NASA, Langley Research Center, Hampton, VA) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 11-21. refs (AIAA PAPER 90-3121) Copyright

Two simulations, one batch and one real-time, of an aeroelastically-scaled wind-tunnel model were developed. The wind-tunnel model was a full-span, free-to-roll model of an advanced fighter concept. The batch simulation was used to

generate and verify the real-time simulation and to test candidate control laws prior to implementation. The real-time simulation supported hot-bench testing of a digital controller, which was developed to actively control the elastic deformation of the wind tunnel model. Time scaling was required for hot-bench testing. The wind-tunnel model, the math models for the simulations, the techniques employed to reduce the hot-bench time-scale factor, and the verification procedures are described. Author

A91-16686*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

THE AERODYNAMIC EFFECT OF HEAVY RAIN ON AIRPLANE PERFORMANCE

DAN D. VICROY (NASA, Langley Research Center, Hampton, VA) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 78-85. refs (AIAA PAPER 90-3131) Copyright

The National Aeronautics and Space Administration has been conducting a series of tests to determine the effect of heavy rain on airfoil aerodynamics. The results of these tests have shown that heavy rain can significantly increase drag as well as decrease lift and stall angle of attack. This paper describes a recent effort to use the heavy rain airfoil data to determine the aerodynamic effect on a conventional twin-jet transport. The paper reports on the method used to model the heavy rain aerodynamic effect and the resulting performance degradation. The heavy rain performance effect is presented in terms of the diminished climb performance associated with increasing rain rates. The effect of heavy rain on the airplane's ability to escape a performance-limiting wind shear is illustrated through a numerical simulation of a wet microburst encounter. The results of this paper accentuate the need for further testing to determine scaling relationships and flow mechanics, and the full configuration three-dimensional effects of heavy rain. Author

A91-16705#

SOME METHODS FOR REDUCING TIME DELAYS IN FLIGHT SIMULATION

R. M. HOWE (Michigan, University; Applied Dynamics International, Ann Arbor) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 225-232. refs (AIAA PAPER 90-3154) Copyright

Some methods for latency compensation that take advantage of the inherent lags in the dynamics of the airframe are examined in this paper. In particular, it is shown how rearranging the order of computation within each integration frame so that the calculations requiring the real-time inputs are left to last can lead to sizeable reductions in latency. This reduction in latency can be further improved by using a local linearization of the acceleration with respect to the inputs, where the required acceleration gradient is a byproduct of the acceleration function-generation mechanization. The dynamic performance of the simulation can also be improved through multi-rate input sampling, where the average of the samples over each frame is used in computing the acceleration associated with the frame. It is also shown how multi-rate input sampling and associated techniques can be combined to produce an accurate multi-rate output with almost no penalty in processing time. This in turn leads to much smoother and more accurate DAC outputs in an airframe simulation. Author

A91-16713*# MasPar Computer Corp., Santa Clara, CA.

IMPLEMENTATION OF A BLADE ELEMENT UH-60 HELICOPTER SIMULATION ON A PARALLEL COMPUTER ARCHITECTURE IN-REAL-TIME

BRUCE C. MOXON (MasPar Computer Corp., Sunnyvale, CA) and JOHN A. GREEN (Advanced Rotorcraft Technology, Inc., Mountain View, CA) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers.

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Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 293-303. Research supported by BBN Advanced Computers, Inc.
(Contract NAS2-11960)
(AIAA PAPER 90-3164) Copyright

A high-performance platform for development of real-time helicopter flight simulations based on a simulation development and analysis platform combining a parallel simulation development and analysis environment with a scalable multiprocessor computer system is described. Simulation functional decomposition is covered, including the sequencing and data dependency of simulation modules and simulation functional mapping to multiple processors. The multiprocessor-based implementation of a blade-element simulation of the UH-60 helicopter is presented, and a prototype developed for a TC2000 computer is generalized in order to arrive at a portable multiprocessor software architecture. It is pointed out that the proposed approach coupled with a pilot's station creates a setting in which simulation engineers, computer scientists, and pilots can work together in the design and evaluation of advanced real-time helicopter simulations. V.T.

A91-16717# COCKPIT AUTOMATION DESIGN ISSUES AND RECOMMENDATION

CRAIG M. ARNDT (USAF, Armstrong Aerospace Medical Research Laboratory, Wright-Patterson AFB, OH) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 320-325. refs
(AIAA PAPER 90-3170)

This paper investigates the consequences of implementing cockpit automation into new and existing cockpit designs and the operational considerations. Three phases of automation implementation are defined, as a function of how tasks are delegated and during what phase of the design and operation of the aircraft the delegation takes place. These phases are (1) during the design phase, (2) during the configuration phase, and (3) during the operational phase of the aircraft subsystem definition. The paper also describes a systems approach to automation implementation as a function of design application: (1) total integrated cockpits, (2) partly integrated cockpits, and (3) insertion into already existing cockpits (retrofit efforts). Author

A91-16744# DIRECT FLUID-STRUCTURE COUPLING IN TRANSONIC FLUTTER [COUPLAGE DIRECT FLUIDE STRUCTURE EN AEROELASTICITE TRANSSONIQUE]

J. P. GRISVAL and J. L. MEURZEC (ONERA, Chatillon-sous-Bagneux, France) (Colloque d'Aerodynamique Appliquee, 27th, Marseille, France, Oct. 15-17, 1990) ONERA, TP no. 1990-165, 1990, 14 p. In French. refs
(ONERA, TP NO. 1990-165)

A method of calculating transsonic flutter by direct linkage is proposed. This method takes into account steady state deformation and solves the coupled fluid-structure system directly with respect to unsteady time periods. It is shown that this calculation method permits direct access to the parameters for estimating a flutter stability pattern. R.E.P.

N91-11714# Aerospatiale, Toulouse (France). Aircraft Div.
**ATR 72: THE FIRST CIVIL AIRCRAFT WITH A CARBON
FIBRE REINFORCED PLASTIC WING**
B. MEDDA IN DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 47-51 1989
Avail: NTIS HC/MF A10

The equipping of ATR 72 commuters with an outer wing in carbon fiber reinforced plastic is addressed. The structural design and two specific criteria for certification, impact resistance and lightning behavior of this composite wing box, are described. Comparative tests between composite structures and their metallic counterparts showed a better behavior of the composite part under lightning and hail strikes. The experience gained makes it possible

for the production of a larger wing box for a 100 to 200 seater aircraft to be envisaged. ESA

N91-11726# Groupement d'Interest Economique, Cergy-Saint Christophe (France).

NEW TECHNOLOGIES AND CUSTOMER ACCEPTANCE

E. PAVARD IN DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 133-136 1989
Avail: NTIS HC/MF A10

The reasons pushing aircraft manufacturers towards new technologies and the acceptance of such technologies by regional airlines are considered. Some specifics of the commuter market with regard to this acceptance are described. Precise examples based on experience gained during the design phase and marketing of the ATR 42 and ATR 72, which are recognized new technology commuterliners, are given. These examples include the Electronic Flight Instrument System cockpit, composite materials on primary and secondary structures, and carbon brakes. These examples show that, as a general rule, novel techniques are well accepted provided that the real benefits can be properly substantiated by the manufacturer. ESA

N91-11728# Messerschmitt-Boelkow-Blöhm G.m.b.H., Hamburg (Germany, F.R.). Fatigue and Fracture Mechanics Dept.

FULL SCALE FATIGUE AND DAMAGE TOLERANCE TESTING OF MODERN TRANSPORT AIRCRAFT

H.-J. SCHMIDT and B. BRANDECKER IN DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 147-155 1989
Avail: NTIS HC/MF A10

The essential aspects of major full scale fatigue and damage tolerance tests for metallic structure are described using the Airbus A320 example. Details about test philosophy, test load program, test execution and supporting coupon testing are given, which comprises more than 15 years experience of fatigue and damage tolerance testing for metallic structure of aircraft and the results of numerous discussions with European and other airworthiness authorities. Specific aspects of regional aircraft full scale testing are discussed with respect to definition of test specimen, test speed, simplification of test spectrum and justification of repairs. ESA

N91-11746 Georgia Inst. of Tech., Atlanta. A METHOD OF COMPUTING THE AERODYNAMIC INTERACTIONS OF A ROTOR-FUSELAGE CONFIGURATION IN FORWARD FLIGHT Ph.D. Thesis

JOHN DONALDSON BERRY 1990 184 p
Avail: Univ. Microfilms Order No. DA9031257

A method is derived for determining the combined aerodynamic effects of a lifting rotor system in the presence of a non-lifting fuselage. The method allows for the full aerodynamic interaction of the lifting rotor blades, the non-lifting body, and the wake sheets trailing from the rotor blades. The wake sheets are allowed to convect with the local induced velocities, creating a distorted wake geometry. The method models the fluid viscous effects by confining these effects to regions adjacent to the bodies and to the wake sheet. The flow outside these regions is modelled as an incompressible potential. A vortex lattice system consisting of discrete vortex filaments is used to represent the lifting rotor system and rotor wake. The non-lifting fuselage is modelled with constant strength source panels. The method develops the trailing wake system by time marching from an initial impulsive start. Azimuthal dependent velocities and pressures are predicted. The predictions are compared with other analysis and experimental data. Dissert. Abstr.

N91-11747# Technische Univ., Berlin (Germany, F.R.). Sonderforschungsbereich 203.

A MODULUS FOR FLIGHT SIMULATION IN A COMPUTER AIDED PROJECT OF COMMERCIAL AIRPLANES [EIN MODULE ZUR FLUGSIMULATION IM RECHNERUNTERSTUETZTEN ENTWURF VON

VERKEHRESFLUGZEUGEN]

P. MATSIRIDIS Feb. 1990 84 p In GERMAN
(ILR-MITT-235(1990); ETN-90-97908) Avail: NTIS HC/MF A05

A high capacity Computer Aided Design (CAD) system for an aircraft preliminary design was developed. During the research work, it appeared necessary to increase the analysis accuracy of the concept project through a simulation modulus. The modulus for flight simulation is presented. The motivation for its acceptance in the system is explained. The motion equations are determined and the moments and forces working on the aircraft are calculated. The problematics of the critical values of the system variables is explained, using the flight mechanical model built in this connection. The results of the representative simulation tasks are indicated.

ESA

N91-11748# Naval Postgraduate School, Monterey, CA.

APPLICATION OF H INFINITY METHOD TO MODERN FIGHTER CONFIGURATION M.S. Thesis

TA-CHIEH HSU Dec. 1989 88 p
(AD-A225400) Avail: NTIS HC/MF A05 CSCL 01/1

H-Infinity optimal control theory, based on singular value loop shaping, is used to synthesize a controller for the statically unstable longitudinal dynamics of X-29 aircraft. Two design cases are studied: 2-input 2-output; and 3-input 3-output cases. H-Infinity theory provides a direct, effective procedure for synthesizing control laws satisfying specified performance objectives and robustness specifications. The 2 I/O case has better performance, a better response and is more robust, than 3 I/O case.

GRA

N91-11749# Messerschmitt-Boelkow-Blom G.m.b.H., Munich (Germany, F.R.).

EFA DEVELOPMENT: KEY TECHNOLOGY AND DESIGN FEATURES Status Report

PETER WEGER 1990 33 p Presented at 22nd European Symposium, Arles, France, 30 May - 1 Jun. 1990
(MBB/FE44/S/PUB/0402; ETN-90-98149) Avail: NTIS HC/MF A03

The development status of EFA (European Fighter Aircraft) aerodynamics, structure and engine is discussed. The delta-canard design, moving foreplane, flight control system, sealed slats, two shock chin intake with varicowl and flight control characteristics are described. The weight of the aircraft is investigated. Excess thrust is addressed. The EFA airplane will be powered by two turbofan engines. New technological features are outlined. The development schedule, flight test principles and trials philosophy are described.

ESA

N91-11768# Technische Univ., Delft (Netherlands).

OPTIMAL INPUTS FOR AIRCRAFT PARAMETER ESTIMATION

J. A. MULDER In *its* Essays on Stability and Control 36 p
Oct. 1989

Avail: NTIS HC/MF A12

The accuracy of aircraft stability and control derivatives as estimated from dynamic response measurements depends on the form of the time histories of the control inputs. After selecting a suitable criterion and imposing constraints on either the aircraft's state or the control inputs it is possible to optimize the form of these time histories. A method for control input optimization is proposed which avoids some disadvantages of earlier methods and was successfully applied in the design of longitudinal and lateral flight test maneuvers.

ESA

N91-12574# Honeywell, Inc., Glendale, AZ. Commercial Flight Systems Group.

GULFSTREAM 4 FLIGHT MANAGEMENT SYSTEM

STEVEN C. RUNO In AIAA, Proceedings of the 1990 AIAA/FAA Joint Symposium on General Aviation Systems p 312-329 May 1990

Avail: NTIS HC/MF A17

In February 1990, the Gulfstream IV (G-IV) received Federal Aviation Administration (FAA) certification of the most advanced flight management system (FMS) available on business aircraft. This certification completed the Honeywell SPZ-8000 Digital

Automatic Flight Control System (DAFCS) that is standard on all G-IVs. Vertical guidance, aircraft performance management, and an autothrottle are the primary additions to the previous capabilities of the SPZ-8000.

Author

N91-12575# Beech Aircraft Corp., Wichita, KS.

DESIGN AND CERTIFICATION OF AIRCRAFT FOR THE HERF ENVIRONMENT

JACK GLECIER and JOSEPH P. CROSS In AIAA, Proceedings of the 1990 AIAA/FAA Joint Symposium on General Aviation Systems p 330-347 May 1990

Avail: NTIS HC/MF A17

Certification authorities world-wide are in the process of amending regulations to add new standards which will provide requirements for the protection of aircraft flight critical functions from the effects of high energy radiated electromagnetic fields (HERF). In late 1989, the Federal Aviation Administration (FAA) imposed requirements on the Beech Model 2000 Starship airplane requiring qualification of the installed equipment for operation in HERF conditions. Field levels imposed for aircraft certification to the HERF threat require hardening aircraft electronic systems to a level two orders of magnitude above today's typical equipment qualification levels. Two large design challenges are thereby imposed: (1) hardening equipment requires extraordinary measures to insure performance; and (2) conventional test methods and test equipment used for qualification are not capable of adequately assessing performance at the high field levels. HERF design considerations and solutions relative to the above subjects and the experience gained by Beech Aircraft during the Starship and subsequent development programs in evaluating flight critical system performance of aircraft certification in the HERF environment are discussed.

Author

N91-12661# Ohio State Univ., Columbus. Dept. of Aeronautical and Astronautical Engineering.

HYPERSONIC AIRCRAFT DESIGN Final Report

HANI ALKAMHAWI, TOM GREINER, GERRY FUERST, SHAWN LUICH, BOB STONEBRAKER, and TODD WRAY May 1990
174 p Prepared in cooperation with Universities Space Research Association, Houston, TX Sponsored by NASA
(Contract RF PROJ. 767919/722941)

(NASA-CR-187008; NAS 1.26:187008) Avail: NTIS HC/MF A08
CSCL 01/3

A hypersonic aircraft is designed which uses scramjets to accelerate from Mach 6 to Mach 10 and sustain that speed for two minutes. Different propulsion systems were considered and it was decided that the aircraft would use one full scale turbofan-ramjet. Two solid rocket boosters were added to save fuel and help the aircraft pass through the transonic region. After considering aerodynamics, aircraft design, stability and control, cooling systems, mission profile, and landing systems, a conventional aircraft configuration was chosen over that of a waverider. The conventional design was chosen due to its landing characteristics and the relative expense compared to the waverider. Fuel requirements and the integration of the engine systems and their inlets are also taken into consideration in the final design. A hypersonic aircraft was designed which uses scramjets to accelerate from Mach 6 to Mach 10 and sustain that speed for two minutes. Different propulsion systems were considered and a full scale turbofan-ramjet was chosen. Two solid rocket boosters were added to save fuel and help the aircraft pass through the transonic region. After the aerodynamics, aircraft design, stability and control, cooling systems, mission profile, landing systems, and their physical interactions were considered, a conventional aircraft configuration was chosen over that of a waverider. The conventional design was chosen due to its landing characteristics and the relative expense compared to the waverider. Fuel requirements and the integration of the engine systems and their inlets were also considered in the designing process.

Author

N91-12662# Ohio State Univ., Columbus. Dept. of Aeronautical and Astronautical Engineering.

STB-WHITE Final Report

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

DAN MOLNAR, ROB AMMON, TODD GALLAGHER, PAT GOUHIN, STEVE HERMANN, JOHN BRYAN ROOS, CRAIG SAURER, and HEATHER WHITE May 1990 167 p Prepared in cooperation with Universities Space Research Association, Houston, TX Sponsored by NASA (NASA-CR-187012; NAS 1.26:187012) Avail: NTIS HC/MF A08 CSCL 01/3

The final design of a hypersonic, SCRAMjet research aircraft, which is to be dropped from a carrier plane, is considered. Topics such as propulsion systems, aerodynamics, component weight analysis, and aircraft design with waverider analyses are stressed with smaller emphasis placed on aircraft systems such as cockpit design and landing gear configurations. Propulsion systems include analysis of the turbofanramjet for acceleration to low hypersonic speed (Mach 6.0) and analysis of the SCRAMjets themselves to carry the aircraft to Mach 10.0. Both analyses include the use of liquid hydrogen as fuel. Inlet design for both propulsion systems is analyzed as well. Aerodynamic properties are found using empirical and theoretical formulas for lift and drag on delta-wing aircraft. The aircraft design involves the integration of all preliminary studies into a modified waverider configuration. Author

N91-12663 ESDU International Ltd., London (England). **PITCHING MOMENT AND LIFT FORCE DERIVATIVES DUE TO RATE OF PITCH FOR AIRCRAFT AT SUBSONIC SPEEDS**

Abstract Only

Jul. 1990 45 p

(ESDU-90010; ISBN-0-85679-736-7; ISSN-0141-397X) Avail: ESDU

ESDU 90010 provides a method that applies to a rigid aircraft at low angles of attack and relies on summing the separate contributions of the body, wing, and tailplane with an allowance for the interference effect of the body on the wing. The body contribution to the pitching moment derivative is calculated from a semi-empirical equation in which the body lift-curve slope from slender body theory is modified for body fineness ratio, afterbody geometry, and its cross-section shape. The body contribution to the lift derivative is negligible. For the wing contribution to both derivatives, strip theory is also modified empirically for straight-tapered wings while for delta and cropped-delta wings it is found that data derived from Multhopp's lifting-line theory can be applied directly. Other wing planforms are converted to straight-tapered through the equivalent wing concept of ESDU 76003. The tailplane contribution is found most-closely to match the available data if it is treated as an isolated surface (with lift-curve slope derived from ESDU 70011). The body interference on the wing is accounted for by the use of the gross planform and a shift in aerodynamic center position for the body carry-over lift. The accuracy of the predictions is discussed, and sketches of experimental results plotted against predictions are given for the moment derivative, for body and wing alone and for wing-body combinations. Two worked examples, one for a typical transport configuration and one for a typical interceptor aircraft, illustrate the use of the methods. ESDU

N91-12664# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Dienstleistungsbereich.

MBB BO 108 HELICOPTER GROUND AND FLIGHT TEST EVALUATION

D. SCHIMKE, B. ENENKL, and E. ALLRAMSEDER Dec. 1989 21 p Presented at 15th European Rotorcraft Forum, Amsterdam, Netherlands, 12-15 Sep. 1989

(MBB-UD-0546-89-PUB; ETN-90-97854) Avail: NTIS HC/MF A03

The particular design features and an overview of the successful ground and flight testing of MBB (Messerschmitt-Boelkow-Blohm) the BO 108 light twin engine helicopter, designed for integrating new technologies into the next generation of helicopters are described. Technology innovations include the composite bearingless main rotor system, new aerodynamic blade design, tail rotor with elastomeric bearings, composite structures, anti-resonance vibration isolation system, electrical and avionic systems, new gearbox design, and engine

integration. These components were tested and evaluated separately and mounted in the prototype. The ground test evaluation contained aeroelastic stability on the whirl tower, shake tests of the fuselage, and ground resonance tests. The main items of the flight test were air resonance stability, loads, flight performance, handling qualities, and the flight envelope survey. Besides verifying the new technologies, the flight behavior of the new helicopter was rated as excellent by the pilots and flight test analysis confirmed the expected performances. ESA

N91-12665# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.

AN INVESTIGATION OF AIRCRAFT MANEUVERABILITY AND AGILITY Final Report, Jun. 1989 - May 1990 M.S. Thesis

FREDERICK W. STELLAR 17 May 1990 77 p

(AD-A224587) Avail: NTIS HC/MF A05 CSCL 01/3

Improved effectiveness of close air support (CAS) aircraft has increased counter-air developments and the possibility of air-to-air combat (ATAAC). Maneuverability and agility are desired attributes of CAS aircraft which must operate close to terrain or engage in air combat. The objective was to investigate maneuverability and agility of modern CAS aircraft. The investigation was accomplished by expanding the capabilities of HELCOM to incorporate fixed wing aircraft modeling. HELCOM is a series of computer programs which use energy/force balancing methods to determine maneuverability and agility parameters. Joint Air Attack Team (JAAT), integrating OH-58D, AH-64A, and A-10A aircraft, served as the CAS air force for investigating maneuverability and agility. HELCOM, as a tool for understanding maneuverability and agility, was improved to provide a good approximation for both rotary wing and fixed wing aircraft. Tilt-rotor aircraft concept was compared to current CAS aircraft and shown to incorporate design features desired in highly maneuverable and agile aircraft. GRA

N91-12666# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Information und Dokumentation.

ANALYTICAL METHODS FOR THE QUALIFICATION OF HELICOPTER STRUCTURES

FRITZ OCH Apr. 1990 16 p Presented at the 70th Agard Structures and Materials Panel Meeting and Workshop on Analytical Qualification of Aircraft Structures, Sorrento, Italy, 1-6 Apr. 1990 (MBB-UD-0569-90-PUB; ETN-90-97839) Copyright Avail: NTIS HC/MF A03

During the development of composite fuselage for the BK 117, both an analytical and an experimental strength substantiation was performed, which corresponded very well and formed the basis for airworthiness qualification of this experimental helicopter under flight testing now. A large number of components in the dynamic system are designed primarily so that they will provide adequate fatigue strength, defined in terms of an endurance limit, or in terms of fatigue life. The analytical qualification of these fatigue critical structures, on the basis of measured fatigue loadings and calculated working S-N curves, is state of the art in the helicopter industry. In the nonlinear domain, analytical methods were applied for highly limited elastomeric bearings and for the crashworthiness qualification of both crushable subcomponents and complete helicopters. The results gained allow the application of analytical methods, partly in combination with coupon or component testing, for the qualification of helicopter structures. ESA

N91-12667# Technion - Israel Inst. of Tech., Haifa. Jet Propulsion Lab.

NOVEL, POST-STALL, THRUST-VECTORED F-15 RPVS: LABORATORY AND FLIGHT TESTS Annual Report No. 1, 1

Apr. 1989 - 31 Mar. 1990

BENJAMIN GAL-OR 24 Apr. 1990 188 p

(Contract MIPR-FY1456-8905052; AF-AFOSR-0445-89)

(AD-A225717; TAE-160-0559) Avail: NTIS HC/MF A09 CSCL 01/3

Presenting the major problems confronting the development, tests, and validation of Post Stall (PST) Thrust Vectored Fighters (TVF), this project is based on the development of an integrated

laboratory flight testing methodology of PST-F-15-TVF/RPVs, including the tests of new types of yaw-pitch and roll-yaw pitch thrust vectoring nozzles and high alpha, PST inlets. GRA

N91-12668# Federal Aviation Administration, Long Beach, CA.

REPAIRS TO DAMAGE TOLERANT AIRCRAFT

T. SWIFT 22 Mar. 1990 25 p Presented at the International Symposium on Structural Integrity of Aging Airplanes, Atlanta, GA (AD-A225742) Avail: NTIS HC/MF A03 CSCL 01/3

Results of displacement compatibility analysis, representing a variety of repair doubler and lap splice configurations, are presented to illustrate how structural repairs can degrade the fatigue initiation life and damage tolerance capability of primary transport aircraft structures. Examples show that fatigue initiation life is directly related to the peak loads induced in the first fastener rows at the edges of repair doublers. Design of repairs to an equal or better static strength capability and the associated static strength analysis will not normally highlight these peak loads which can result in considerable degradation of structural fatigue life. Critical fastener loads, based on displacement compatibility analysis accounting for fastener flexibility, are parametrically presented for a variety of skin and doubler thicknesses. Suggestions are made on how repair designs can be modified to improve fatigue initiation life and subsequent fatigue crack detectability particularly in the event of multiple-site damage. The importance of riveting quality during repairs, often not up to initial manufacturing standards, is discussed with respect to fatigue initiation life. A simplified but conservative method to generate crack growth curves is discussed with a view to easing the analytical burden for the small modifiers. GRA

N91-12671# Oak Ridge National Lab., TN.

COMMERCIAL AIRCRAFT FUEL EFFICIENCY POTENTIAL THROUGH 2010

DAVID L. GREENE 1990 7 p Presented at the 25th Intersociety Energy Conversion Engineering Conference, Reno, NV, 12-17 Aug. 1990

(Contract DE-AC05-84OR-21400)

(DE91-000720; CONF-900801-34) Avail: NTIS HC/MF A02

Aircraft are second only to motor vehicles in the use of motor fuels, and air travel is growing twice as fast. Since 1970 air travel has more than tripled, but the growth of fuel use has been restrained by a near doubling of efficiency, from 26.2 seat miles per gallon (SMPG) in 1970 to about 49 SMPG in 1989. This paper explores the potential for future efficiency improvements via the replacement of existing aircraft with '1990's generation' and 'post 2000' aircraft incorporating advances in engine and airframe technology. Today, new commercial passenger aircraft deliver 50 to 70 SMPG. New aircraft types scheduled for delivery in the early 1990's are expected to achieve 65 to 80 SMPG. Industry and government researchers have identified technologies capable of boosting aircraft efficiencies to the 100 to 150 SMPG range. Under current industry plans, which do not include a post-2000 generation of new aircraft, the total aircraft fleet should reach the vicinity of 65 SMPG by 2010. A new generation of 100 to 150 SMPG aircraft introduced in 2005 could raise the fleet average efficiency to 75 to 80 SMPG in 2010. In any case, fuel use will likely continue to grow at from 1 to 2 percent per yr. through 2010. DOE

N91-12672# Naval Aerospace Medical Research Lab., Pensacola, FL.

SUSTAINED FLIGHT OPERATIONS IN NAVY P-3 AIRCRAFT Final Report

L. G. MEYER and C. A. DEJOHN Apr. 1990 27 p Sponsored by Naval Medical Research and Development Command, Bethesda, MD

(AD-A226412; NAMRL-1355) Avail: NTIS HC/MF A03 CSCL 06/10

Flight crew fatigue during sustained flight operations (SUSOPS) is an important aeromedical problem. We evaluated the effects of SUSOPS on aircrew stress and fatigue in three U.S. Navy P-3 Orion crews (n = 21) before, during, and after a 6-month overseas deployment. Pre- and postdeployment laboratory tests measured

aerobic capacity, pulmonary function, muscular strength and endurance, and resting blood chemistry. Postdeployment lung capacity, blood chemistry values, grip strength, and leg endurance all improved while leg strength, aerobic capacity, and percentage body fat decreased. During deployment, we collected inflight urine samples and subjective fatigue and positive/negative mood surveys hourly. Urinary sodium and potassium levels were significantly higher inflight compared to postdeployment control values. Urinary norepinephrine concentrations inflight were lower compared to controls. Subjective-fatigue scores decreased from preflight to postflight. Positive mood scores decreased while negative mood scores increased. Subjects showed varying levels of stress and fatigue, which did not appear to compromise performance and safety. The 15-h nonflying intervals between flights provided sufficient rest for the crews. GRA

N91-12673# Rockwell International Corp., Los Angeles, CA.

SUPERPLASTIC FORMED ALUMINUM-LITHIUM AIRCRAFT STRUCTURES Final Report, May 1988 - Jul. 1989

C. E. ANTON and G. R. MARTIN Jun. 1990 396 p

(Contract F33615-87-C-3223; AF PROJ. 2401)

(AD-A226516; N4-89-1361L; WRDC-TR-89-3015) Avail: NTIS HC/MF A17 CSCL 11/6

This final report contains the results of Phase 2 of this two phase program which is primarily concerned with technology demonstration. The report begins with the submission of three advanced superplastic formed (SPF) designs; a floor support beam, keelson shear panel and a forward fuselage bulkhead. A detailed Weight and Life Cycle cost (LCC) trade study was done on each of these. The LCC study showed a cost savings of \$14.8 million for the floor support beam, a \$5.01 million savings for the keelson shear panel and a \$7.8 million cost increase for the forward bulkhead (this was attributed to design complexity). The weight savings study showed a weight savings for the floor support beam and keelson shear panel (7.05 lbs and 2.57 lbs) and a weight penalty of 3.85 lbs for the forward bulkhead. The durability and damage tolerance analysis of the floor support beam resulted in a durability life of 63,650 cycles and a damage tolerant life of 34,000 cycles. Strength data results from the solution heat treatment optimization confirmed that longer solution heat treatment intervals did not increase the strength properties of the 8091 Al-Li material. GRA

N91-12674# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.

TWELFTH PLANTEMA MEMORIAL LECTURE ON ASSESSMENT OF SERVICE LOAD EXPERIENCE

J. B. DEJONGE 10 Mar. 1990 46 p Presented at 15th ICAF Symposium, Jerusalem, Israel, Jun. 1989

(NLR-TP-89097-U; ETN-90-98057) Avail: NTIS HC/MF A03

A review of the various types of loading acting on the aircraft structure and the ability to accurately predict their magnitude and frequency of occurrence for a given aircraft usage is presented. Attention is paid to the variation in load experience and its causes, with specific reference to the variation in aircraft usage. For transport type aircraft these variations are largely defined by the variation in flight length and payload. For combat type aircraft, the variability is considerably larger and consequently more difficult. For the assessment of actual service load spectra, operational flight load measurements and/or service usage monitoring are required. The rapid development of electronics during the last decades has opened the possibility for advanced processor based service fatigue load monitoring systems at relatively low price. For transport aircraft simple usage monitoring may already provide highly relevant information. For combat type aircraft, the determination of average mission type spectra from in flight multiparameter recordings, in combination with mission usage monitoring for individual airplane tracking appears to be an adequate solution. ESA

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

N91-12675# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.

RE-ASSESSING THE F-16 DAMAGE TOLERANCE AND DURABILITY LIFE OF THE RNLA F-16 AIRCRAFT

D. J. SPIEKHOUT 9 Jun. 1990 26 p Presented at 15th ICAF Symposium, Jerusalem, Israel, Jun. 1989 Previously announced in IAA as A90-49881

(NLR-TP-89184-U; ETN-90-98058) Avail: NTIS HC/MF A03

Usage and loading experience of the RNLA F-16 (Royal Netherlands Air Force) with their F-16 aircraft is completely different from the ones assumed in the design phase. Reassessment of the damage tolerance and durability performance was therefore carried out. A contribution to this is presented. It is concluded that it is of great importance for a relatively small airforce such as RNLA F-16 to follow such a damage tolerance and durability life reassessment very closely. The risks involved in making general assumptions in such an international program covering all sorts of usages is shown to be real. ESA

N91-12676# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Hubschrauber und Flugzeuge.

THIRTY YEARS OF STRUCTURAL DYNAMIC INVESTIGATIONS AT MBB-UF

OTTO SENSBURG 7 May 1990 46 p (MBB/FE2/S/PUB/0399; ETN-90-98155) Copyright Avail: NTIS HC/MF A03

The tests and developments which enabled the German aircraft industry to become competitive again with other leading nations are summarized. During the last 30 years a revolution in the development of airplanes and helicopters has taken place. The introduction of microelectronic flight control systems has given the possibility to control loads and vibrations actively. New composite materials allow us tailoring of the elasticity of surfaces in a way to fulfill the requirements of strength, deformation and flutter with minimum structural weight. On the other side there is no more redundant inherent structural stiffness found as on metal structures and there is a large possibility of aeroservoelastic instability due to fast responding hydraulic actuators. Therefore the prediction of unsteady airforces, the measurement of these forces on wind tunnel models and the updating of analytical models with measured data is even more important now than it was 30 years ago. ESA

N91-12689*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

THE INTEGRATED AIRFRAME/PROPULSION CONTROL SYSTEM ARCHITECTURE PROGRAM (IAPSA)

DANIEL L. PALUMBO, GERALD C. COHEN (Boeing Advanced Systems Co., Seattle, WA.), and CHARLES W. MEISSNER /n AGARD, Fault Tolerant Design Concepts for Highly Integrated Flight Critical Guidance and Control Systems 5 p Apr. 1990

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The Integrated Airframe/Propulsion Control System Architecture program (IAPSA) is a two-phase program which was initiated by NASA in the early 80s. The first phase, IAPSA 1, studied different architectural approaches to the problem of integrating engine control systems with airframe control systems in an advanced tactical fighter. One of the conclusions of IAPSA 1 was that the technology to construct a suitable system was available, yet the ability to create these complex computer architectures has outpaced the ability to analyze the resulting system's performance. With this in mind, the second phase of IAPSA approached the same problem with the added constraint that the system be designed for validation. The intent of the design for validation requirement is that validation requirements should be shown to be achievable early in the design process. IAPSA 2 has demonstrated that despite diligent efforts, integrated systems can retain characteristics which are difficult to model and, therefore, difficult to validate. Author

N91-13314*# Washington Univ., Seattle. Dept. of Aeronautics and Astronautics.

NATURAL LAMINAR FLOW APPLICATION TO TRANSPORT AIRCRAFT

LOUIS B. GRATZER /n Hampton Univ., NASA/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1990 p 50-51 Sep. 1990

Avail: NTIS HC/MF A07 CSDL 01/3

A major goal of NASA during the last 15 years has been the development of laminar flow technology for aircraft drag reduction. Of equal importance is achieving a state of readiness that will allow the successful application of this technology by industry to large, long-range aircraft. Recent progress in achieving extensive laminar flow with limited suction on the Boeing 757 has raised the prospects from practical application of the hybrid laminar flow control (HLFC) concept to subsonic aircraft. Also, better understanding of phenomena affecting laminar flow stability and response to disturbances has encouraged consideration of natural laminar flow (NLF), obtained without suction or active mechanical means, for application to transport aircraft larger than previously thought feasible. These ideas have inspired the current NASA/ASEE project with goals as follows: explore the feasibility of extensive NLF for aircraft at high Reynolds number under realistic flight conditions; determine the potential applications of NLF technology and the conditions under which they may be achieved; and identify existing aircraft that could be adapted to carry out flight experiments to validate NLF technology application. To achieve these objectives, understanding of the physical limits to natural laminar flow and possible ways to extend these limits was sought. The primary factors involved are unit Reynolds number, Mach number, wing sweep, thickness, and lift coefficients as well as surface pressure gradients and curvature. Based on previous and ongoing studies using laminar boundary layer stability theory, the interplay of the above factors and the corresponding transition limits were postulated. Author

N91-13333*# Military Academy, West Point, NY. Dept. of Aerospace Engineering.

CALCULATION OF ROTOR IMPEDANCE FOR USE IN DESIGN ANALYSIS OF HELICOPTER AIRFRAME VIBRATIONS

KIP P. NYGREN /n Hampton Univ., NASA/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1990 p 91-92 Sep. 1990

Avail: NTIS HC/MF A07 CSDL 01/3

Excessive vibration is one of the most prevalent technical obstacles encountered in the development of new rotorcraft. The inability to predict these vibrations is primarily due to deficiencies in analysis and simulation tools. The Langley Rotorcraft Structural Dynamics Program was instituted in 1984 to meet long term industry needs in the area of rotorcraft vibration prediction. As a part of the Langley program, this research endeavors to develop an efficient means of coupling the rotor to the airframe for preliminary design analysis of helicopter airframe vibrations. The main effort was to modify the existing computer program for modeling the dynamic and aerodynamic behavior of rotorcraft called DYSCO (DYnamic System COupler) to calculate the rotor impedance. DYSCO was recently developed for the U.S. Army and has proven to be adaptable for the inclusion of new solution methods. The solution procedure developed to use DYSCO for the calculation of rotor impedance is presented. Verification of the procedure by comparison with a known solution for a simple wind turbine model is about 75 percent completed, and initial results are encouraging. After the wind turbine impedance is confirmed, the verification effort will continue by comparison to solutions of a more sophisticated rotorcraft model. Future work includes determination of the sensitivity of the rotorcraft airframe vibrations to helicopter flight conditions and rotor modeling assumptions. When completed, this research will ascertain the feasibility and efficiency of the impedance matching method of rotor-airframe coupling for use in the analysis of airframe vibrations during the preliminary rotorcraft design process. Author

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A91-15349

A STUDY OF THE ERRORS OF A MECHANICAL DATA PROCESSING AND MEASURING SYSTEM [OB ISSLEDOVANII POGRESHNOSTEI INFORMATSIONNO-IZMERITEL'NOI MEKHANICHESKOI SISTEMY]

E. N. BEZVESIL'NAIA (Kievskii Politekhnikheskii Institut, Kiev, Ukrainian SSR) *Prikladnaia Mekhanika* (ISSN 0032-8243), vol. 26, April 1990, p. 113-119. In Russian. refs

Copyright

An equation of motion for an airborne gravimetric system is obtained and analyzed. A functional scheme of such a system is defined. The systematic errors of the gravimetric system are investigated, and requirements are formulated for accuracy in determining the parameters of aircraft conducting gravimetric measurements. V.L.

A91-16580

COLLISION INSURANCE

GEORGE C. LARSON *Air and Space* (ISSN 0886-2257), vol. 5, Dec. 1990-Jan. 1991, p. 50-54.

Copyright

An overview is presented of the ongoing development of air traffic control and anticollision systems over the past several decades. Since 1955 these efforts have concentrated on the search for improved aircraft-based systems to alert cockpit crews to potential collisions, which would be complementary to ATC radar. The FAA decided to take advantage of radar transponder beacons so they could be tracked and identified by ground-based radar more readily. Then, the transponder was linked to the altimeter so the aircraft's altitude could also be displayed automatically on radarscopes. Continuing improvements have led to the proposed TCAS II which consists of a computer, some form of cockpit display, and a transponder which will resolve conflicts by vertical maneuvering alone. Lateral maneuvering would be added with an advanced TCAS III at some later date. R.E.P.

A91-16613

FLIGHT DATA RECORDER - AH-64A ENHANCED DIAGNOSTIC SYSTEM

DAVID G. STALL (U.S. Army, Aviation Applied Technology Directorate, Fort Eustis, VA) *Vertiflite* (ISSN 0042-4455), vol. 36, Nov.-Dec. 1990, p. 73-76.

Copyright

The AH-64A Enhanced Diagnostic System (EDS) is a research and development program at Aviation Applied Technology Directorate (AATD) which demonstrates various capabilities and potential benefits associated with recording and processing Apache helicopter MIL-STD-1553 multiplex bus (mxbus) data for fault detection/isolation (FD/I) and condition monitoring applications. These applications involve in-flight and postflight ground-based functions. These functions include the recording and processing of mxbus parameters, engine condition monitoring, structural condition monitoring, exceedance monitoring, and fault detection and isolation, all of which are discussed in detail. An army troop maintenance demonstration which was held alongside the EDS flight test helicopter, is discussed and laboratory developments and demonstrations are reviewed. It is concluded that results of the EDS program indicate that recorded and processed mxbus parameters for diagnostic purposes can reduce AH-64 maintenance man-hours. L.K.S.

A91-16910#

FLIGHT DEMONSTRATION OF FIBER OPTIC GYROS AHRS

E. HANDRICH, M. KRINGS, and H.-J. BUESCHELBERGER (LITEF GmbH, Freiburg im Breisgau, Federal Republic of Germany) IN: *Symposium Gyro Technology 1989*, Stuttgart, Federal Republic of

Germany, Sept. 19, 20, 1989, Proceedings. Stuttgart/Duesseldorf, Universitaet Stuttgart/Deutsche Gesellschaft fuer Ortung und Navigation, 1989, p. 11.0-11.38.

Results are presented from a flight test performance evaluation of a fiber-optic gyro (FOG) suitable for use in a self-aligning, strapdown, Attitude and Heading Reference System (AHRS) capable of 0.1 deg/hr drift repeatability and stability levels. In the FOG-AHRS, raw incremental angle and velocity data from all aircraft instruments are initially processed by compensation software to remove known error sources from the data, and then transformed from the body frame to the computational frame. The third-order damping attitude-control loops use true airspeed as reference, and provide estimates of earth rates, uncompensated gyro biases, and transport rates. O.C.

A91-16922

LMK-2000 - A NEW AERIAL SURVEY CAMERA SYSTEM

NOBERT DIETE *Jena Review* (ISSN 0448-9497), vol. 35, no. 3, 1990, p. 135-138.

Copyright

A camera with the shutter speed of 1/500 s, focal length of 150 mm, maximum angular aperture of 47 deg, and frequency of external oscillations acting on the camera of 8 Hz is described. In addition to forward-motion compensation, it has a gyro-stabilized mount for avoiding the influence of angular oscillations of the aircraft on the camera and the quality of its images. A new 150-mm f/4 lens allows a mean resolution of 120 l/mm at high contrast. Emphasis is placed on the system's central module, control unit, and navigation and control unit, as well as crew configurations and the automatic correction of effective film speed. V.T.

A91-16923

THE NEW GYRO-STABILIZED MOUNT FOR LMK AERIAL SURVEY CAMERAS

HEINRICH KLOSE *Jena Review* (ISSN 0448-9497), vol. 35, no. 3, 1990, p. 138-140.

Copyright

Factors contributing to the deterioration of aerial images taken with high-resolution films or on flights with low altitudes in turbulent conditions are outlined, and it is pointed out that the compensation of forward motion in such a way that the film follows the direction and speed of movement of the image projected on it during exposure, in addition to the rotational stabilization of camera axes will reduce these negative factors. Focus is placed on a hydraulic system for the stabilization of the horizontal axes, the stabilization of the vertical axes, and passive vibration insulation. It is shown that with the initial angular velocities of up to 10 deg/s to be compensated, the mean residual angular velocities amount to 0.3 deg/s. V.T.

N91-11715# British Aerospace Public Ltd. Co., Woodford (England).

THE CERTIFICATION OF THE AVIONIC SYSTEMS ON THE ATP TO JAR 25

J. A. SHIMMIN *In DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification* p 53-61 1989
Avail: NTIS HC/MF A10

The use of digital avionic systems including an Electronic Flight Instrument System (EFIS) in the design of the Advanced Turbo Prop aircraft is described. The certification process used for the EFIS, the software of the digital systems, and the lightning protection of the aircraft are described. The method used to show compliance with Joint Aviation Requirement 25.1309 is described. ESA

N91-11729# Deutsche Gesellschaft fuer Luft- und Raumfahrt, Bonn (Germany, F.R.).

DIGITAL GLASS COCKPIT FOR COMMUTER AIRCRAFT

HORST KISTER *In its European Forum: The Evolution of Regional Aircraft Technologies and Certification* p 157-168 1989
Avail: NTIS HC/MF A10

The evolution of cockpit information systems is described and an outlook on future generation smaller and more cost and weight

06 AIRCRAFT INSTRUMENTATION

sensitive aircrafts is derived. Systems architecture and display formats are described. The A-310 and A-320 systems were addressed. ESA

N91-11750 Kansas State Univ., Manhattan.
INTEGRATION OF TIME-VARYING DATA INTO KNOWLEDGE-BASED SYSTEMS FOR AVIONICS APPLICATIONS Ph.D. Thesis

DAVID SCOTT HARDIN 1989 93 p
Avail: Univ. Microfilms Order No. DA9016521

Any knowledge-based system that is to be placed in the cockpit must deal with a wealth of time-varying data, and do so in real time. An avionics knowledge-based system thus requires a conventional signal processing front end to identify relevant signal characteristics, a knowledge representation scheme that lends itself naturally to the representation of uncertain numeric data, and an efficient, interruptible inferencing method. A hardware architecture for knowledge-based avionics systems is proposed which consists of a signal processor and one or more symbol processors. The blackboard paradigm is proposed as the basis for the software architecture. Dempster-Shafer theory is used to express uncertain numerical data. It is shown that the Dempster-Shafer formalism and the four-valued logic of Belnap are complementary, allowing numeric and non-numeric expressions of uncertainty to co-exist. It is also demonstrated that the Kalman filter, a common software component of avionics systems, can be used to provide uncertainty information about numeric data to a Dempster-Shafer evidential reasoning system. An initial software implementation developed in the Ada programming language is discussed. Dissert. Abstr.

N91-11761# Technische Univ., Delft (Netherlands).
INSTRUMENTATION REQUIREMENTS AND PRESAMPLE FILTER DESIGN FOR MEASUREMENTS DURING NON STEADY MANEUVERS WITH THE HAWKER HUNTER MK 7, PH-NLH

K. VANWOERKOM *In its* Essays on Stability and Control 15 p
Oct. 1989

Avail: NTIS HC/MF A12

The requirements for the instrumentation for the Hunter measurements are described with emphasis on the design of the presample filters. The applied data collection described has a sample rate of 400 measurements per second and an overall accuracy of 0.02 percent. The transducers used have different accuracies depending on the type and application, from 0.01 to 5 percent. To monitor the accuracy during the flight test period, rather extensive calibrations were carried out before, between and after the actual measurement flights. Diagrams are given including the architecture of the instrumentation system, and the accompanying ground equipment. Formal requirements for flight test instrumentation systems are discussed, and the method used for the design of the required electronic filters is described. ESA

N91-12576# Federal Aviation Administration, Atlantic City, NJ.
THE FAA TECHNICAL CENTER'S AVIONICS DATA LINK INITIATIVE

ALBERT J. REHMANN *In* AIAA, Proceedings of the 1990 AIAA/FAA Joint Symposium on General Aviation Systems p 348-357 May 1990

Avail: NTIS HC/MF A17

Weather and air traffic control (ATC) services have been developed at the Federal Aviation Administration (FAA) Technical Center to be delivered to aircraft via data link. The six weather and three air traffic control (ATC) services were designed to meet the needs of pilots and air traffic controllers. To assess the suitability of data link services to both user groups, two mini studies and a full fidelity operational evaluation were conducted. In the mini studies, pilots were asked to view data link cockpit presentations depicted on a personal computer (PC) display. In the operational evaluation, four general aviation pilots flew a GAT II B cockpit simulator configured as a Cessna 421. Four airline crews flew a B-727 cockpit simulator. Subjective and objective data were collected on pilot performance during the operational evaluation. Results showed that the pilots' interaction time with

data link was comparable to the time spent in voice communications. Furthermore, thirteen errors/callbacks/repeats were logged in with voice communications while none were logged with data link. The Technical Center plans to continue the human factors research to broaden the pilot performance data base. Research will also continue to provide low cost solutions to expensive avionics. Author

N91-12677*# Lockheed Aeronautical Systems Co., Marietta, GA.

DIVERTER DECISION AIDING FOR IN-FLIGHT DIVERSIONS Final Report

FREDERICK M. RUDOLPH, DAVID A. HOMOKI, and GEORGE A. SEXTON Aug. 1990 323 p Original contains color illustrations

(Contract NAS1-18029)

(NASA-CR-182070; NAS 1.26:182070; LG90ER0040) Avail: NTIS HC/MF A14; 3 functional color pages CSCL 01/4

It was determined that artificial intelligence technology can provide pilots with the help they need in making the complex decisions concerning en route changes in a flight plan. A diverter system should have the capability to take all of the available information and produce a recommendation to the pilot. Phase three illustrated that using Joshua to develop rules for an expert system and a Static database provided additional flexibility by permitting the development of dynamic weighting of diversion relevant parameters. This increases the fidelity of the AI functions cited as useful in aiding the pilot to perform situational assessment, navigation rerouting, flight planning/replanning, and maneuver execution. Additionally, a prototype pilot-vehicle interface (PVI) was designed providing for the integration of both text and graphical based information. Advanced technologies were applied to PVI design, resulting in a hierarchical menu based architecture to increase the efficiency of information transfer while reducing expected workload. Additional efficiency was gained by integrating spatial and text displays into an integrated user interface. Author

N91-12679# Operational Test and Evaluation Force, Norfolk, VA.

FOLLOW-ON OPERATIONAL TEST AND EVALUATION OF THE CPU-152/A STANDARD CENTRAL AIR DATA COMPUTER (SCADC) Report, 1-20 Jul. 1990

21 Aug. 1990 5 p

(AD-A226310) Avail: NTIS HC/MF A01 CSCL 12/6

The purpose of the evaluation was to verify that all the deficiencies from OT-IIC OPEVAL has been corrected prior to approval for full fleet introduction. The evaluation was based on the results of non-scenario operational tests conducted under Project M756, supplemented by the results of OPEVAL, developmental testing, and operational experience. Based on this evaluation, the CPU-152/A SCADC as installed in the S-3A/B aircraft is determined to be operationally effective and operationally suitable. Approval for full fleet introduction of the CPU-152/A is recommended. The SCADC uses air pressure from the pitot static system and temperature signals from the temperature probe to provide air data outputs for navigation, cockpit display, sonobuoy and weapon delivery systems, Automatic Flight Control System (AFCS), and altitude reporting. While the digital SCADC is a form, fit, and function replacement for the existing S-3 Airspeed Altitude Computer Set (AACs), it has, in addition, a Built-in-test (BIT) function allowing maintenance personnel to determine system status without removing the unit. GRA

N91-12680# Boeing Military Airplane Development, Seattle, WA.

3-D IMAGERY COCKPIT DISPLAY DEVELOPMENT Final Report, Oct. 1986 - Feb. 1989

T. C. WAY, R. E. HOBBS, J. QUALY-WHITE, and J. D. GILMOUR Aug. 1990 170 p

(Contract F33615-86-C-3601; AF PROJ. 2403)

(AD-A226411; WRDC-TR-90-7003) Avail: NTIS HC/MF A08 CSCL 01/4

The 3-D Imagery Cockpit Display Development Program was

designed to evaluate the potential payoff in situation awareness of adding retinal disparity (3-D) to pictorial formats for use in advanced aircraft and to advance the evolution of the pictorial formats themselves. The study consisted of designing the formats, evaluation of formats in part-task, part-mission, and full-mission simulation, and redesigning formats based on air crew feedback if needed. GRA

N91-12698# Crouzet Aerospace and Systems, Valence (France).

BREAKDOWN METHODOLOGY FOR FLIGHT CRITICAL APPLICATIONS INTO ELEMENTARY COMPONENTS

BERNARD CHAVANA and FRANCOIS DESAINTEMAIRESVILLE /n AGARD, Fault Tolerant Design Concepts for Highly Integrated Flight Critical Guidance and Control Systems 9 p Apr. 1990 In FRENCH

Copyright Avail: NTIS HC/MF A12; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The objective is to explain the steps in specification/conception used in the case of critical product development for aircraft safety. The explanation does not approach from the design aspect, but in the specification sense from the middle of the design (coding, testing...). At each stage, it is shown how a simple step is discovered for assuming project limits. Transl. by E.R.

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.

A91-13027#

ADVANCED AIRCRAFT GAS TURBINE ENGINE CONTROLS

W. E. WRIGHT and J. C. HALL (GE Aircraft Engines, Cincinnati, OH) ASME, Transactions, Journal of Engineering for Gas Turbines and Power (ISSN 0022-0825), vol. 112, Oct. 1990, p. 561-564. refs

(Contract F33657-82-C-2265; F33657-85-C-2131; N00140-83-C-9046)

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Lampert et al.'s (1982) solution to the 'Byzantine General's problem' is presently used as the basis of a fault-tolerant engine control architecture for military aircraft incorporating such features as thrust vectoring for maneuvering and vertical lift. 'Byzantine resilience' refers to the ability of a multichannel control system to accommodate any arbitrarily malicious fault; an architecture organized according to the Byzantine General's principle contains the fault within the affected channel and prevents it from propagating into other control computations. Attention is given to the INTERFACE IIL control program and Vehicle Management System applications of Byzantine principles. O.C.

A91-13028*# McDonnell Aircraft Co., Saint Louis, MO.

DEVELOPMENT OF THE HIDECL INLET INTEGRATION MODE

J. D. CHISHOLM, S. G. NOBBS (McDonnell Aircraft Co., Saint Louis, MO), and J. F. STEWART (NASA, Flight Research Center, Edwards, CA) ASME, Transactions, Journal of Engineering for Gas Turbines and Power (ISSN 0022-0825), vol. 112, Oct. 1990, p. 565-572. refs

Copyright

The Highly Integrated Digital Electronic Control (HIDECL) development program conducted at NASA-Ames/Dryden will use an F-15 test aircraft for flight demonstration. An account is presently given of the HIDECL Inlet Integration mode's design concept, control law, and test aircraft implementation, with a view to its performance benefits. The enhancement of performance is a function of the use of Digital Electronic Engine Control corrected engine airflow computations to improve the scheduling of inlet ramp positions in

real time; excess thrust can thereby be increased by 13 percent at Mach 2.3 and 40,000 ft. Aircraft supportability is also improved through the obviation of inlet controllers. O.C.

A91-13029#

SIMULATION OF BIRD STRIKES ON TURBINE ENGINES

E. NIERING (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, Federal Republic of Germany) ASME, Transactions, Journal of Engineering for Gas Turbines and Power (ISSN 0022-0825), vol. 112, Oct. 1990, p. 573-578. refs

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External components of aircraft engines, such as casings and intake blades, must be capable of withstanding bird strikes. Various methods of computer simulation that have been developed are presented. The most accurate and meaningful results are obtained with finite element programs specifically developed for impact events. Bird and component are divided into finite elements. The component model must allow for great elastoplastic deformation, where the yield strength is a function of the strain rate. A model shape and a homogeneous substitute material must be defined for the complicated and nonhomogeneous structure of the bird. Bird strikes on a rotating spinner and an intake blade are investigated with the finite element program DYNA3D. Author

A91-13039*# General Electric Co., Cincinnati, OH.

AERODYNAMIC PERFORMANCE OF A SCALE-MODEL, COUNTERROTATING UNDUCTED FAN

T. J. SULLIVAN (General Electric Co., Cincinnati, OH) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 112, Oct. 1990, p. 579-586. Previously announced in STAR as N88-17666. refs

(Contract NAS3-24080)

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The aerodynamic performance of a scale model, counter-rotating unducted fan has been determined and the results are discussed. Experimental investigations were conducted using the scale model propulsor simulator and uniquely shaped fan blades. The blades, designed for a high disk loading at Mach 0.72 at 35,000 feet altitude maximum climb condition are aft-mounted on the simulator in a pusher configuration. Data are compared with analytical predictions at the design point and show good agreement. Author

A91-13042#

ON THE MECHANISM OF DANGEROUS BLADE VIBRATION DUE TO BLADE FLOW INTERACTIONS ON CENTRIFUGAL COMPRESSORS

U. HAUPT, D. F. JIN, and M. RAUTENBERG (Hannover, Universitaet, Hanover, Federal Republic of Germany) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 112, Oct. 1990, p. 702-713. Research supported by DFG and Forschungsvereinigung Verbrennungskraftmaschinen. refs (ASME PAPER 89-GT-291) Copyright

Severe blade flow interactions at part-load operation conditions were investigated on a centrifugal compressor with a vaned diffuser leading to material stresses beyond the allowable values. By means of a number of measurement and analysis techniques it could be found, that a stationary periodic pressure field is produced on the circumference by the vibrating blade itself, which is induced at resonance conditions by the peripheral pressure nonuniformity due to the outlet tube. This peripheral pressure field of an integer wave number intensifies the blade resonance excitation from downstream leading to an additivity effect between wave amplitude and blade displacement. The significant role in this mechanism plays the reverse flow near the corner shroud/suction side in the impeller, occurring at part-load operation, which is controlled by the interaction of the tip angle of the vibrating blade and the flow angle at that location. It could be demonstrated that this dangerous blade vibration, in addition, is the source of a shift of the surge line toward higher mass flow, reducing the compressor operating range considerably in this operating zone. Author

A91-13044#

UNSTEADY AERODYNAMIC DAMPING MEASUREMENT OF ANNULAR TURBINE CASCADE WITH HIGH DEFLECTION IN TRANSONIC FLOW

H. KOBAYASHI (National Aerospace Laboratory, Chofu, Japan) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 112, Oct. 1990, p. 732-740. Research supported by MITI. refs

Copyright

Unsteady aerodynamic forces acting on oscillating blades of a transonic annular turbine cascade were investigated in both aerodynamic stable and unstable domains, using a Freon gas annular cascade test facility. In the facility, whole blades composing the cascade were oscillated in the torsional mode by a high-speed mechanical drive system. In the experiment, the reduced frequency K was changed from 0.056 to 0.915 with a range of outlet Mach number M(2) from 0.68 to 1.39, and at a constant interblade phase angle. Unsteady aerodynamic moments obtained by two measuring methods agreed well. Through the moment data the phenomenon of unstalled transonic cascade flutter was clarified as well as the significance of K and M(2) for the flutter. The variation of flutter occurrence with outlet flow velocity in the experiments showed a very good agreement with theoretical analysis. Author

A91-13045#

PARAMETRIC TRENDS IN THE FLUTTER OF ADVANCED TURBOPROPS

E. F. CRAWLEY and E. H. DUCHARME (MIT, Cambridge, MA) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 112, Oct. 1990, p. 741-750. Research supported by the General Electric Co. refs

(ASME PAPER 89-GT-280) Copyright

The parametric trends in the aeroelastic behavior of an advanced turboprop were experimentally investigated using a subvelocity-scaled testing procedure. A 2-ft-diameter sub-velocity-scaled model was constructed and its flutter behavior was favorably correlated to that of a full-velocity-scaled Unducted Fan model for which a flutter point had been documented. With the validity of the subvelocity-scaled procedure established, the inherent versatility was exploited through the construction and flutter testing of models which allowed for the parametric variation of sweep, mass distribution, and solidity. As is typical of moderate mass ratio wings and blades, the flutter was found to be of a coalescence type, the onset of which is determined by a critical relative velocity with a slight dependence on loading and cascade effects. Author

A91-13048#

ANNULAR CASCADE STUDY OF LOW BACK-PRESSURE SUPERSONIC FAN BLADE FLUTTER

H. KOBAYASHI (National Aerospace Laboratory, Chofu, Japan) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 112, Oct. 1990, p. 768-777. Research supported by MITI. refs

(ASME PAPER 89-GT-297) Copyright

An oscillation-controlled annular cascade test facility has been used to investigate torsional-mode low back-pressure blade flutter in a supersonic fan. The blades were measured at a range of reduced frequencies, six different interblade phase angles, and inlet flow velocities from subsonic to supersonic flow. Reductions in flutter-boundary frequency substantially increased when the blade suction flow became subsonic. The interblade phase angles causing flutter were in the range from 40 to 160 deg, for flowfields ranging from high subsonic to supersonic; shock-wave movements due to blade oscillation generated large, unsteady aerodynamic forces that powerfully stimulated blade oscillation. O.C.

A91-13049#

BLADE VIBRATION WITH NONLINEAR TIP CONSTRAINT - MODEL DEVELOPMENT

L. F. WAGNER (Westinghouse Science and Technology Center, Pittsburgh, PA) and J. H. GRIFFIN (Carnegie-Mellon University,

Pittsburgh, PA) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 112, Oct. 1990, p. 778-785. refs (ASME PAPER 89-GT-293) Copyright

Turbine blades having integrally machined tip shrouds, with associated gaps between adjacent shrouds, often exhibit unusual vibratory responses with significant differences between the amplitudes and frequencies of individual blades on the same stage. These differences result from unavoidable variations in the shroud gaps causing, for large enough excitation, nonlinear constraint at the blade tips which varies from blade to blade. This study shows that the blade stresses cannot be adequately represented by the type of single-degree-of-freedom models that are often used for dynamic impact studies, but require the participation of higher frequency beam-type modes. The extension of the resulting beam model to multi-degree-of-freedom systems will allow the study of the 'gap mistuning' phenomenon for practical bladed disks. Author

A91-13052#

A NOTE ON EFFICIENCY SENSITIVITY TO TIP CLEARANCE CHANGES IN AXIAL FLOW COMPRESSORS

I. N. MOYLE (U.S. Naval Postgraduate School, Monterey, CA) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 112, Oct. 1990, p. 795, 796. refs

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The general form of the constant power sensitivity correlation with gap/blade height in axial-flow compressors is presently noted to suggest that losses mount rapidly at small clearance levels, and that different flow conditions and hardware geometries do not significantly affect this loss trend. The efficiency decrement at constant power grows less rapidly with increasing clearance gap; this trend is not predicted by numerous models which consider efficiency variations as a function of tip gap. O.C.

A91-13549

DEVELOPMENT OF JET ENGINES FOR HIGH-SPEED FLIGHT - SYNTHESIS OF ACHIEVEMENTS IN VARIOUS FIELDS OF SCIENCE AND TECHNOLOGY [RAZVITIE VOZDUSHO-REAKTIVNYKH DVIGATELEI DLIA AVIATSII VYSOKIKH SKOROSTEI POLETA - SINTEZ DOSTIZHENII RAZLICHNYKH OTRASLEI NAUKI I TEKHNIKI]

O. N. FAVORSKII (Tsentral'nyi Nauchno-Issledovatel'skii Institut Aviatsionnogo Motorostroeniia, Moscow, USSR) and R. I. KURZINER Teplofizika Vysokikh Temperatur (ISSN 0040-3644), vol. 28, July-Aug. 1990, p. 793-803. In Russian. refs

Copyright

Achievements in thermochemistry are briefly reviewed with particular reference to their role in the synthesis of combined engines based on thermodynamic cycles that are superior to the Brayton cycle traditionally used in jet engines. The possibility of using the high cooling capacity and performance of endothermic fuels is discussed. The results of the study provide a way to increase the flight speed of aviation engines using hydrocarbon fuels. V.L.

A91-13575

SELECTION OF THE OPTIMAL ORIENTATION OF SINGLE CRYSTAL AXES IN GAS TURBINE ENGINE BLADES [VYBOR RATSIONAL'NOI ORIENTATSII OSEI MONOKRISTALLA V LOPATKAKH GAZOTURBINNYKH DVIGATELEI]

G. N. AZAROVA, B. IA. KLADNITSKII, and IU. V. SHEKHTMAN Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela (ISSN 0572-3299), July-Aug. 1990, p. 185-190. In Russian.

Copyright

The use of single-crystal nickel-based alloys for the manufacture of gas turbine blades is briefly reviewed, and results of a study concerned with the selection of optimal single crystal orientation in cooled turbine blades are reported. The problem is solved in a three-dimensional formulation, making it possible to analyze the stress-strain state of the blade for arbitrary crystallization axis orientation. Recommendations are given concerning the preferred single crystal orientations for different operating conditions. V.L.

A91-13711

DETERMINATION OF THE MOST STRESSED BLADE OF A MISTUNED TURBOMACHINE ROTOR [K VOPROSU OPREDELENIIA NAIBOLEE NAPRIAZHENNOI LOPATKI RASSTROENNOGO RABOCHEGO KOLESIA TURBOMASHINY]A. P. ZIN'KOVSKII and M. V. SMERTIUK (AN USSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR) Problemy Prochnosti (ISSN 0556-171X), Sept. 1990, p. 86-89. In Russian. refs
Copyright

Changes in the maximum resonance amplitude ratio of the subsystems of a rotationally symmetric system modeling a turbine rotor are investigated, in the case of a saw-tooth frequency distribution, as a function of their elastic interaction and vibration excitation harmonics. The results obtained demonstrate the importance of considering the elastic interaction of blades and their vibration excitation harmonics, in addition to asymmetry distribution over the blade row, when determining the most stressed blade of a mistuned turbine rotor. V.L.

A91-14320

MATHEMATICAL MODEL AND DIGITAL SIMULATION OF TURBOJET ACCELERATION

SIQI FAN, YUNHUA XU, and ZHUANG SHU (Northwestern Polytechnical University, Xian, People's Republic of China) Chinese Journal of Aeronautics (ISSN 1000-9361), vol. 3, May 1990, p. 123-130.

Copyright

The acceleration performance of a turbojet is one of its important characteristics. In terms of control system, the engine is a controlled object. The acceleration performance not only depends on the engine, but also on the controller; therefore both the engine and the controller must be combined in a control system to make research for this performance. This paper presents a mathematical model of the turbojet acceleration control system and digital simulation method. Because the engine acceleration is a large variation transient process, the models of the engine and the controller are described by nonlinear equations. The methods of solving nonlinear equations and iterative techniques of calculating acceleration control system are discussed in this paper. The calculated results, as compared with test results, show that the simulation for this system is satisfactory. Author

A91-14430*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NUMERICAL STUDY OF SUPERSONIC COMBUSTORS BY MULTI-BLOCK GRIDS WITH MISMATCHED INTERFACES

YOUNG J. MOON (NASA, Lewis Research Center; Sverdrup Technology, Inc., Cleveland, OH) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 13 p. refs

(Contract NAS3-25266)

(AIAA PAPER 90-5204) Copyright

A three-dimensional, finite-rate chemistry, Navier-Stokes code has been extended to a multi-block with mismatched interface code for practical calculations of supersonic combustors. To ensure global conservation, a conservative algorithm was used for the treatment of mismatched interfaces. The extended code was checked against one test case, i.e., a generic supersonic combustor with transverse fuel injection, examining solution accuracy, convergence, and local mass flux error. After testing, the code was used to simulate the chemically reacting flow fields in a scramjet combustor with parallel fuel injectors (unswept and swept ramps). Computational results were compared with experimental shadowgraph and pressure measurements. Fuel-air mixing characteristics of the unswept and swept ramps were compared and investigated. Author

A91-14443#

COMPARISONS OF A THREE-DIMENSIONAL, FULL NAVIER STOKES COMPUTER MODEL WITH HIGH MACH NUMBER COMBUSTOR TEST DATA

WILLIAM B. WATKINS (Pratt and Whitney Group, West Palm Beach, FL) AIAA, International Aerospace Planes Conference,

2nd, Orlando, FL, Oct. 29-31, 1990. 7 p. refs

(Contract F33657-86-C-2137)

(AIAA PAPER 90-5217) Copyright

Three-dimensional full Navier-Stokes calculations of hypersonic scramjet combustion were carried out and compared with experimental data for a scramjet combustor, to verify and substantiate CFD codes and application procedures. The combustor model is described, and two types of experimental data selected for CFD comparisons are discussed. One of these involved the holographic interferometry of a large flow-path cross section, providing a planar image of path-averaged constant density contours. The other involved traditional pointwise values of wall static pressure. Very good agreement between CFD and data was obtained with respect to locations, sizes, and orientations of the supersonic-flow features. I.S.

A91-14466*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

EXPERIMENTAL INVESTIGATION OF A SINGLE FLUSH-MOUNTED HYPERMIXING NOZZLE

D. O. DAVIS, W. R. HINGST, and A. R. PORRO (NASA, Lewis Research Center, Cleveland, OH) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 11 p. refs

(AIAA PAPER 90-5240) Copyright

Reported herein are the results of an experimental wind tunnel investigation of a circular supersonic jet ($M_j = 3.47$) injected at a 10 degree angle into a supersonic freestream. Measurements were made for nominal freestream Mach numbers of 1.6, 2.0, 2.5 and 3.0. Three jet total pressures were run at each freestream Mach number, resulting in twelve separate operating conditions. The measurements indicate the presence of two pairs of contra-rotating vortices. One pair follows the jet trajectory and tends to split the jet into two streams. A smaller pair, rotating in an opposite sense, develops in the near wall region. Reported results include Mach number and volume fraction distributions in the cross plane, as well as jet penetration and mixing efficiency. Author

A91-14467*# Lockheed Engineering and Sciences Co., Hampton, VA.

ANALYSIS OF GENERIC SCRAMJET EXTERNAL NOZZLE FLOWFIELDS EMPLOYING SIMULANT GASESKENNETH E. TATUM (Lockheed Engineering and Sciences Co., Hampton, VA), WILLIAM J. MONTA, DAVID W. WITTE (NASA, Langley Research Center, Hampton, VA), and ROBERT W. WALTERS (Virginia Polytechnic Institute and State University, Blacksburg) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 13 p. refs
(AIAA PAPER 90-5242)

Experimental and computational results are presented for a generic scramjet nozzle/afterbody model. Mixtures of argon and Freon were employed as simulant scramjet exhaust gases because they correctly model the inviscid simulation parameters of actual scramjet combustion products, allowing test and analysis at significantly reduced temperatures. Air was also employed as an exhaust gas to provide experimental and computational comparisons with simulant gas effects. Several computational aerodynamic analysis codes, employing different levels of theoretical modeling, were applied to compute solutions about the scramjet geometry. The solutions are compared with measured surface static and flowfield pitot pressure data taken in a Mach 6 freestream. Author

A91-14938#

EXPERIMENTAL RESEARCH ON AUTOIGNITION OF FUEL INJECTED TRANSVERSELY INTO SUPERSONIC AIRSTREAM

JINGHUA LIU, LIXIN YANG, YUNQI GE, YUREN WANG, and XIAOUE LIU (MAS, 31st Research Institute, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), Oct. 1990, p. 17-22. In Chinese, with abstract in English. refs

An ignition test of hydrogen and kerosene fuels injected transversely into Mach 2 supersonic airstream heated in a electric

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arc wind-tunnel was carried out. Physical characteristics of ignition are described, and a modified coefficient for the ignition criterion is also proposed. Author

A91-16973

NEW BITE FROM COMPOSITES

GEORGE MARSH / Aerospace Composites and Materials (ISSN 0954-5832), vol. 2, Nov.-Dec. 1990, p. 20, 21, 23, 24, 26. Copyright

The present development status evaluation of composite structure propellers notes advancements in materials technologies which have for the first time allowed the precise realization of aerodynamically ideal contours. Composite propellers have the further advantages of reparability in case of impact damage, superior fatigue resistance, and improved structural damping and flexibility, relative to Al alloy blades. Kevlar 49 fibers have come to be used as the reinforcement in the load-carrying structure of many propellers, in conjunction with a high temperature epoxy resin matrix. Composite blades are molded around a urethane foam core, and incorporate a nickel leading-edge erosion shield. O.C.

N91-11725# Motoren- und Turbinen-Union Muenchen G.m.b.H. (Germany, F.R.).

ENGINE MAINTAINABILITY: OBJECTIVES AND METHODS

A. SENFT / In DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 129-132 1989
Avail: NTIS HC/MF A10

Major considerations used to improve engine maintainability are identified. The basis for maintainability features are a lot of requirements. These requirements are defined by the customer and created using several analyses. Criteria for good maintainability features of an engine are considered to be design requirements. The engine shall be designed for ease and simplicity of maintenance. Modular concept and quantitative/qualitative design targets are necessary to meet specified requirements. Maintainability reviews and maintainability demonstrations have to be conducted during engine development to show that the requirements given have been met. ESA

N91-11730# Motoren- und Turbinen-Union Muenchen G.m.b.H. (Germany, F.R.).

PROPAN TECHNOLOGY

M. DUPSLAFF, P. WEHLITZ, and P. SCHIMMING / In DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 169-172 1989
Avail: NTIS HC/MF A10

The main objective in recent engine development is to combine the efficiency of the propeller with the advantages of the turbofan. In this context, the shrouded propfan-concept Counter Rotating Integrated Shrouded Propfan (CRISP) was introduced, followed by the aerodynamic design consideration for its scale model. Preliminary results of aerodynamic fan experiments, which were part of the experimental program, provide the decisive new technologies for this shrouded fan concept, and encourage further activity in this direction towards the development of a new generation of jet engines. ESA

N91-11731# Rolls-Royce Ltd., Derby (England).

THE PLACE FOR THE TURBOFAN ENGINE IN THE REGIONAL AIRLINES

P. SIMPKIN / In DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 173-179 1989
Avail: NTIS HC/MF A10

The historical situation and a case for the turbofan are presented. A turbofan is described, which is a cost effective powerplant for regional and feeder aircraft designed for cruise speeds of 350 kts and above, and requiring jet standard of comfort. ESA

N91-11732# Aerospatiale, Toulouse (France).

CHOICE OF PROPULSION FOR NEXT GENERATION AIRCRAFT

ROBERT HINSINGER / In DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 181-187 1989

Avail: NTIS HC/MF A10

For three sizes of commuter aircraft for the next decade (30, 60, 90 seaters), different types of propulsion are considered: modern propellers, where Mach number (M) is greater than 0.5 and less than 0.6; open rotor systems where M is greater than 0.7 and less than 0.78; ducted propellers where $M = 0.78$, and turbofan where $M = 0.78$. Requirements are defined for each aircraft category. An optimization is done to minimize the operating cost. The results are provided versus number of seats and range. ESA

N91-11733# Motoren- und Turbinen-Union Muenchen G.m.b.H. (Germany, F.R.).

REQUIREMENTS FOR TURBOPROP AND TURBOFAN ENGINES IN REGIONAL AIRCRAFT

H. E. GROENEWALD and E. WUERZINGER / In DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 189-194 1989
Avail: NTIS HC/MF A10

The various applications of turboprop and turbofan engines in regional aircraft are explained. Reference is made to the differing performance objectives for these aircrafts. It is shown that, in the adaptation of the engine to the aircraft, the climb phase of flight is the most significant factor for engine dimensioning. Areas of development emphasis from the point of view of market requirements are discussed with regard to their impact on design. It is shown that engines of simple design with low mechanical and thermal stressing of components but with high component efficiencies form the ideal basis for regional aircraft propulsion. This concept is seen to provide for low procurement and maintenance costs. ESA

N91-11734# Motoren- und Turbinen-Union Muenchen G.m.b.H. (Germany, F.R.).

PW300: POWERPLANT FOR REGIONAL AIRCRAFT

R. HILL / In DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 195-199 1989
Avail: NTIS HC/MF A10

The PW300, a modern high bypass turbofan, is addressed. It will initially have a takeoff thrust of about 22 KN (5,000 Lbf) and compared to existing turbofans of this class will offer up to a 20 percent reduction in specific fuel consumption. A technical description of each engine component is given as well as an explanation of how the exceptional performance is achieved. The growth potential and derivative versions of the engine are discussed. ESA

N91-11754 California Univ., Berkeley.

RAMJET COMBUSTION INSTABILITIES: AN ANALYTICAL AND NUMERICAL MODEL Ph.D. Thesis

LUC BAUWENS 1989 109 p

Avail: Univ. Microfilms Order No. DA9028735

A stability analysis of a ramjet combustor is presented. The analysis focuses on a situation for which experimental data are available. The Mach number is low, pressure oscillations are large, and frequencies are lower than acoustics. The flame oscillates and goes through the exhaust nozzle during part of each cycle. The data are consistent with a slow modulation of the total mass of mixture in the system. This bulk oscillation interferes with entropy modes of oscillation and may destabilize them. A multiple time scale analysis is developed. It decouples to some extent the fast mechanisms: acoustics and flame motion, from the slow bulk/entropy mode. Both problems, fast and slow are then analyzed. The flame motion forces inlet duct acoustics. A numerical simulation of the flame motion shows that for typical combustor dimensions, the flame will eventually reach the exhaust nozzle, thus not only forcing inlet acoustics, but also creating conditions for the bulk instability. However, assuming the slow problem to remain stable, once the flame reaches the nozzle, its motion approaches a stable, stationary pattern. This validates the

assumption that the long time scale, bulk oscillation is the instability mechanism. Results of a stability analysis for the slow problem show the bulk/entropy mode to be unstable if the burning rate decreases at a sufficiently strong rate when the velocity at the inlet to the combustor increases. Dissert. Abstr.

N91-11755 California Univ., Berkeley.
**LOW-FREQUENCY PRESSURE OSCILLATIONS IN A MODEL
 RAMJET DUMP COMBUSTOR** Ph.D. Thesis
 KENNETH HYUPSANG YU 1989 138 p
 Avail: Univ. Microfilms Order No. DA9029081

An experimental investigation was undertaken to understand the nature of low frequency, high amplitude pressure oscillations that occur in ramjet dump combustors. These oscillations often cause significant practical problems (excessive vibration, excessive heat transfer, and inlet unstart). A two dimensional, variable geometry, dump combustor model was used. To determine the sources of pressure disturbances in the flow field, a cold flow study, utilizing a hot film, was carried out. A reacting flow study included pressure, velocity, and radiation measurements as well as flow visualizations which employed a phase sensitive schlieren technique. Pressure and velocity measurements were made at various locations in the inlet duct and combustor to determine the pressure and velocity field during an unstable operation. Global C₂ and CH radical emission intensities were measured to determine the phase relation between heat release rate and pressure in the combustor. The phase sensitive schlieren technique allowed tracking of the flame front during the entire pressure cycle. Holding the equivalence ratio fixed, the combustor geometry and inlet velocity were varied under two different inlet configurations. The parametric variations were used to study the effect of mean fluid residence time on frequency of the oscillation. The experimental results interpreted with the aid of acoustic and residence time analyses show that the low frequency instability does not always occur at the acoustic resonance frequencies. The frequency appears to be controlled by both the acoustics in the inlet duct and the fluid convection inside the combustor. Specifically, the instability period appears to be the sum of the fluid convection time inside the combustor and the corresponding feedback time from the inlet acoustic resonance characteristic. The sustenance of the oscillations during instability seems to be the result of oscillating heat release which occurs at the proper phase which satisfies Rayleigh's criterion. Dissert. Abstr.

N91-11756# Universal Technology Corp., Dayton, OH.
**GROUND ENVIRONMENT CHARACTERIZATION OF STOVL
 FIGHTER PROPULSION SYSTEMS** Final Report, Nov. 1988 -
 Nov. 1989
 RANDOLPH W. SPRATT Aug. 1990 89 p
 (Contract F33615-88-C-2823; AF PROJ. 3066)
 (AD-A225372; WRDC-TR-90-2058) Avail: NTIS HC/MF A05
 CSCL 01/3

The report contains information on the ground environment produced by STOVL propulsion systems. Data on impingement flow fields, heat transfer rates of impinging jets, and STOVL fighter exhaust characteristics are included. An analysis method was developed by UTC to estimate STOVL ground environments. Ground environments were estimated for the AV-8, Remote Augmented Lift (RAL), Remote Exhaust (REX), Hybrid Fan Vectored Thrust (HFVT), ejector augmentor, and lift plus lift/cruise propulsion systems. The effect of these ground environments on aluminum plates, asphalt concrete, Portland Cement Concrete (PCC), and steel plates was estimated. Facilities capable of conducting ground environment test were identified. GRA

N91-11757# Air Force Materials Lab., Wright-Patterson AFB, OH. Materials Integrity Branch.
**PROCEEDINGS OF THE 1989 STRUCTURAL INTEGRITY
 PROGRAM CONFERENCE** Final Report
 THOMAS D. COOPER, ed. and JOHN W. LINCOLN, ed.
 (Aeronautical Systems Div., Wright-Patterson AFB, OH.) Apr. 1990 1033 p Conference held in San Antonio, TX, 5-7 Dec. 1989 LIMITED REPRODUCIBILITY: Availability: Document partially

illegible
 (AD-A225541; WRDC-TR-90-4051) Avail: NTIS HC/MF A99
 CSCL 01/3

The purpose of this conference was to bring together technical personnel in DOD and the aerospace industry involved in the various turbine engines, airframes and other mechanical systems. It provided a forum to exchange ideas relating to the critical aspects of durability and damage tolerance technology for aircraft systems. Session topics included structural analysis; structural analysis and testing; materials and nondestructive evaluation; aircraft engine structural integrity; and force management. GRA

N91-11758# Wright Research Development Center,
 Wright-Patterson AFB, OH. Technology Branch.
**STAGE EFFECTS ON STALLING AND RECOVERY OF A
 HIGH-SPEED 10-STAGE AXIAL-FLOW COMPRESSOR** Final
 Report, 1 Feb. 1987 - 1 Jan. 1989
 WILLIAM W. COPENHAVER Jun. 1990 401 p
 (Contract AF PROJ. 3066)
 (AD-A225662; WRDC-TR-90-2054) Avail: NTIS HC/MF A18
 CSCL 13/7

Results of a High-speed 10-stage axial-flow compressor test involving overall compressor and individual stage performance while stalling and operating in quasi-steady rotating stall are described. Test procedures and data acquisition methods used to obtain the dynamic stalling and quasi-steady in-stall data are explained. Unstalled and in-stall data obtained from the compressor operating at five different shaft speeds and one off-schedule variable vane condition are presented. The effects of compressor speed and variable geometry on overall compressor in-stall pressure rise and hysteresis extent are illustrated through the use of quasi-steady stage temperature and pressure rise characteristics. The results indicate that individual stage performance during overall compressor. Time resolved install data acquired at two different shaft speeds are presented in support of the notion that stage operation varies significantly from entrance to exit of the compressor. Both time-averaged and time-resolved individual stage results suggest that stage matching is important, not only for unstalled performance but also for in-stall performance and recoverability from stall. The measured high-speed 10-stage test compressor individual stage pressure and temperature characteristics were input into a stage-by-stage dynamic compressor performance model. The analytical model had been previously validated for the prediction of low-speed compressor stalling and in-stall performance. GRA

N91-12529# National Aerospace Lab., Tokyo (Japan).
NUMERICAL COMPUTATION OF FLOW FOR SCRAMJET
 TOMIKO ISHIGURO, SATORU OGAWA, and YASUHIRO WADA
In its Proceedings of the 7th NAL Symposium on Aircraft
 Computational Aerodynamics p 99-104 1989 In JAPANESE;
 ENGLISH summary
 Avail: NTIS HC/MF A14

A numerical procedure to analyze a flowfield through or around a scramjet engine inlet is proposed. The 3-dimensional full Navier-Stokes equations in the generalized curvilinear coordinate system are solved by a time-marching method. The total variation diminishing scheme is applied for spatial discretizations of the convective terms of the equations and the implicit approximate factorization method using diagonalization for simplified inversion work is applied for the time integration. To treat boundary conditions (wall, symmetry etc.) accurately, all boundaries are mapped onto faces of rectangular parallelepipeds. A computational mesh space is made by connecting them. To show capability of this numerical procedure, numerical simulations of flow are carried out about three inlets with various sweep angles and a common V-shaped thick cowl, which are used in experiments by Kanda et al. The computational results and comparisons with their experiments are presented. Author

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N91-12534# Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).

AEROTHERMAL ANALYSIS FOR GAS TURBINE COMBUSTION LINER COOLING SLOTS

HIDEMI TOH, YUKINORI SATO, YASUNORI ANDO, and MASAFUMI KAWAI *In* NAL, Proceedings of the 7th NAL Symposium on Aircraft Computational Aerodynamics p 129-134 1989 *In* JAPANESE; ENGLISH summary.
Avail: NTIS HC/MF A14

Aerothermal analysis for gas turbine combustion liner cooling slots is presented. A finite-volume numerical analysis method for the solution of three-dimensional incompressible steady Navier-Stokes equations in general curvilinear coordinate system is used for the analysis. The main solution algorithm of the method is an extension of the SIMPLE algorithm to present general curvilinear coordinate formulation. The standard k -epsilon two equations is used for the turbulence model. This method is applied to calculate the velocity, temperature, liner skin temperature distributions and cooling effectiveness. Effects of combustion liner cooling slot configuration on such distributions were examined.

Author

N91-12569# John Deere Technologies International, Inc., Wood-Ridge, NJ.

ADVANCED STRATIFIED CHARGE ROTARY ENGINE TECHNOLOGY FOR GENERAL AVIATION SYSTEMS

ROBERT S. MOUNT and EDWARD S. WRIGHT *In* AIAA, Proceedings of the 1990 AIAA/FAA Joint Symposium on General Aviation Systems p 202-221 May 1990
Avail: NTIS HC/MF A17

Technology enablement activities in progress at John Deere Technologies International, Inc., Rotary Engine Division, toward advanced stratified charge rotary engines are discussed. Specific references are made to critical component technology needs and the supportive research and technology in progress. Included are multi-fuel aspects, fuel economy, combustion modeling, advanced turbomachinery, fuel injection systems, performance objectives and progress to date. Long range goals and potential for meeting advanced aviation system needs, in propulsion and auxiliary power unit areas for commercial and military systems, are discussed, including projected market potential and strategies.

Author

N91-12628# National Aerospace Lab., Tokyo (Japan).

DESIGN OF ULTRA HIGH BYPASS FAN WITH NUMERICAL SOLUTION OF NAVIER-STOKES EQUATIONS

OSAMU NOZAKI, YOSHIO SAITO, ATSUHIRO TAMURA, and KAZUHIRO NAKAHASHI (Osaka Univ., Suita, Japan) *In its* Proceedings of the 6th NAL Symposium on Aircraft Computational Aerodynamics p 249-255 Dec. 1988 *In* JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A12

A hardware model of an ultra high bypass fan blade was designed as a result of a numerical simulation based on Navier-Stokes (NS) equations. In the initial design, a double circular arc blade configuration was specified by the streamline curvature method. In a subsequent modification of the blade shape, the detailed flow fields around the blade were solved and visualized with a combination of NS code and a three dimensional graphic display unit. Finally, the optimum configuration of the blade was obtained. The purpose of this research is to propose a new design technique for the practical design of fluid machines by connecting NS codes and numerical visualization techniques.

Author (NASDA)

N91-12681# Air Force Systems Command, Wright-Patterson AFB, OH. Foreign Technology Div.

EXPERIMENTAL RESEARCH ON DIGITAL CONTROL OF ENGINE JT15D-4

REI MA, DAZHONG JINANG, YUANYE LI, and HUACONG LE 19 Jun. 1990 7 p Transl. into ENGLISH from Acta Aeronautica et Astronautica Sinica (Peoples Republic of China), v. 10, no. 6, Jun. 1989 p 272-274

(AD-A225342; FTD-ID(RS)T-0242-90) Avail: NTIS HC/MF A02 CSDL 21/5

This study carried out experimental research on digital control systems for the JT15D-4 engine. It probed into problems associated with the design and operation of digital control systems. In order to raise the reliability of digital control in the systems, we selected for use duplex communications, condition performance monitoring, hydraulic mechanism reserve regulators, software malfunction diagnosis alarm, and other similar types of measures. Going through digital simulation, semi-physical simulations, and various phases of actual operation on test platforms, the correctness of the system structure and design were experimentally verified, and this supplied experience in actual use for research on a more advanced development of full-function digital control.

GRA

08

AIRCRAFT STABILITY AND CONTROL

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

A91-14227

A SYNTHETIC RESEARCH FOR AIRCRAFT ACTIVE FLUTTER SUPPRESSION

QING CHEN and ZHAOFENG HU (Beijing University of Aeronautics and Astronautics, People's Republic of China) Chinese Journal of Aeronautics (ISSN 1000-9361), vol. 3, Aug. 1990, p. 159-167. refs

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In this paper a new idea, based on discussing the essence of flutter, is used to investigate flutter problems. A few modes of an aeroelastic system are studied instead of studying the whole. In light of this, an approach to analyzing flutter characteristics which combines the merit of graphic and analytical methods is presented. An optimal cost function with clear physical meaning which can overcome some inherent drawbacks of linear quadratic technique is developed. A numerical example of an elastic wing, in which some comparisons between the present approach and the 'V-G' method for calculating the critical point are carried out, is also presented.

Author

A91-15045#

A NOTE ON THE WEIGHT VS DYNAMIC STABILITY RELATIONS OF SUBSONIC AIRPLANES

KANICHIRO KATO and KENJI KARASAWA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 38, no. 438, 1990, p. 379-385. *In* Japanese, with abstract in English.

Dynamic stability of subsonic airplanes is discussed with reference to the relation between the dynamic stability and the weight. Linearized, decoupled equations of motion are used and five motion modes are calculated for four different airplanes, which cover 10 to the 7th times weight-change. The result points out that airplane dynamic stability is generally strengthened with a decrease in weight if the airplane is dynamically stable.

Author

A91-15050#

A NOTE ON THE VELOCITY VS DYNAMIC STABILITY RELATIONS OF AIRCRAFTS

KENJI KARASAWA and KANICHIRO KATO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 38, no. 439, 1990, p. 431-436. *In* Japanese, with abstract in English.

A correlation is discussed between aircraft velocities and natural frequencies of short-period and Dutch-roll modes. It is pointed out that those frequencies multiplied by $\sqrt{q} l$ (W/l), where W is weight and l is airplane length, are fairly well correlated with n/α (ratio of load-factor change to angle of attack change) in

short-period as well as in Dutch-roll mode. n/α is a parameter strongly correlated with aircraft dynamic pressure or velocity.

Author

A91-16071#

DIRECT APPROACH TO THE ANALYSIS OF CONTROL REVERSAL AND ITS SENSITIVITY

P. MANTEGAZZA and S. RICCI (Milano, Politecnico, Milan, Italy)
AIAA Journal (ISSN 0001-1452), vol. 28, Nov. 1990, p. 1995, 1996. refs

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The present approach to the loss of control efficiency at increasing dynamic pressure for high performance flexible aircraft designs proceeds by casting control reversal into a single eigenvalue problem whose solution and sensitivity calculations can be obtained by well known formulas requiring standard numerical methods. The reversal constraint can thereby be included in any optimal structural design process, since a feasible design is easily obtainable through the uniform scaling of design variables upward. O.C.

A91-16285*# Douglas Aircraft Co., Inc., Long Beach, CA. INTERPRETING THE HANDLING QUALITIES OF AIRCRAFT WITH STABILITY AND CONTROL AUGMENTATION

J. HODGKINSON, E. H. POTSDAM (Douglas Aircraft Co., Long Beach, CA), and R. E. SMITH (NASA, Flight Research Center, Edwards, CA) AIAA, Atmospheric Flight Mechanics Conference, 8th, Portland, OR, Aug. 20-22, 1990. 13 p. refs (AIAA PAPER 90-2825)

The general process of designing an aircraft for good flying qualities is first discussed. Lessons learned are pointed out, with piloted evaluation emerging as a crucial element. Two sources of rating variability in performing these evaluations are then discussed. First, the finite endpoints of the Cooper-Harper scale do not bias parametric statistical analyses unduly. Second, the wording of the scale does introduce some scatter. Phase lags generated by augmentation systems, as represented by equivalent time delays, often cause poor flying qualities. An analysis is introduced which allows a designer to relate any level of time delay to a probability of loss of aircraft control. This view of time delays should, it is hoped, allow better visibility of the time delays in the design process. Author

A91-16546

DESIGN OF A MULTIVARIABLE HELICOPTER FLIGHT CONTROL SYSTEM FOR HANDLING QUALITIES ENHANCEMENT

WILLIAM L. GARRARD (Minnesota, University, Minneapolis) and BRADLEY S. LIEBST (USAF, Institute of Technology, Wright-Patterson AFB, OH) American Helicopter Society, Journal (ISSN 0002-8711), vol. 35, Oct. 1990, p. 23-30. refs (Contract DAAL03-86-K-0056)

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A methodology for the direct design of helicopter flight-control systems which meet handling-qualities specifications is presented. This methodology uses full state feedback to place closed-loop eigenvalues to achieve bandwidth specifications and to shape closed-loop eigenvectors to decouple lateral and longitudinal responses to control inputs. Full state feedback requires that all state variables be known; however, only angular rates and normal acceleration are measured by sensors. Thus a state estimator is required in the feedback loop in order to convert sensor outputs to control inputs. This estimator is designed using eigenstructure assignment so as to achieve loop transfer recovery. Design of a feedback system for use in precise hovering control for a modern attack helicopter is used to illustrate the method. Author

N91-12570*# National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

AN EVALUATION OF AUTOMATIC CONTROL SYSTEM CONCEPTS FOR GENERAL AVIATION AIRPLANES

E. C. STEWART In AIAA, Proceedings of the 1990 AIAA/FAA

Joint Symposium on General Aviation Systems p 236-259 May 1990

Avail: NTIS HC/MF A17 CSDL 01/3

A piloted simulation study of automatic longitudinal control systems for general aviation airplanes has been conducted. These automatic control systems were designed to make the simulated airplane easy to fly for a beginning or infrequent pilot. Different control systems are presented and their characteristics are documented. In a conventional airplane control system each cockpit controller commands combinations of both the airspeed and the vertical speed. The best system in the present study decoupled the airspeed and vertical speed responses to cockpit controller inputs. An important feature of the automatic system was that neither changing flap position nor maneuvering in steeply banked turns affected either the airspeed or the vertical speed. All the pilots who flew the control system simulation were favorably impressed with the very low workload and the excellent handling qualities of the simulated airplane. Author

N91-12682# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Guidance and Control Panel.

FAULT TOLERANT DESIGN CONCEPTS FOR HIGHLY INTEGRATED FLIGHT CRITICAL GUIDANCE AND CONTROL SYSTEMS

Apr. 1990 263 p In ENGLISH and FRENCH The 49th symposium was held in Toulouse, France, 10-13 Oct. 1989 (AGARD-CP-456; ISBN-92-835-0552-2; AD-A223733) Copyright Avail: NTIS HC/MF A12; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Papers presented covered the following topics: trends in integrated flight critical systems; advanced fault tolerant design concepts; system architectures, mechanization and integration issues; high integrity software design methodologies and algorithms; and system validation, simulation and flight test experience.

N91-12684# Aerospatiale, Toulouse (France).

CIVIL APPLICATIONS TRENDS

PASCAL TRAVERSE In AGARD, Fault Tolerant Design Concepts for Highly Integrated Flight Critical Guidance and Control Systems 17 p Apr. 1990 In FRENCH

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Flight control of Airbus A320 marked a stage in the history of aeronautics as well as in the history of fault tolerant information systems. This control system is examined along with its possible evolution. This evolution is detailed, especially the architecture of the computer, the architecture of the information system, use in optics, and the design of the systems. E.R.

N91-12687# Draper (Charles Stark) Lab., Inc., Cambridge, MA. THE ROLE OF TIME-LIMITED DISPATCH OPERATION IN FAULT-TOLERANT FLIGHT CRITICAL CONTROL SYSTEMS

DEBORAH F. ALLINGER, FRANK J. LEONG, PHILIP S. BABCOCK, IV, RICHARD F. LAPRAD, and GARY C. HORAN (Pratt and Whitney Aircraft, East Hartford, CT.) In AGARD, Fault Tolerant Design Concepts for Highly Integrated Flight Critical Guidance and Control Systems 12 p Apr. 1990

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The use of fault-tolerant system design concepts to achieve otherwise unattainable levels of reliability in modern flight critical control systems is rapidly becoming commonplace. Fault-tolerant flight and propulsion control systems, for example, are now being deployed in modern aircraft, spacecraft, and submersibles. The characteristics of these systems pose new problems for the designers of such systems and afford new opportunities for their users. A basic motivation for introducing fault tolerance is to be able to preserve some level of functionality of the system in the wake of failures of some of the system's components. This property of fault-tolerant systems affords an opportunity to dispatch these systems with failed components for a limited time period. This mode of operation is referred to as time-limited dispatch. In

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time-limited dispatch operation, benefits related to both maintenance and operations can be realized. Aircraft maintenance actions can be deferred until a more convenient time or place, for example. Similarly, the sortie rates that can be realized in tactical situations can be increased. In order to determine optimal or near optimal dispatch policies for fault-tolerant systems, one must have a systematic means of establishing dispatch policies and be able to quantify the benefits that can be realized by adopting specific dispatch policies. A tractable methodology for doing so is described and illustrated. Author

N91-12688# GEC Avionics Ltd., Rochester (England). Flight Control Div.

A FAULT TOLERANT FLY BY WIRE SYSTEM FOR MAINTENANCE FREE APPLICATIONS

R. W. DENNIS and A. D. HILLS *In* AGARD, Fault Tolerant Design Concepts for Highly Integrated Flight Critical Guidance and Control Systems 14 p Apr. 1990

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A triplex primary flight computer system based on a reconfigurable architecture with extensive use of Application Specific Integrated Circuits (ASIC) is described. The system is under development and comprises fault tolerant Fly-by-Wire (FBW) computers which are triplex dissimilar in both software and hardware. These command Actuator Control Electronics (ACE) units via DATAC (ARINC 629) data buses. The Fly-by-Wire computers form the core of the full authority FBW system and perform all the computational commands for the pitch, roll and yaw surface actuation systems. The key requirements placed on the FBW computers are: the probability of loss of the FBW function due to random failure in the FBW computer system shall be less than $1.0E-10$; the FBW system shall survive a generic failure which could arise from either hardware or software; and the system reliability shall have a design aim of 0.95 dispatch probability after at least 30,000 operating hours. The architectural design issues, in terms of integrity requirements and fault tolerance, are reviewed. The FBW computer architecture is based on dividing the basic path into three sub-functional elements. Each of these elements is then replicated to provide fault tolerance. Communication between any one element and its adjacent elements is via point to point bidirectional serial data buses. For a FBW computer to be operable only one of each element type needs to be functional. The internal element redundancy management function, performed both in hardware and software, is able to detect and isolate faulty elements and perform the necessary reconfiguration. Redundancy management is also addressed from a system viewpoint together with the implementation in terms of both hardware and software. The development hardware produced is described. The software structure and the use of dissimilarity is also addressed. The Fly-by-Wire system is being evaluated using an iron bird rig in which FBW computers, DATAC buses, Actuator Control Electronics, and actuators were installed. Author

N91-12690# Royal Signals and Radar Establishment, Malvern (England).

DEPENDABLE SYSTEMS USING VIPER

J. KERSHAW *In* AGARD, Fault Tolerant Design Concepts for Highly Integrated Flight Critical Guidance and Control Systems 7 p Apr. 1990

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Computer systems are being used increasingly in applications where a malfunction could cause loss of life or massive environmental damage. Redundancy is used to guard against random hardware failure in such systems, but redundancy alone does not protect against design faults which might affect every channel at the same time: the classic Common-Cause Failure (CCF). The risk of CCF is all-pervasive. Latent faults can be inserted, over a period, into all the channels of a previously correct system. All these types of event have caused real system breakdowns. The most common defense against design error is diversity, the use of two or more different and separately designed

channels which will be assumed to fail independently. This is expensive, and it still does not protect against errors in the original specification. True diverse implementation of software is surprisingly difficult: even when the specification of a program was clearly separated from its implementation, design decisions usually leak from the specification into some or all of the implementations. At some point, all redundant systems need to decide which channel is faulty. This decision is critical to the operation of the whole system. A simple voter, which merely compares a few logical signals or takes a mean of 3 or 4 analog values, can be made extremely reliable. Digital versions of such a voter are less satisfactory than analog - deciding whether or not several values are within a reasonable tolerance of one another is much easier in the analog world. A really simple digital voter cannot tolerate diverse inputs. The more diverse the channels of a system are, the more complex the decision maker is likely to be. Obviously it must be substantially more reliable than any single channel, or it would compromise the integrity of the system as a whole. Ideally the voter should be distributed among the redundant channels of the system, to minimize the number of critical points at which a single failure would be disabling and to take advantage of diversity in the decision making as well as in the information processing. This leads to Byzantine voting protocols and massive overheads, and still leaves some risk of CCF through errors in the specification. Beyond a certain point, complexity may be self-defeating. Author

N91-12691# General Electric Co., Binghamton, NY. Dept. of Aircraft Control Systems.

FAULT-TOLERANT, FLIGHT-CRITICAL CONTROL SYSTEMS

TOM SADEGHI and GERRY MAYVILLE *In* AGARD, Fault Tolerant Design Concepts for Highly Integrated Flight Critical Guidance and Control Systems 12 p Apr. 1990

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Two leading Fault-Tolerant, Flight-Critical Systems (FTFCSs) currently being developed are described and compared. These technologies, driven by the aircraft performance, reliability, and maintainability requirements, are: the Self-Repairing Flight Control System (SRFCS) and the Vehicle Management System (VMS). SRFCS has two technology thrusts: Control Reconfiguration Strategy (CRS) and Onboard Expert System (OES). VMS is focused on: Vehicle Management Computer (VMC) development and Integrated Diagnostics System (IDS). SRFCS has the potential to reduce brute force hardware redundancy, where the VMS is driven by increased functional complexity demands for increased hardware redundancy. A cursory examination of these technologies suggests that SRFCS can be considered as a complement to VMS development. Contrary to this view, the attributes of each of these technologies are examined and the needs for future development identified. The remaining challenge to be overcome by systems designers is finding the best balanced solution for the future FTFCS, utilizing a proper blend of SRFCS and VMS technologies. Author

N91-12692# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Aircraft Div.

METHODS TO PRESERVE THE INTEGRITY OF A COMBAT AIRCRAFT FLIGHT CONTROL SYSTEM THROUGH MAJOR UPGRADE PROGRAMMES

M. ROESSLER and W. SCHMIDT *In* AGARD, Fault Tolerant Design Concepts for Highly Integrated Flight Critical Guidance and Control Systems 9 p Apr. 1990

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During the years of in-service operation, the Autopilot and Flight Director System/Terrain Following (AFDS/TF) subsystem of the PANAVIA TORNADO has gained a high level of confidence. Methods were developed, to keep control of the integrity of the flight critical system through plenty of modifications. As part of major upgrade programs of the weapon system TORNADO, several improvements will be introduced to the automatic flight control system. How the new elements can be integrated into the existing

system architecture without jeopardizing the integrity and availability of the system and how the enhanced flight control system will be validated and put into operation are explained. Author

N91-12694# Honeywell, Inc., Minneapolis, MN. Systems and Research Center.

INTEGRATED DIAGNOSTICS FOR FAULT-TOLERANT SYSTEMS

HARRY A. FUNK and MARK M. JEPSON /in AGARD, Fault Tolerant Design Concepts for Highly Integrated Flight Critical Guidance and Control Systems 9 p Apr. 1990

(Contract F33615-85-C-3613)

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An integrated approach to the maintainability of high-reliability fault-tolerant flight control systems is presented. Modern aircraft provide designers of maintenance systems a tremendous amount of data on the health of subsystem elements. Examples include initiated built-in-test, continuous built-in-test, redundancy management status, reconfiguration status, and time-stress measurement data. Advances in both on-aircraft and off-aircraft diagnostic hardware and software provide the designer with a wide range of partitioning options to most effectively use these data. An integrated maintenance approach is discussed using both a portable maintenance aid at the flight line and on-aircraft in-flight diagnostic resources. An implementation strategy for each of these systems is presented along with a technique that ensures designed-in commonality between the on-aircraft and off-aircraft systems. The proper use of these systems in addressing particular maintenance problems (re-test okays and cannot-duplicates) is discussed. Author

N91-12700# Grumman Aerospace Corp., Bethpage, NY. Aircraft Systems Div.

PILOTTED SIMULATION VERIFICATION OF A CONTROL RECONFIGURATION STRATEGY FOR A FIGHTER AIRCRAFT UNDER IMPAIRMENTS

RICHARD MERCADANTE /in AGARD, Fault Tolerant Design Concepts for Highly Integrated Flight Critical Guidance and Control Systems 24 p Apr. 1990

(Contract F33615-84-C-3607)

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Piloted simulation performed at the USAF large amplitude multi-mode aerospace research simulator (LAMARS) verified the capability of a reconfiguration strategy to improve aircraft controllability. USAF Tactical Air Command pilots and test pilots from a number of organizations evaluated the characteristics of a next-generation fighter aircraft subjected to control surface damage and/or actuation failures. Tests were performed both with and without the aid of the reconfiguration strategy. For the aircraft configuration simulated, pilot opinions, ratings, and target tracking scores demonstrated the capability of the system to improve aircraft response for a large variety of control surface impairments throughout the subsonic flight envelope. Results ranged from slight to dramatic improvement and departure prevention. Author

N91-12702*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

FLIGHT DEMONSTRATION OF A SELF REPAIRING FLIGHT CONTROL SYSTEM IN A NASA F-15 FIGHTER AIRCRAFT

JAMES M. URNES, JAMES STEWART, and ROBERT ESLINGER (Wright Research Development Center, Wright-Patterson AFB, OH.) /in AGARD, Fault Tolerant Design Concepts for Highly Integrated Flight Critical Guidance and Control Systems 17 p Apr. 1990

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Battle damage causing loss of control capability can compromise mission objectives and even result in aircraft loss.

The Self Repairing Flight Control System (SRFCS) flight development program directly addresses this issue with a flight control system design that measures the damage and immediately refines the control system commands to preserve mission potential. The system diagnostics process detects in flight the type of faults that are difficult to isolate post flight, and thus cause excessive ground maintenance time and cost. The control systems of fighter aircraft have the control power and surface displacement to maneuver the aircraft in a very large flight envelope with a wide variation in airspeed and g maneuvering conditions, with surplus force capacity available from each control surface. Digital flight control processors are designed to include built-in status of the control system components, as well as sensor information on aircraft control maneuver commands and response. In the event of failure or loss of a control surface, the SRFCS utilizes this capability to reconfigure control commands to the remaining control surfaces, thus preserving maneuvering response. Correct post-flight repair is the key to low maintainability support costs and high aircraft mission readiness. The SRFCS utilizes the large data base available with digital flight control systems to diagnose faults. Built-in-test data and sensor data are used as inputs to an Onboard Expert System process to accurately identify failed components for post-flight maintenance action. This diagnostic technique has the advantage of functioning during flight, and so is especially useful in identifying intermittent faults that are present only during maneuver g loads or high hydraulic flow requirements. A flight system was developed to test the reconfiguration and onboard maintenance diagnostics concepts on a NASA F-15 fighter aircraft. Author

N91-12703# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Inst. fuer Flugfuehrung.

FLIGHT TESTING OF A REDUNDANT FBW/FBL HELICOPTER CONTROL SYSTEM

H. BECKER, K. BENDER, K. D. HOLLE, and G. MANSFELD /in AGARD, Fault Tolerant Design Concepts for Highly Integrated Flight Critical Guidance and Control Systems 13 p Apr. 1990

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The DLR has designed and developed an experimental fault-tolerant four-axis flight control computer system for helicopters named DISCUS. The acronym stands for Digital Self-healing Control for Upgraded Safety. The main objective for the design of this computer system was to get a tool for various research tasks related to fault-tolerance, control law design and flight testing of new technologies. The design features of the DISCUS flight control computer system, the hardware realization, the software functions implemented so far and results of flight tests, all this performed in close cooperation with German industry are described. Although the hardware and the executive software of the flight control computer system are designed for four-axes applications, in the reported phase the DISCUS system is first of all flight tested in the yaw-axis control mode only. Author

N91-12705*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

HYPERSONIC VEHICLE SIMULATION MODEL: WINGED-CONE CONFIGURATION

JOHN D. SHAUGHNESSY, S. ZANE PINCKNEY, JOHN D. MCMINN, CHRISTOPHER I. CRUZ, and MARIE-LOUISE KELLEY Nov. 1990 142 p

(NASA-TM-102610; NAS 1.15:102610) Avail: NTIS HC/MF A07 CSCL 01/3

Aerodynamic, propulsion, and mass models for a generic, horizontal-takeoff, single-stage-to-orbit (SSTO) configuration are presented which are suitable for use in point mass as well as batch and real-time six degree-of-freedom simulations. The simulations can be used to investigate ascent performance issues and to allow research, refinement, and evaluation of integrated guidance/flight/propulsion/thermal control systems, design concepts, and methodologies for SSTO missions. Aerodynamic force and moment coefficients are given as functions of angle of attack, Mach number, and control surface deflections. The model

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data were estimated by using a subsonic/supersonic panel code and a hypersonic local surface inclination code. Thrust coefficient and engine specific impulse were estimated using a two-dimensional forebody, inlet, nozzle code and a one-dimensional combustor code and are given as functions of Mach number, dynamic pressure, and fuel equivalence ratio. Rigid-body mass moments of inertia and center of gravity location are functions of vehicle weight which is in turn a function of fuel flow. Author

N91-12706# Naval Air Development Center, Warminster, PA. Dept. of Air Vehicle and Crew Systems Technology.

OPTIMAL CONTROL AND MODEL REDUCTION USING A FINITE-INTERVAL H UPSILON CRITERION Final Report, Mar. 1989 - Mar. 1990

M. BALA SUBRAHMANYAM Apr. 1990 49 p Sponsored by Office of Naval Technology, Arlington, VA (AD-A226490; NADC-90043-60) Avail: NTIS HC/MF A03 CSDL 01/4

A finite-interval H sub infinity control problem is posed and solved making use of nonlinear programming algorithms. An important problem in flight control and flying qualities is the approximation of a complex high order system by a low order model. Making use of a certain correlation index, the model reduction problem is solved by selecting the reduced order model matrices which give the best correlation index. GRA

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.

A91-14452#

NEWLY CONSTRUCTED HIGH SPEED WIND TUNNEL AT THE INSTITUTE OF SPACE AND ASTRONAUTICAL SCIENCE (ISAS) AND RELATED ACTIVITIES

YOSHIFUMI INATANI, KEIICHI KARASHIMA, KOZO FUJII, NOBUHIRO TANATSUGU, and TAKASHI ABE (Institute of Space and Astronautical Science, Sagami-hara, Japan) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 9 p. refs

(AIAA PAPER 90-5226) Copyright

The Institute of Space and Astronautical Science (ISAS) built a new high-speed wind tunnel facility in 1989 in Sagami-hara campus. The objective of the facility construction is to conduct the aerodynamic research of high-speed air and space transportation systems, air-breathing propulsion systems and recovery systems, as well as basic studies in the field of high-speed aerodynamics. The facility consists of a set of high pressure air-supply system and a transonic and a supersonic tunnel. Although both wind tunnels are of conventional blow-down type, the manual procedures in tunnel operations and measurements are highly simplified by making use of fully automatic control systems to save manpower and driving energy necessary for the execution of the wind tunnel experiments. Brief summaries of the facility and its performance, and some of the results obtained in tunnel verification tests as well as a proposed experimental study are summarized. Author

A91-14453#

SEMI-ELLIPTICAL NOZZLE STRUCTURAL TEST FACILITY

JOHN R. SIMMS and WILLIAM F. STIEGLITZ (McDonnell Douglas Missile Systems Co., Saint Louis, MO) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 6 p.

(AIAA PAPER 90-5227) Copyright

The McDonnell Douglas Missile Systems Company (MDMSC) is developing a new thermal-structural test facility. The heart of

this new facility is a semi-elliptical supersonic nozzle. Panels to be thermally and structurally tested form a portion of the flat side of the test nozzle. Arc heated gases are expanded through the nozzle throat and expansion section to Mach 3.65 where it enters the test chamber. The panel to be tested forms the top wall of the nozzle and is thus exposed to the aerodynamic heating of the high enthalpy supersonic flow. The facility includes a test chamber that allows tension loading of the panel simultaneous with the aerodynamic heating. If desired, the ends of the panel are clamped to the fixture for tension loading. The tension loads can be up to 50,000 lb. The enthalpy and pressure can be varied thus providing variable heating rates. When operated in the wedge flow mode, the model is mounted at the exit of the adapter at an angle-of-attack to the test stream. Author

A91-14454*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

A UNIQUE HIGH HEAT FLUX FACILITY FOR TESTING HYPERSONIC ENGINE COMPONENTS

MATTHEW E. MELIS and HERBERT J. GLADDEN (NASA, Lewis Research Center, Cleveland, OH) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 8 p. refs

(AIAA PAPER 90-5228) Copyright

This paper describes the Hot Gas Facility, a unique, reliable, and cost-effective high-heat-flux facility for testing hypersonic engine components developed at the NASA Lewis Research Center. The Hot Gas Facility is capable of providing heat fluxes ranging from 200 Btu/sq ft per sec on flat surfaces up to 8000 Btu/sq ft per sec at a leading edge stagnation point. The usefulness of the Hot Gas Facility for the NASP community was demonstrated by testing hydrogen-cooled structures over a range of temperatures and pressures. Ranges of the Reynolds numbers, Prandtl numbers, enthalpy, and heat fluxes similar to those expected during hypersonic flights were achieved. I.S.

A91-15029#

CHARACTERISTICS OF A CRYOGENIC WIND TUNNEL AT NATIONAL DEFENSE ACADEMY. I - THE OPERATION WITH MANUAL CONTROLS

YUTAKA YAMAGUCHI, SHIZUYUKI YOSHIDA, and HIDEKI KABA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 38, no. 432, Jan. 1990, p. 49-55. In Japanese, with abstract in English. refs

A two-dimensional, small high-speed cryogenic wind tunnel was constructed at the National Defense Academy (NDA) in 1985, using the stainless steels SUS 304 and SCS 13 as materials of the pressure shell. The features of the cryogenic tunnel and its operation procedures are described. The initial operational tests were intensively performed to optimize the general operation method for the present tunnel with the original manual control systems. Those tests showed that the original control systems were fairly acceptable, but had to be modified to automatic controls for more precise control of the tunnel flow conditions in cryogenic temperature range. Author

A91-16050#

THE UPSIDE-DOWN AIR FORCE

SIGMUND S. GRUDZINSKI (USAF, Rome Air Development Center, Griffiss AFB, NY) Aerospace America (ISSN 0740-722X), vol. 28, Nov. 1990, p. 30-33.

Copyright

A review is presented of test and evaluation work conducted at the Rome Air Development Center for electronic warfare testing. As most outside stores that cause interference to ECM emissions are mounted underside of the aircraft it was found to be most efficient to test electronics equipment with the aircraft mounted upside-down on a pedestal. Thus the 'upside-down airforce' is operated to study the effects of external equipment and airframe interference on antenna patterns. As fuel tanks, missiles, countermeasure pods, or other externally mounted equipment have an effect on antenna patterns and radar signatures, the sites at RADC are used to determine what those effects are and how to

minimize them. Since the airframes can be tested at a full 360 degrees azimuth and different elevation angles, pedestal sites are far superior and more complete than flight testing for obtaining antenna patterns. Installation, testing and development modifications are described for various tactical and strategic aircraft including the latest B-1 acquisition. R.E.P.

A91-16676**AIAA FLIGHT SIMULATION TECHNOLOGIES CONFERENCE AND EXHIBIT, DAYTON, OH, SEPT. 17-19, 1990, TECHNICAL PAPERS**

Washington, DC, American Institute of Aeronautics and Astronautics, 1990, 371 p. For individual items see A91-16677 to A91-16721.

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This conference presents papers in the fields of computer systems, crew station design, visual systems, modeling, motion cuing, and simulation networking. Also presented are papers covering verification/validation, simulator research, computational methods, training systems, tactical simulations, simulation applications, and data bases. R.E.P.

A91-16679#**SOFTWARE RELIABILITY FOR FLIGHT CREW TRAINING SIMULATORS**

GEORGE E. STARK (Mitre Corp., Houston, TX) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 22-26. refs (AIAA PAPER 90-3122) Copyright

Flight crew simulator failures are costly and may impact the timing or efficiency of a mission; thus, reliability is one of the most important issues facing simulator developers today. The reliability of a simulator is the probability that a training session of length can be completed without a failure. This paper defines simulator failure and then identifies and compares the three sources of simulator failure: hardware, software, and human, focusing on the cost of software failure. The paper next describes a model for software reliability measurement and proposes a method for establishing a software reliability object. Data from the NASA Shuttle Mission Training Facility illustrate the technique. Finally, the paper examines the implications of using the method on the software testing successes. Author

A91-16699*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DESIGN, DEVELOPMENT AND TESTING OF AN AMBIENT LIGHTING SIMULATOR FOR EXTERNAL ILLUMINATION OF A TRANSPORT SIMULATOR COCKPIT

VERNON M. BATSON and LAWRENCE E. GUPTON (NASA, Langley Research Center, Hampton, VA) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 183-187. refs (AIAA PAPER 90-3146) Copyright

Researchers at the NASA-Langley Research Center several years ago began to examine concepts for a facility which could simulate the full range of lighting conditions encountered in flight. The purpose of this facility was to evaluate advanced technology display devices in a cockpit environment. The Aircraft Cockpit Ambient Lighting Simulation System (ACALSS) has been developed to meet that need. The ACALSS surrounds a wide-body part-task simulator cockpit, the Advanced Display Evaluation Cockpit, and interfaces with a VAX 11/780 computer, which is used to host both a math model of a modern transport aircraft and a solar motion model (which animates a servoed sun simulator). Several concepts were evaluated and an efficient design using an ellipsoid reflector and Fresnel luminaires was selected for implementation. Author

A91-16707#**LOW COST AVIATION TECHNOLOGY TESTBED**

BRIAN F. GOLDIEZ, KEVIN C. ULIANO (Central Florida, University,

Orlando, FL), and DENNIS MCBRIDE (DARPA, Washington, DC) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 244-251. refs

(AIAA PAPER 90-3157) Copyright

This paper describes efforts to develop a low cost aviation technology testbed to investigate the flying qualities and performance parameters of limited fidelity flight simulators. Initial efforts in this testbed have revolved around specifications and preliminary feasibility testing of a video-based data acquisition system. Initial pilot-in-the-loop experiments have also been conducted to investigate the usefulness of pilot opinion as data. The preliminary results from this testbed are encouraging. Further efforts will center on the identification and testing of quantitative measures of simulator fidelity. Author

A91-16716#**A RAPID DATABASE CONFIGURATION SYSTEM USING MULTISPECTRAL IMAGERY**

JEFFREY A. LICKENBROCK, KARL A. SPUHL, and R. E. BROWN (McDonnell Aircraft Co., Saint Louis, MO) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 316-319. (AIAA PAPER 90-3169) Copyright

McDonnell Aircraft Flight Simulation has developed a system for creating high-detail real-world simulator databases from satellite imagery. This system is operator interactive and is usable in both a stand-alone mode and as an enhancement tool for an autonomous feature extraction system. A sample database tile is presented as well as a simulated radar image generated from it. Author

A91-16718#**VALIDATION AND VERIFICATION OF FLIGHT SIMULATORS - THE FACTS AND FICTIONS**

BRIAN P. HAMPSON (CAE Electronics, Ltd., Montreal, Canada) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 337-340.

(AIAA PAPER 90-3173) Copyright

The paper concentrates on the philosophy of the FAA's Advanced Simulation Plan and highlights some current practices demonstrating a poor understanding of this physiology and introducing flaws in the system. It is pointed out that one of the major objectives of the plan is the establishment of a benchmark from which any deterioration in the standard of simulation will become obvious and quantifiable during the device's operational life, while a secondary objective is that reapproval of a simulator at each of its recurrent inspections may be carried out against a known set of criteria. It is found that technology is not being supported by the quality nor quantity of data necessary to take advantage of state of the art simulation, and the solution proposed is for the certification process of the aircraft to require the production of a minimum standard of data for the flight simulator. In addition, the need for comprehensive validation and verification testing is discussed, along with recurrent checking, the effectiveness of flight simulators, and an automated recurrent evaluation coupled with stringent configuration controls. V.T.

N91-11759# Technische Univ., Delft (Netherlands). Faculty of Aerospace Engineering.

ESSAYS ON STABILITY AND CONTROL

M. BAARSPUL, ed. and J. A. MULDER, ed. Oct. 1989 252 p (LR-600; ETN-90-97166) Avail: NTIS HC/MF A12.

The role of the human pilot in flight management and control was considered through mathematical models of pilot behavior, the role of the engineering pilot in flight deck development, and the visual-vestibular interaction in pilot's perception of aircraft or simulator motion. Instrumentation requirements and presample filter design for measurements during unsteady maneuver is discussed.

09 RESEARCH AND SUPPORT FACILITIES (AIR)

Simulation techniques, and the specifying, buying and accepting of a flight simulators are examined. Semi passive attitude stabilization concepts for geodetic satellite are studied. Mathematical models for parameter estimation for stochastic systems, optimal inputs for aircraft parameter estimation, and flight in turbulence and wind shear are given.

N91-11763# National Aerospace Lab., Amsterdam (Netherlands).

PHASE 2 FLIGHT SIMULATOR MATHEMATICAL MODEL AND DATA-PACKAGE, BASED ON FLIGHT TEST AND SIMULATION TECHNIQUES

A. M. H. NIEUWPOORT, J. H. BREEMAN, M. BAARSPUL, and J. A. MULDER (Technische Univ., Delft, Netherlands) *In its* Essays on Stability and Control 18 p Oct. 1989 Previously announced in IAA as A89-13633

Avail: NTIS HC/MF A12

A flight simulator for ground training of Cessna Citation 500 aircraft is addressed. In order to acquire the necessary information in the relatively short period of time available for the execution of the flight tests and the analysis, use was made intensively of dynamic flight test techniques in relation with computer data processing. The mathematical models to be identified must give an adequate description of the aerodynamic forces and moments, the engine characteristics, the flight control system and the landing gear characteristics. In order to evaluate and test the general models, both offline and online (pilot in the loop) simulations were performed on the computer and moving base flight simulator. Comparisons were made between the measured flight test time histories and the computed model responses. The employed instrumentation system, the flight test program, the data processing and corresponding parameter identification and the synthesis of the various models, are presented. ESA

N91-11764# Royal Dutch Airlines, Amsterdam (Netherlands). **FLIGHT DECK DEVELOPMENT AND THE ENGINEERING PILOT**

H. BENEDICTUS *In* Tech. Univ. Delft, Essays on Stability and Control 27 p Oct. 1989

Avail: NTIS HC/MF A12

Background information on the procedures followed when a new flight deck has to be developed is presented. The Boeing 747-400 is used as a typical example. Dealings between the manufacturer and the airline company are outlined. The airline input is useful to achieve a safe, economic and user friendly product. Only a fraction of the discussions are covered. These include: the integrated display system; EFIS and ELCAS features; caution and warning features; navigation; and autoflight. ESA

N91-11771# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Structures and Materials Panel, Working Group 22.

AIRCRAFT OPERATIONS ON REPAIRED RUNWAYS

DUNCAN J. ECKFORD, ed. Aug. 1990 119 p (AGARD-R-731; ISBN-92-835-0574-3) Copyright Avail: NTIS HC/MF A06; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The results of an AGARD Working Group, (WG.22) directed by the Structures and Materials Panel are presented. The Working Group was tasked to develop design requirements and qualification methods the application of which, across NATO, would improve aircraft utilization and interoperability. The subject of repaired-runway operation is developed and illustrated; its sections reflect the various aims of the Working Group while the appendices amplify particular aspects. Throughout, topics are discussed from fundamentals so that it may provide an introduction to the structural and dynamical implications of repaired-runway operation as well as a statement of the current level of development of techniques in design, assessment, and operational clearance. Author

N91-11772# Army Engineer Waterways Experiment Station, Vicksburg, MS. Geotechnical Lab.

CONDITION SURVEY AND PAVER IMPLEMENTATION, EDWARDS AIR FORCE BASE (NORTH BASE), CALIFORNIA Final Report

ROSS A. BENTSEN Jun. 1990 37 p

(Contract F04611-89-X-0091)

(AD-A224978; WES/MP/GL-90-7) Avail: NTIS HC/MF A03 CSCL 01/5

A pavement condition survey was performed on the North Base airfield at Edwards Air Force Base, California, in August 1989 for the purpose of determining the pavement condition index of the airfield features and for performing the initial implementation of the PAVER pavement management system. The pavement identification and condition survey data were input into a Micro Paver data base. GRA

N91-11773# Army Engineer Waterways Experiment Station, Vicksburg, MS. Geotechnical Lab.

CONDITION SURVEY AND PAVER IMPLEMENTATION, EDWARDS AIR FORCE BASE, CALIFORNIA Final Report

ROSS A. BENSTEN Jun. 1990 71 p

(Contract F04611-89-X-0091)

(AD-A224979; WES/MP/GL-90-9) Avail: NTIS HC/MF A04 CSCL 05/1

A pavement condition survey was performed at Edwards Air Force Base, California, in August 1989 for the purpose of determining the pavement condition index of the airfield features and for performing the initial implementation of the PAVER pavement management system. The pavement identification and condition survey data were input into a Micro PAVER data base. GRA

N91-11774# IIT Research Inst., Lanham, MD.

OBJECT-ORIENTED SOFTWARE REQUIREMENTS SPECIFICATION FOR THE UH-1 HELICOPTER FLIGHT SIMULATOR

KATHERINE S. MILLER, DONALD L. ROSS, DONNA E. GRIMES, and MARILYN J. MARCELLI 28 Jun. 1990 157 p

(Contract MDA903-87-D-0056)

(AD-A225041) Avail: NTIS HC/MF A08 CSCL 01/2

The purpose of this document is to explore object-oriented requirements analysis. The document is divided into three sections. The first section is a theoretical overview of object-oriented requirements analysis. It attempts to define what object-oriented requirements analysis is and to justify its use. The second section details the approach adopted for identifying and formulating the requirements listed in this document. The third section contains a case study, in which the approach described in the preceding section is applied. GRA

N91-11775# Pailen-Johnson Associates, Inc., Vienna, VA.

CRITERIA FOR THE USE OF LIME-CEMENT-FLYASH ON AIRPORT PAVEMENTS Final Report

WILLIAM PAILEN Dec. 1989 132 p

(Contract DTFA01-85-C-01047)

(AD-A225226; DOT/FAA/DS-89/36) Avail: NTIS HC/MF A07 CSCL 01/5

A laboratory Lime Cement Flyash (LCF) assessment program was conducted in which samples were fabricated using LCF materials from Ohio, Pennsylvania, Oregon, and Texas sources. The samples were analyzed for the effects of LCF ingredient variations on modulus of resilience, unconfined compressive strength, fracture toughness, tensile strength, and fatigue. Effects of deicing chemicals on modulus of resilience, unconfined compressive strength, fracture toughness, and tensile strength were analyzed. A field testing program was conducted in which core samples were obtained from Newark, Portland, and JFK airports. The samples were tested for modulus of resilience and unconfined compressive strength. A search was conducted of pertinent recent literature on pavement design and analysis, especially LCF pavements. GRA

N91-11776# Naval Civil Engineering Lab., Port Hueneme, CA.
RAPID RUNWAY REPAIR (RRR) TECHNIQUES: A SYSTEMS ANALYSIS Final Report, Jun. 1987 - Jan. 1990
 SHUJIE CHANG May 1990 66 p
 (AD-A225238; NCEL-TN-1813) Avail: NTIS HC/MF A04 CSCL 01/5

An evaluation of nine rapid runway repair (RRR) techniques was performed using the systems analysis approach. This analysis was based on a logical step-by-step procedure of examining the smallest details of each RRR system. The primary objective was to evaluate the RRR systems against criteria (evaluation factors) that were identified to be important in RRR. These criteria included repair time, cost, complexity, etc. The final results showed that the best RRR systems are asphalt blocks, fiberglass reinforced plastic (FRP) mats, and FRP foldable mats. These repair techniques possess the desirable advantages in a RRR system. They are fast, simple, and cost effective, and extensive training is not required. This analysis is not intended to make the decision of which RRR system to implement; it is merely a tool to clearly state the procedures, factors, and rationale that are used to make a decision. GRA

N91-12707 ESDU International Ltd., London (England).
FREQUENCIES OF RESONANCE IN WIND TUNNELS WITH VENTILATED WALLS AND PLENUM CHAMBER Abstract Only
 Apr. 1990 16 p
 (ESDU-90005; ISBN-0-85679-730-8; ISSN-0141-397X) Avail: ESDU

ESDU 90005 derives semi-empirical equations for the resonance frequencies that occur at subsonic speeds in wind-tunnels with walls having slots or circular perforations. Results from the equations for the first resonance frequency (which can limit the usefulness of the tunnel for dynamic testing) are presented graphically for plenum chamber depth-to-height ratios of between 2 and 4. Comparisons between predictions by the method and both test data and finite element calculations suggest the accuracy maybe within 10 percent at Mach numbers below 0.8 but may fall to 20 percent at higher subsonic Mach numbers. Two examples illustrating the use of the item are included. A FORTRAN program of the prediction method is available on magnetic media as ESDUpac 9005. ESDU

N91-12708# Stuttgart Univ. (Germany, F.R.). Inst. fuer Luftfahrtantriebe.
ENHANCEMENT OF THE STUTTGART ALTITUDE TEST FACILITY
 W. BRAIG 1990 16 p
 (ETN-90-97860) Avail: NTIS HC/MF A03

The rather small capacity of the Stuttgart altitude test facility originally established 25 years ago was increased according to the test programs expected for the future. Two additional compressors with appropriate piping, cooling and control systems applicable for both intake air compression and exhaust gas evacuation were installed. A new exhaust gas cooling system was established, now allowing reheat testing up to stoichiometric combustion. Other features include an additional test cell with a hydrostatic thrust balance, an inertia air cleaner and an increased data recording and display system for plant control. The enhanced plant allows testing of engines and components with massflows up to 140 kg/s and with flight Mach numbers up to 2.2. ESA

N91-12712*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A USER'S GUIDE TO THE LANGLEY 16-FOOT TRANSONIC TUNNEL COMPLEX. REVISION 1
 Sep. 1990 240 p Supersedes NASA-TM-83186
 (NASA-TM-102750; NAS 1.15:102750) Avail: NTIS HC/MF A11 CSCL 14/2

The operational characteristics and equipment associated with the Langley 16-foot transonic tunnel complex which is located in buildings 1146 and 1234 at the Langley Research Center are described in detail. This complex consists of the 16-foot transonic wind tunnel, the static test facility, and the 16- by 24-inch water

tunnel research facilities. The 16-foot transonic tunnel is a single-return atmospheric wind tunnel with a 15.5 foot diameter test section and a Mach number capability from 0.20 to 1.30. The emphasis for research conducted in this research complex is on the integration of the propulsion system into advanced aircraft concepts. In the past, the primary focus has been on the integration of nozzles and empennage into the afterbody of fighter aircraft. During the last several years this experimental research has been expanded to include developing the fundamental data base necessary to verify new theoretical concepts, inlet integration into fighter aircraft, nozzle integration for supersonic and hypersonic transports, nacelle/pylon/wing integration for subsonic transport configurations, and the study of vortical flows (in the 16- by 24-inch water tunnel). The purpose here is to provide a comprehensive description of the operational characteristics of the research facilities of the 16-foot transonic tunnel complex and their associated systems and equipments. Author

N91-13338*# Christian Brothers Coll., Memphis, TN. Dept. of Chemical Engineering.

FINE-TUNING OF PROCESS CONDITIONS TO IMPROVE PRODUCT UNIFORMITY OF POLYSTYRENE PARTICLES USED FOR WIND TUNNEL VELOCIMETRY

ASIT K. RAY In Hampton Univ., NASA/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1990 p 101-103 Sep. 1990
 Avail: NTIS HC/MF A07 CSCL 14/2

Monodisperse polymer particles (having uniform diameter) were used for the last two decades in physical, biological, and chemical sciences. In NASA Langley Research Center monodisperse polystyrene particles are used in wind tunnel laser velocimeters. These polystyrene (PS) particles in latex form were formulated at the Engineering Laboratory of FENG D using emulsion-free emulsion polymerization. Monodisperse PS latices particles having different particle diameters were formulated and useful experimental data involving effects of process conditions on particle size were accumulated. However, similar process conditions and chemical recipes for polymerization of styrene monomer have often yielded monodisperse particles having varying diameters. The purpose was to improve the PS latex product uniformity by fine-tuning the process parameters based on the knowledge of suspension and emulsion polymerization. Author

N91-13340*# Virginia Commonwealth Univ., Richmond. Dept. of Mathematical Sciences.

FACILITATING RESEARCHER USE OF FLIGHT SIMULATORS
 C. RAY RUSSELL In Hampton Univ., NASA/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1990 p 107-109 Sep. 1990
 Avail: NTIS HC/MF A07 CSCL 14/2

Researchers conducting experiments with flight simulators encounter numerous obstacles in bringing their ideas to the simulator. Research into how these simulators could be used more efficiently is presented. The study involved: (1) analyzing the Advanced Concepts Simulator software architecture, (2) analyzing the interaction between the researchers and simulation programmers, and (3) proposing a documentation tool for the researchers. Author

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.

A91-13851#

REUSABLE AEROSPACE SYSTEM WITH HORIZONTAL TAKE-OFF

G. E. LOZINO-LOZINSKII (NPO Molniia, Moscow, USSR), L. M. SHKADOV, and V. P. PLOKHIKH (Tsentral'nyi Aerogidrodinamicheskii Institut, Moscow, USSR) IAF, International Astronautical Congress, 41st, Dresden, Federal Republic of Germany, Oct. 6-12, 1990. 12 p. refs (IAF PAPER 90-176) Copyright

An aerospace system (ASS) concept aiming at cost reductions for launching facilities, reduction of ground preparations for start and launch phases, flexibility of use, international inspection of space systems, and emergency rescue operations is presented. The concept suggests the utilization of an AN-225 subsonic carrier aircraft capable of carrying up to 250 ton of the external load, external fuel tank, and orbital spacecraft. It includes a horizontal take-off, full reusable or single-use system, orbital aircraft with hypersonic characteristics, the use of an air-breathing jet engine on the first stage of launch, and the utilization of advanced structural materials. Among possible applications for ASS are satellite launches into low supporting orbits, suborbital cargo and passenger flights, scientific and economic missions, and the technical servicing of orbital vehicles and stations. V.T.

A91-13915#

DESIGN CHALLENGES FOR THE NATIONAL AERO-SPACE PLANE

FRANK D. BOENSCH (National Aero-Space Plane Joint Program Office, Wright-Patterson AFB, OH) IAF, International Astronautical Congress, 41st, Dresden, Federal Republic of Germany, Oct. 6-12, 1990. 6 p. (IAF PAPER 90-266)

The National Aero-Space Plane is a program conceived in 1986 by the United States' Defense Advanced Research Projects Agency, to develop and demonstrate in flight, the technologies necessary for hypersonic flight including single-stage-to-orbit and cruise at sustained mach numbers. In order to do this, a number of technologies, propulsion, structures, aerodynamics, computational fluid dynamics, and materials must be matured to the point that hypersonic flight is practical. This paper will show the progress that has been made in the critical areas of materials and structures. It will highlight advances in propulsion, computational fluid dynamics made possible by high materials such as titanium aluminides and carbon-carbon. Finally, the paper will conclude with an examination of the utility of hypersonic flight both in terms of a single-stage-to-orbit mission, and the commercial potential for hypersonic flight. Author

A91-14137#

COMPARISON OF THREE DIFFERENT APPROACHES TO THE LATERAL MOTION CONTROL SYSTEM DESIGN OF A SINGLE-STAGE-TO-ORBIT AIRCRAFT

JUS KOCIJAN IAF, International Astronautical Congress, 41st, Dresden, Federal Republic of Germany, Oct. 6-12, 1990. 7 p. refs

(IAF PAPER ST-90-003) Copyright

Three approaches to the design of the lateral-motion control of a single-stage-to-orbit aircraft are described and applied to a model of lateral motion of a single-stage-to-orbit aircraft: the state feedback coupling controller in combination with observer and univariable PI controllers; an output feedback pole assignment

multivariable PID controller; and a compensator for achieving diagonal dominance, using the inverse Nyquist array (INA) technique. Results of computer simulations showed that the pole assignment method and the decoupling method give acceptable results, while the INA approach was not successful. I.S.

A91-14437#

DECENTRALIZED INTEGRATED CONTROL OF HYPERSONIC VEHICLES

MASSOUD SINAI (Rockwell International Corp., Downey, CA) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 6 p. Research supported by Rockwell International Corp. refs (AIAA PAPER 90-5211) Copyright

This paper describes a design methodology for integrated control of hypersonic vehicles. The methodology adopts a hierarchical structure for design of integrated engine airframe control with resulting simplicity in both design and implementation phases. Additionally, the developed control laws provide the means for a decentralized implementation. Developed controls are contrasted against a nonintegrated control for decreased stabilizing control power requirements. Author

A91-14442#

DESIGN CONSIDERATIONS FOR COMBINED AIR BREATHING-ROCKET PROPULSION SYSTEMS

DAVID L. KORS (Aerojet-General Corp., Propulsion Div., Sacramento, CA) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 8 p. refs (AIAA PAPER 90-5216) Copyright

Combined air breathing-rocket propulsion systems have been studied and carried through proof-of-principle demonstrations during the last three decades. Currently, a number of countries are studying and in some cases actually starting development of demonstrator vehicles for hypersonic flight which use combinations of air breathing and rocket propulsion. A summary of this activity including the propulsion options being investigated is discussed in this paper. This type of propulsion is much more revolutionary in nature than most previous propulsion developments and thus results in technology challenges that are even more severe than those faced by either conventional air breathing propulsion or rocket designers. These include: (1) propulsion/vehicle integration, (2) engine stability over a wide operating range, (3) high performance over a wide operating range, (4) system level thermal management and (5) advanced materials. A discussion of these technical issues including the impact of underachieved development goals on system level performance is also included in this paper. Author

A91-14444*# Lockheed Engineering and Sciences Co., Hampton, VA.

AN OVERVIEW OF SELECTED NASP AEROELASTIC STUDIES AT THE NASA LANGLEY RESEARCH CENTER

CHARLES V. SPAIN, DAVID L. SOISTMANN, ELLEN C. PARKER, MICHAEL D. GIBBONS (Lockheed Engineering and Sciences Co., Hampton, VA), and MICHAEL G. GILBERT (NASA, Langley Research Center, Hampton, VA) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 15 p. refs (AIAA PAPER 90-5218) Copyright

Following an initial discussion of the NASP flight environment, the results of recent aeroelastic testing of NASP-type highly swept delta-wing models in Langley's Transonic Dynamics Tunnel (TDT) are summarized. Subsonic and transonic flutter characteristics of a variety of these models are described, and several analytical codes used to predict flutter of these models are evaluated. These codes generally provide good, but conservative predictions of subsonic and transonic flutter. Also, test results are presented on a nonlinear transonic phenomena known as aileron buzz which occurred in the wind tunnel on highly swept delta wings with full-span ailerons. An analytical procedure which assesses the effects of hypersonic heating on aeroelastic instabilities (aerothermoelasticity) is also described. This procedure accurately predicted flutter of a heated aluminum wing on which experimental

data exists. Results are presented on the application of this method to calculate the flutter characteristics of a fine-element model of a generic NASP configuration. Finally, it is demonstrated analytically that active controls can be employed to improve the aeroelastic stability and ride quality of a generic NASP vehicle flying at hypersonic speeds. Author

A91-14447#**AUTOMATED STRUCTURAL ANALYSIS FOR HYPERSONIC VEHICLES**

T. M. WILSON, D. A. KOSHIBA, B. L. MATTHEWS, T. W. HESTERMAN, and J. M. COYLE (McDonnell Douglas Corp., Saint Louis, MO) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 6 p. (AIAA PAPER 90-5221) Copyright

An automated analysis system has been developed which integrates the engineering analyses necessary to perform full vehicle thermal/structural optimization for hypersonic vehicles. This system can be used for a wide range of structural sizing applications. It is particularly suited for analyses which must address elevated temperature environments and require short analysis cycle times. Optimization methods for unstiffened, stiffened, and sandwich panel concepts have been developed. The system architecture is modular and allows newly developed methods to be incorporated with minimal effort. An overview of the process is presented with discussion of the following topics: system philosophy, discipline specific analysis methods, data transfer techniques linking analyses, manufacturing considerations and validation of the sizing tools. Author

A91-14449#**CONCEPT AND TECHNOLOGY DEVELOPMENT FOR HOPE SPACEPLANE**

TESTSUICHI ITO, TOSHIO AKIMOTO, HIROSHI MIYABA, YASUOMI KANO, NORIO SUZUKI (NASDA, Tsukuba, Japan) et al. AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 9 p. (AIAA PAPER 90-5223) Copyright

HOPE spaceplane has been studied for several years in NASDA. The purpose of the current study is to establish the feasible concept of HOPE and to prepare the technical bases. The primary mission of HOPE is the Space Station Freedom/JEM logistics transportation complementing with U.S. Space Shuttle fleet. Besides previous concept of ten ton class orbiter launched by H-II rocket, extended size orbiter concept has been studied along with enhancement of H-II rocket, which is called H-IID (derivative) rocket. An orbiter derived from this study weighs 20t at lift off and has three to five tons of payload capability, based on the H-IID configuration of H-II first stage with six solid boosters strapped on. Subsystems design and technology development in such field as aerodynamics, structure and materials, guidance-navigation and control, and Space Station interface are in progress. In order to acquire the reentry flight data, orbital reentry experiment is planned and under development utilizing orbital flight opportunity of H-II test flight in 1993. These concepts are under review and trade off in NASDA for establishing HOPE development scenario. Author

A91-14450*# Eagle Engineering, Inc., Hampton, VA.

INFLUENCE OF VEHICLE CONFIGURATION AND FLIGHT PROFILE ON X-30 SONIC BOOMS

DOMENIC J. MAGLIERI, VICTOR E. SOTHCOTT (Eagle Engineering, Inc., Hampton, VA), and JOHN HICKS (NASA, Flight Research Center, Edwards, CA) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 12 p. refs (Contract NAS9-17900) (AIAA PAPER 90-5224)

The role of vehicle configuration and the flight profile on sonic booms produced by the experimental NASP X-30 is investigated. Sonic boom signatures, overpressure levels, and footprints for X-30 are presented and compared with sonic boom measurements for F-104, SR-71, Concorde, XB-70, and STS Orbiter. Results show

that the sonic boom signatures for X-30 fall within those of previous high-speed planes. I.S.

A91-14451#**CONCEPTUAL STUDY OF SPACE PLANE POWERED BY HYPERSONIC AIRBREATHING PROPULSION SYSTEM**

MASATAKA MAITA, YOSHIKI OHKAMI, TATSUO YAMANAKA (Science and Technology Agency, National Aerospace Laboratory, Chofu, Japan), and TAKASHIGE MORI (Mitsubishi Heavy Industries, Ltd., Nagoya Aerospace Systems Works, Japan) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 10 p. refs (AIAA PAPER 90-5225) Copyright

The paper describes the investigations of aerospace plane concept, conducted by the National Aerospace Laboratory (NAL) of Japan, with particular attention given to a concept which integrates a scram/liquid air cycle engine (LACE) hypersonic propulsion system fueling with slush hydrogen. The key requirements in achieving the space plane using scram/LACE propulsion system are described along with the mission requirements and the vehicle characteristics. Typical outputs of SSTO analysis are presented. I.S.

A91-14455#**FLIGHT TESTING HYPERSONIC VEHICLES - THE X-30 AND BEYOND**

SCOTT PARKS (National Aero-Space Plane Joint Program Office, Wright-Patterson AFB, OH) and BARRY WALDMAN (Rockwell International Corp., Rocketdyne Div., Seal Beach, CA) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 7 p. (AIAA PAPER 90-5229)

Various approaches to flight testing are considered with special attention given to the applicability of these approaches to air-breathing hypersonic vehicles such as the experimental NASP X-30. It is emphasized that, for a vehicle like the X-30, trades must be made between the test methodology and the impact of methodology on the vehicle design. Particular attention is given to a concept which blends two test approaches which were used successfully in the past with the environment specific for a hypersonic flight. I.S.

A91-14469#**NASP GUIDANCE DESIGN FOR VEHICLE AUTONOMY**

E. A. WAGNER, I. LI, D. D. NGUYEN, and P. L. NGUYEN (General Dynamics Corp., Fort Worth, TX) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 11 p. refs (AIAA PAPER 90-5245) Copyright

Vehicle guidance for General Dynamics' NASP vehicle is planned to be self-contained onboard the vehicle, and independent of any ground support during the mission. It will include real-time onboard abort and ascent trajectory optimization capability. Although these features should be considered a natural outgrowth of research in guidance and trajectory optimization and advances in computation, facilitating full vehicle autonomy for NASP represents a significant advance relative to any flight-demonstrated guidance. Algorithms and processing requirements for autonomous NASP vehicle guidance are considered. Author

A91-14472*# National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

CFD SUPPORT OF NASP DESIGN

CHARLES R. MCCLINTON (NASA, Langley Research Center, Hampton, VA), ROBERT D. BITTNER, and PRADEEP S. KAMATH (Analytical Services and Materials, Inc., Hampton, VA) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 22 p. refs (AIAA PAPER 90-5249) Copyright

This paper presents a summary of design studies from the 'open' literature which illustrate the level of effort and the use of computational fluid dynamics (CFD) to support the National Aerospace Plane (NASP) X-30 design. CFD plays a major role in

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the NASP program, particularly for the very high speed regions (Mach greater than 10) where wind tunnels cannot fully simulate the flow, and flow field measurements are difficult to obtain. Full simulation (nose-to-tail analysis) of the NASP flow field, both internal and external, is discussed. Author

A91-16711#

ROCKWELL'S REAL-TIME SIMULATOR AIDS HYPERSONIC VEHICLE/NASP DESIGNS

WILLIAM G. BURNETT (Rockwell International Corp., Space Systems Div., Downey, CA) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 277-283. Research supported by Rockwell International Corp. (AIAA PAPER 90-3162) Copyright

Simulation development operations and the methodology for a hypersonic vehicle (HSV) laboratory, including the system architecture of HSV simulation are considered. Focus is placed on a secure facility for simulating HVS such as the Shuttle, Assured Crew Return Vehicle, and Advanced Launch System. The simulator development and its major tasks are covered, and vision systems, glass-cockpit generation, and crew systems are described. It is noted that the simulator is a major forcing function for subsystem integration, especially when testing man-in-the-loop operations. A simulation test plan designed to explore HSV technology by expanding the vehicle flight envelope from subsonic to extremely high Mach numbers is outlined, as well as simulation math models including a complete real-time six-degree-of-freedom configuration. V.T.

A91-11799*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

UNSTEADY BLADE-SURFACE PRESSURES ON A LARGE-SCALE ADVANCED PROPELLER: PREDICTION AND DATA

M. NALLASAMY (Sverdrup Technology, Inc., Brook Park, OH.) and J. F. GROENEWEG Jul. 1990 15 p Presented at the 26th Joint Propulsion Conference, Orlando, FL, 16-18 Jul. 1990; sponsored in part by AIAA, SAE, ASME, and ASEE Previously announced in IAA as A90-47220 Original contains color illustrations

(Contract NAS3-24105)

(NASA-TM-103218; E-5630; NAS 1.15:103218) Avail: NTIS HC/MF A03; 1 functional color page CSCL 21/8

An unsteady 3-D Euler analysis technique is employed to compute the flow field of an advanced propeller operating at an angle of attack. The predicted blade pressure waveforms are compared with wind tunnel data at two Mach numbers, 0.5 and 0.2. The inflow angle is three degrees. For an inflow Mach number of 0.5, the predicted pressure response is in fair agreement with data: the predicted phases of the waveforms are in close agreement with data while the magnitudes are underpredicted. At the low Mach number of 0.2 (takeoff), the numerical solution shows the formation of a leading edge vortex which is in qualitative agreement with measurements. However, the highly nonlinear pressure response measured on the blade suction surface is not captured in the present inviscid analysis. Author

A91-11856# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Stuttgart (Germany, F.R.). Inst. for Structures and Design.

DEVELOPMENT AND REAL-TEST OF A RAMJET NOZZLE MADE OF LIQUID-SILICON-INFILTRATED C/SIC

H. HALD, P. SZASZ, and K. DITTRICH In ESA, Space Applications of Advanced Structural Materials p 283-289 Jun. 1990 Copyright Avail: NTIS HC/MF A19

A ramjet nozzle with an integrated secondary combustion chamber is produced using C/SiC material. The mechanical properties of the material are evaluated by means of equivalent C/SiC tubes tested in a hydraulic pressure test set up at ambient temperature. Material pseudo-plasticity is observed which provides a certain damage tolerance. The nozzle, 250 mm long, 75 mm in

mean diameter with a mass of 220 g is tested at an experimental ramjet test facility to its thermo-mechanical limits. The applicability of C/SiC material for highly thermomechanically loaded structures is confirmed. A limited lifetime in oxidative atmospheres is however demonstrated. ESA

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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.

A91-13350* Texas Instruments, Inc., Dallas.

THE MICROSTRUCTURE AND PROPERTIES OF RAPIDLY SOLIDIFIED, DISPERSION-STRENGTHENED NIAL

S. C. JHA (Texas Instruments, Inc., Dallas) and R. RAY (Marko Materials, Inc., North Billerica, MA) JOM (ISSN 1047-4838), vol. 42, Oct. 1990, p. 58-61. refs

(Contract NAS3-25448)

Copyright

An advanced rapid solidification technology for processing reactive and refractory alloys, utilized to produce large quantities of melt-spun filaments of NiAl, is presented. The melt-spun filaments are pulverized to fine particle sizes, and subsequently consolidated by hot extrusion or hot isostatic pressing. Rapid solidification process gives rise to very fine-grained microstructures. However, exposure to elevated temperature during hot consolidation leads to grain growth. Alloying agents such as borides, carbides, and tungsten can pin the grain boundaries and retard the grain growth. Various alloy compositions are investigated. The eventual goal is to utilize the hot-extruded and forged stock to grow single-crystal NiAl blades for advanced gas-turbine engine applications. Single-crystal NiAl, containing a uniform dispersion of carbide strengthening precipitates, is expected to lead to highly creep-resistant turbine blades, and is of considerable interest to the aerospace propulsion industry. B.P.

A91-13929#

METALLIC LEADING EDGE WITH ACTIVE THERMAL PROTECTION

P. HEBRARD, H. GAY, and R. LE TOUCHE (Aerospatiale, Division Systemes Strategiques et Spatiaux, Les Mureaux, France) IAF, International Astronautical Congress, 41st, Dresden, Federal Republic of Germany, Oct. 6-12, 1990. 7 p.

(IAF PAPER 90-284) Copyright

An original solution of the problem of excessive heating of leading edges of hypersonic missiles due to aerothermral loads is described. The solution involves the use of a coating of a product which has been used as a high-performance thermal protection against long-lasting fires. The operating mode of the compound is described, and the results of tests using it are reviewed and compared with solutions using insulators. The realization of a leading edge using the product is described. C.D.

A91-14268

CREEP OF A CO-RICH NI BASE SUPERALLOY

R. MERABTINE (Annaba, Universite, Algeria), C. BERTRAND, J.-P. DALLAS, J. DEVAUD-RZEPSKI, M.-F. TRICHET (CNRS, Centre d'Etudes de Chimie Metallurgique, Vitry-sur-Seine, France) et al. Scripta Metallurgica et Materialia (ISSN 0956-716X), vol. 24, Nov. 1990, p. 2203-2208. refs

Copyright

An investigation is conducted of the creep behavior of a Co-rich superalloy, whose use in industrial gas turbine blades has been found to lead to premature deformation. Attention is given to the dislocation microstructures resulting from high-temperature plastic deformation at 750 C in the 400-650 MPa stress range. The

apparent applied stress exponent is high due to the gamma-prime precipitates typical of superalloys; the dislocation microstructures observed by TEM are typical of very low deformation rates. Plastic deformation is caused primarily by the formation of stacking faults, which are perhaps due to the alloy's low stacking-fault energy. O.C.

A91-14410

MATERIALS AND STRUCTURAL CONCEPTS FOR NEW SPACE TRANSPORTATION SYSTEMS

H. W. BERGMANN (DLR, Brunswick, Federal Republic of Germany) SAMPE Quarterly (ISSN 0036-0821), vol. 22, Oct. 1990, p. 51-61. refs

Copyright

An evaluation is made of the nature and prospective solutions of refractory materials and structures-related problems encountered in the design of such prospective horizontal takeoff and landing space transportation systems as NASA's NASP, the UK's HOTOL, and Germany's Saenger. Metal-matrix composites under consideration are composed of continuous boron-, carbon-, SiC-, and Al₂O₃-reinforced matrices of Ti-6Al-4V; SiC/Ti-6Al-4V has proven to be a promising material for service temperatures approaching 650 C. Borosilicate, aluminosilicate, and lithium-aluminosilicate glass matrices are found to be applicable in the 500-1100 C range. Ceramic matrices yield the highest refractory performance. The novel design concepts developed for structurally integral LOX and LH₂ cryotanks are noted. O.C.

A91-14948#

A STUDY ON COMBUSTION OF BORON-CONTAINED FUEL FOR SOLID FUEL RAMJETS

SHIJI GONG (MAS, 31st Research Institute, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), Oct. 1990, p. 62-64. In Chinese, with abstract in English.

A91-15400

ROLE OF COLLOID SYSTEMS IN THE FORMATION OF SLUDGE IN JET FUELS [O ROLI KOLLOIDNYKH SISTEM V OBRAZOVANII OSADKOV REAKTIVNYMI TOPLIVAMI]

E. P. SEREGIN, N. M. LIKHTEROVA, V. G. GORODETSKII, A. F. GORENKOV, I. A. LITVINOV et al. Khimiia i Tekhnologiiia Topliv i Masel (ISSN 0023-1169), no. 9, 1990, p. 22-24. In Russian. refs

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The phase composition of commercial jet fuels TS-1 and RT, as well as some laboratory fuels, were investigated in relation to the susceptibility of the fuels to sludge formation during service. The susceptibility to sludge formation under dynamic conditions was estimated experimentally using electron microscopy. It is shown that the size, shape, and number of disperse phase particles depend on the chemical composition of the heteroatomic compounds. The amount and nature of the disperse phase determine the level of thermal oxidation stability, estimated on the basis of the amount of sludge formed on a heated surface. V.L.

A91-16023#

INFLUENCE OF ALTERATION LAYER CREATED BY CREEP-FEED GRINDING ON FATIGUE LIFE OF M17 SUPERALLOY

CHANGSHENG JING, WEILIAN WANG, MINGWEI LIU, and YUEZHEN YANG (Northwestern Polytechnical University, Xian, People's Republic of China) Northwestern Polytechnical University, Journal (ISSN 1000-2758), vol. 8, Oct. 1990, p. 433-438. In Chinese, with abstract in English.

Results are presented concerning machining method effects on the fatigue strength of M17, a nickel-based cast superalloy used as turbojet blade material, for both room temperature and high temperature. Cantilever-beam fatigue tests of M17 specimens with surface layer created by creep-feed grinding and conventional grinding were conducted. It is concluded that, at room temperature, fatigue life is longer with higher compressive residual stress. The influence of surface roughness on fatigue strength is insignificant.

The fatigue life of a specimen with surface layer created by creep-feed grinding is the longest. R.E.P.

A91-16031

LIGHT HIGH TEMPERATURE ALUMINUM ALLOYS FOR SUPERSONIC AND HYPERSONIC VEHICLES

P. S. GILMAN (Allied-Signal, Inc., Morristown, NJ) IN: Thermal Structures Conference, 1st, Charlottesville, VA, Nov. 13-15, 1990, Proceedings. Charlottesville, VA, University of Virginia Light Thermal Structures Center, 1990, p. 111-128. refs

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Historically, aluminum alloys have dominated the aerospace materials market for applications below 150 C such as for airframe structures. A number of design studies have shown the substantial weight savings that may be realized in airframe and engine applications by substituting a high temperature aluminum alloy for titanium alloys in the 150 C to 400 C temperature range. Recognizing this potential, and building upon its expertise in rapid solidification and advanced materials, rapidly-solidified aluminum-iron-vanadium-silicon alloys have been developed which combine a balanced set of elevated temperature strengths and ambient temperature properties critical for aerospace applications. The application of the rapidly solidified Al-Fe-V-Si alloys for supersonic and hypersonic vehicles is discussed. Author

A91-16032* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

ADVANCED METALLICS FOR HIGH TEMPERATURE AIRFRAME STRUCTURES

W. BARRY LISAGOR (NASA, Langley Research Center, Hampton, VA) IN: Thermal Structures Conference, 1st, Charlottesville, VA, Nov. 13-15, 1990, Proceedings. Charlottesville, VA, University of Virginia Light Thermal Structures Center, 1990, p. 129-143. refs

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The development of new lower density materials with improved properties and higher use temperatures, is considered essential enabling technology for nearly all envisioned aeronautics structural applications on the horizon. Notable examples of such applications include the High Speed Civil Transport (HSCT) in the supersonic regime and the National Aerospace Plane (NASP) in the hypersonic regime. This paper reviews the vehicle as well as material requirements for such applications and identifies candidate emerging metallics along with examples of reported properties. Finally, critical needs and current development status of candidate metallics are addressed. Author

A91-16093

TENSILE STRENGTH AND FRACTURE DEFECTS EXPANDED BY SUBCRITICAL CRACK GROWTH OF SILICON NITRIDE AT HIGH TEMPERATURES

T. OHJI, Y. YAMAUCHI, W. KANEMATSU, and S. ITO (Government Industrial Research Institute, Nagoya, Japan) Journal of Materials Science Letters (ISSN 0261-8028), vol. 9, Nov. 1990, p. 1266-1268. refs

Copyright

The effect of fracture defects expanded by subcritical crack growth (SCG) in silicon nitride at 1200 C on the strength properties of the material was investigated using SEM and tensile test measurements. In a fractographic study of internally fractured specimens at 1200 C, a wake of SCG was clearly observed as a circular whitish area. The values of K_{IC} were estimated for each expanded crack and plotted against the crack radius. The increments of K_{IC} showed good agreement with the previously investigated R-curve behavior of hot-pressed silicon nitride in the temperature range 1140-1260 C. I.S.

A91-16559

ULTRASONIC CHARACTERIZATION OF MICROSTRUCTURE IN POWDER METAL ALLOY

B. R. TITTMANN (Pennsylvania State University, University Park), M. ABDEL-GAWAD (Rockwell Science Center, Thousand Oaks, CA), and K. FERTIG (Rockwell International, Palo Alto, CA) Research in Nondestructive Evaluation (ISSN 0934-9847), vol. 2,

11 CHEMISTRY AND MATERIALS

no. 2, 1990, p. 119-133. refs
(Contract W-7405-ENG-82)
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The ultrasonic-wave propagation characteristics of a nickel-based powder-metal alloy (IN-100), used in the manufacturing of aircraft engine components, are investigated. The alloy is selected as a model system for testing the feasibility of microstructure characterization for a variety of nonhomogeneous media including powder metals, ceramics, castings, and composites. Data, obtained for a frequency range of 2-20 MHz, are statistically averaged over numerous volume elements of the samples. Micrographical examination provides size and number distributions for the grain and pore structure. The predominant source for the ultrasonic attenuation and backscatter is found to be a dense (about 100/cu mm) distribution of small micropores (about 10 microns radius). Two samples of different micropore densities are tested and the agreement between the predicted and observed values is found to be satisfactory. The results can be used in nondestructive characterization of anomalous distributions of micropores where conventional ultrasonic imaging is difficult to apply and in early detection of potential failure sites where stress-induced void coalescence leads to crack initiation.

B.P.

A91-16576

CRITICAL PROPERTY EVALUATION OF HIGH-TEMPERATURE COMPOSITES - A CASE STUDY IN MATERIALS DESIGN

DAVID A. WOODFORD (Rensselaer Polytechnic Institute, Troy, NY) JOM (ISSN 1047-4838), vol. 42, Nov. 1990, p. 50-55. refs
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The design and development of a tantalum carbide fiber-reinforced nickel-base superalloy eutectic composites suitable for aerospace applications is described in terms of critical property evaluation. Data are presented demonstrating the technical capability of NiTaC composites for high-pressure blade application, and it is shown that the inadequacy of many eutectic composites can be revealed on the basis of simple creep strength limitations. It is noted that, since the invention of NiTaC14B, the strength potential of this composite was not matched by composites developed later. However, despite its technical success, the issues of producibility and high alloy cost prevented further development of NiTaC14B.

I.S.

A91-16927

AEROSPACE AND DEFENSE STRUCTURAL MATERIALS FOR THE TWENTY-FIRST CENTURY

FRANCIS H. FROES (Idaho, University, Moscow) IN: P/M in aerospace and defense technologies; Proceedings of the Conference and Exhibition, Seattle, WA, Nov. 2, 3, 1989. Volume 1. Princeton, NJ, Metal Powder Industries Federation, 1990, p. 23-49. refs

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An account is given of advanced material aerospace applications' requirements and development prospects into the 21st century, with a view to both airframe and propulsion system materials and the aerothermodynamic loads of hypersonic cruise aircraft. Attention is given to the cost-reduction possibilities presented by heat resistant structural materials' fabrication via P/M techniques. Composites discussed encompass, in addition to the familiar polymeric-matrix ones, novel metal- and ceramic-matrix composites. By the year 2010, it is projected that as much as 80 percent of a typical aircraft engine may be composed of metal and ceramic matrices.

O.C.

A91-16930

AEROSPACE APPLICATIONS OF RAPIDLY SOLIDIFIED ALUMINUM ALLOYS

S. K. DAS, P. S. GILMAN, J. C. LASALLE, J. PELTIER, D. RAYBOULD (Allied-Signal, Inc., Morristown, NJ) et al. IN: P/M in aerospace and defense technologies; Proceedings of the Conference and Exhibition, Seattle, WA, Nov. 2, 3, 1989. Volume 1. Princeton, NJ, Metal Powder Industries Federation, 1990, p.

77-82. refs

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Recent progress in rapid solidification processing of metallic materials has opened new horizons for alloy design, expanding the ranges of possible microstructures and alloy compositions beyond those readily achieved through conventional technology. Alloy systems incorporating high volume fractions of ultrafine dispersed phases can now be produced, yielding improved corrosion and oxidation resistances, as well as enhanced toughness and elevated temperature strength. Two examples discussed below include high temperature aluminum (HTA) alloys capable of competing with titanium alloys, and aluminum-lithium alloys produced by rapid solidification powder metallurgy (RS/PM) techniques.

Author

A91-16933

PM OF HIGH STRENGTH TITANIUM ALLOYS

R. R. BOYER, E. R. BARTA (Boeing Commercial Airplanes, Renton, WA), C. F. YOLTON (Crucible Research Center, Pittsburgh, PA), and D. EYLON (Dayton, University, OH) IN: P/M in aerospace and defense technologies; Proceedings of the Conference and Exhibition, Seattle, WA, Nov. 2, 3, 1989. Volume 1. Princeton, NJ, Metal Powder Industries Federation, 1990, p. 99-115. refs

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There is a substantial payoff in terms of weight savings for ultra-high strength titanium alloys in replacement of steel, particularly for structures such as landing gears. These alloys have compositions that are difficult to melt using ingot metallurgy, so the rapid solidification/powder metallurgy technology appears to be a viable approach to attaining these goals. Preliminary results of an exploratory study of Ti-8V-5Fe-1.3Al alloy are presented. Tensile results comparing ingot metallurgy, gas atomized powder which has been consolidated by Hot Isostatic Pressing (HIP) and extrusion, and extruded Albany Titanium powder products are discussed. A tensile strength of 220 ksi with 8 percent elongation has been achieved in one condition using gas atomized powder product.

Author

N91-11808*# Sikorsky Aircraft, Stratford, CT.

FLIGHT SERVICE EVALUATION OF COMPOSITE HELICOPTER COMPONENTS Final Report, Feb. 1981 - Nov. 1990

GEORGE H. MARDOIAN and MAUREEN B. EZZO Nov. 1990
142 p

(Contract NAS1-16542)

(NASA-CR-182063; NAS 1.26:182063; SER-510349) Avail: NTIS HC/MF A07 CSCL 11/4

An assessment is presented of ten composite tail rotor spars and four horizontal stabilizers exposed to the effects of in-flight commercial service for up to nine years to establish realistic environmental factors for use in future designs. This evaluation is supported by test results of helicopter components and panels which have been exposed to outdoor environmental effects since 1979. Full scale static and fatigue tests were conducted on graphite/epoxy and Kevlar/epoxy composite components removed from Sikorsky Model S-76 helicopters in commercial operations off the Gulf Coast of Louisiana. Small scale static and fatigue tests were conducted on coupons obtained from panels exposed to outdoor conditions in Stratford, CT and West Palm Beach, Florida. The panel materials and ply configurations were representative of the S-76 components. The results are discussed of moisture analyses and strength tests on both the S-76 components and composite panels after up to nine years of outdoor exposure. Full scale tests performed on the helicopter components did not disclose any significant reductions from the baseline strengths. The results increased confidence in the long term durability of advanced composite materials in helicopter structural applications.

Author

N91-11881# Dayton Univ., OH.

COMPOSITES SUPPORTABILITY RAPID TEST AND EVALUATION Final Technical Report, Oct. 1986 - Feb. 1990

D. R. ASKINS, R. KUHBANDER, S. SALIBA, C. GRIFFEN, and G. W. LAWLESS May 1990 167 p

(Contract F33615-86-C-5031)
(AD-A225243; UDR-TR-90-24; WRDC-TR-90-4035) Avail: NTIS
HC/MF A08 CSCL 11/1

Materials investigations were conducted in the general areas of adhesive bonding, composite materials, aircraft transparencies, and elastomeric seals. These studies were oriented towards characterization of new materials and processes, development of repair techniques, development of new processing techniques, and solution of current operational problems involving materials and processing. Some qualification testing was carried out on new materials. Studies involved the characterization of inorganic and water-based primers for adhesive bonding, adhesive and resins for aircraft repair, novel surface preparation procedures for aluminum and composite adherends, high temperature adhesives, bonding of aluminum castings, composite paint removal techniques, techniques to prepare thermoplastic prepreg, use of induction heating to cure composites, honeycomb repair procedures, evaluation of heat lamps for curing of composite repair patches, assessment of resin transfer molding for filament wound structure, studies of battle-damage-repair techniques for aircraft transparencies, and determination of aircraft fuel and lubricating oil compatibility with elastomeric seal materials. GRA

N91-11906# Royal Aerospace Establishment, Farnborough (England). Dept. of Materials and Structures.

THE DEVELOPMENT OF ALUMINUM LITHIUM ALLOYS: AN OVERVIEW

C. J. PEEL *In* AGARD, New Light Alloys 55 p Sep. 1990
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For the last decade the aluminium industry has been redeveloping aluminium-lithium alloys for aerospace use. While not new in concept or in technology, these alloys would appear to offer the aircraft designer as much weight saving as non-metallic composite materials with the added advantage of the continued employment of well developed manufacturing routes supported by existing expensive equipment. It is clear that, were it not for significant technical and production difficulties, many of the airframes produced today would already be manufactured in aluminium-lithium alloy. Not only the property advantages that enable very significant weight savings to be achieved, but those difficulties that are being slowly overcome by intensive effort are highlighted. The scale of this effort can be judged by the fact that the last of the five International Conferences, held exclusively on aluminium-lithium alloys, produced over 1700 pages of print. It is far beyond the scope of this paper to comprehensively review this aggregated volume of work but an attempt is made to precis those aspects thought to be most relevant to the successful outcome of the development. Author

N91-11907# Virginia Univ., Charlottesville. School of Engineering and Applied Science.

THE MICROSTRUCTURE AND PROPERTIES OF ALUMINUM-LITHIUM ALLOYS

EDGAR A. STARKE, JR. and WILLIAM E. QUIST (Boeing Commercial Airplane Co., Seattle, WA.) *In* AGARD, New Light Alloys 21 p Sep. 1990 Previously announced as N90-15187 (Contract DAAL03-86-K-0128; N00014-85-0526; AF-AFOSR-0082-87)

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The advantage to be gained by weight reduction of aerospace structures have encouraged the aluminum industry to develop a family of aluminum alloys which contain lithium as one of the alloying elements. When alloyed with aluminum, lithium can reduce the density by approximately three percent and increase the elastic modulus by six percent for every weight percent added. A new series of aluminum alloys, typified by 2090, 2091, 8090, and 8091, were developed and are currently being produced in commercial quantities. These alloys have densities between 7 and 10 percent lower than the conventional alloy 7075 with correspondingly higher stiffness. Although a combined set of specific properties of the

Al-Li-X alloys often exceeds those of the conventional aluminum materials used in aerospace, these properties seem to be much more sensitive to processing parameters. The strong processing-property relationship is associated with sharp crystallographic textures that are developed during primary processing and very complex precipitate microstructures whose distributions are sensitive to quench rates and degree of deformation prior to aging. The processing-microstructure property relationships of the new Al-Li-X alloys are described and the focus is on strength, ductility, fracture toughness, fatigue and stress corrosion properties. Author

N91-11915# Rolls-Royce Ltd., Derby (England).

PROCESS MODELLING

O. L. TOWERS 6 Dec. 1989 61 p Presented at Institute of Metals Seminar of Characterization of High Temperature Materials. 5: Numerical Techniques, 6 Dec. 1989 (PNR-90716; ETN-90-97943) Copyright Avail: NTIS HC/MF A04

The requirements of a process model are reviewed with respect to how to reduce lead times through close integration between design and manufacture. Particular needs to be met are covered for casting, forging and heat treatment. The modeling of casting and forging are described as examples. Orientation is towards modeling the manufacture of high temperature components for jet engines. ESA

N91-11929# Dayton Univ., OH.

HIGH-TEMPERATURE LUBRICANT ANALYSES USING THE SYSTEM FOR THERMAL DIAGNOSTIC STUDIES (STDS): A FEASIBILITY STUDY Final Report, Jun. 1987 - Mar. 1990

WAYNE A. RUBEY, RICHARD C. STRIEBICH, and DEBRA A. TIREY Jul. 1990 83 p (Contract F33615-84-C-2411) (AD-A225242; UDR-TR-87-124; WRDC-TR-90-2047) Avail: NTIS HC/MF A05 CSCL 11/8

Increased importance has been focused upon the development of lubricants which can withstand more intense thermal exposures. Accordingly, a study was undertaken to determine the applicability of experimentally evaluating the high temperature degradation properties of various lubricants using a System for Thermal Diagnostic Studies (STDS). With recent advances in instrumental chemical analysis techniques and associated instrumentation assemblies, it was considered highly probable that improved measurement and characterization techniques could be implemented for evaluating current and future high performance aircraft lubricants. Therefore, four different lubricant samples were selected and subsequently tested using the STDS, which is an in-line system that performs both the thermal stressing function and the subsequent instrumental chemical analyses. GRA

N91-11938# Wyoming Univ., Laramie. Western Research Inst. **PRODUCTION OF JET FUELS FROM COAL DERIVED LIQUIDS. VOLUME 16: ANALYSIS OF PHENOLIC SPECIES IN COAL DERIVED AVIATION FUELS Interim Report, Sep. 1988 - Jul. 1989**

F. D. GUFFEY and D. E. HUNTER Jun. 1990 43 p (Contract FY1455-86-N-0657; AF PROJ. 2480) (AD-A224656; AFWAL-TR-87-2042-VOL-16) Avail: NTIS HC/MF A03 CSCL 21/4

Samples of jet fuel (JP-4, JP-8, JP-8X) produced from the liquid by-products of the gasification of lignite coal from the Great Plains Gasification Plant were analyzed to determine the quantity and type of organo-oxygen compounds present. Large quantities of oxygen compounds were found in the coal derived liquids and were removed in the refining process. Trace quantities of organo-oxygenate compounds were suspected to be present in the refined fuels. Compounds were identified and quantified as part of an effort to determine the effect of these compounds in fuel instability. GRA

11 CHEMISTRY AND MATERIALS

N91-11939# North Dakota Univ., Grand Forks. Energy and Environmental Research Center.

PRODUCTION OF JET FUELS FROM COAL-DERIVED LIQUIDS. VOLUME 14: OXYGENATES CONTENT OF COAL-DERIVED JET FUELS Interim Report, 26 Nov. 1986 - 31 Jul. 1989

CURTIS L. KNUDSON Jun. 1990 61 p
(Contract FY1455-86-N-0657; DE-AC22-87PC-90016; AF PROJ. 2480)
(AD-A224848; AFWAL-TR-87-2042-VOL-14) Avail: NTIS HC/MF A04 CSDL 21/4

Samples of jet fuel (JP-4, JP-8, JP-8X) produced from the liquid by-products of the gasification of lignite coal from the Great Plains Gasification Plant were analyzed to determine the quantity and type of organo-oxygen compounds present. Results were compared to similar fuel samples produced from petroleum. Large quantities of oxygen compounds were found in the coal derived liquids and were removed in the refining process. Trace quantities of organo-oxygenate compounds were suspected to be present in the refined fuels. Compounds were identified and quantified as part of an effort to determine the effect of these compounds in fuel instability. Results of the analysis showed trace levels of phenols, naphthols, benzofurans, hexanol, and hydrogenated naphthols were present in levels below 100 ppm. GRA

N91-11942# Flow Research, Inc., Kent, WA.
DEVELOPMENT OF A MATHEMATICAL CODE TO PREDICT THERMAL DEGRADATION OF FUEL AND DEPOSIT FORMATION IN A FUEL SYSTEM Final Report, 15 Aug. 1989 - 15 Apr. 1990

SURESH MENON Sep. 1990 49 p
(Contract F33615-89-C-2932)
(AD-A225415; FRI-TR-502; WRDC-TR-90-2084) Avail: NTIS HC/MF A03 CSDL 21/4

It has been observed in both small-scale experiments and full-scale system simulators that jet fuels, when heated, undergo chemical reactions that eventually result in sediment/deposit formation. Thus, the thermal instability of jet fuels has the deleterious effect of causing fuel system malfunctions. This situation is also possible in supersonic aircraft, where an increase in the metal skin temperature due to aerodynamic heating can, in turn, increase the temperature of uninsulated fuel tanks, leading to deposit formation. Although a great deal of experimental data has been obtained, the exact mechanisms of the degradation reaction and the consequent deposit formation process are still largely unknown. This is primarily due to the fact that the degradation process is influenced by many factors, some of which cannot be determined, varied, or controlled in an experiment. Thus, there is a need for a mathematical model that, once validated, can be used to predict the fuel deposition process by combining the effects of the fluid flow and heat transfer processes and the fuel degradation reactions. GRA

N91-12565# IIT Research Inst., Bartlesville, OK. National Inst. for Petroleum and Energy Research.

ETBE IN GENERAL AVIATION AIRCRAFT ENGINES Abstract Only

WILLIAM F. MARSHALL In AIAA, Proceedings of the 1990 AIAA/FAA Joint Symposium on General Aviation Systems p 54-55 May 1990
Avail: NTIS HC/MF A17

Tests were conducted to determine the potential of using ethyl tertiary-butyl ether (ETBE) as a fuel for light aircraft engines. An engine was installed on a test stand and operated at two speed-load conditions with five fuels. The fuels were avgas, an unleaded premium autogas, blends of ETBE in the autogas, and neat ETBE. The air-fuel mixture was controlled at five different stoichiometries at each engine mode. Engine performance and exhaust emissions were measured at each condition. The exhaust emissions measurements included hydrocarbon speciation and aldehydes as well as total hydrocarbon, CO, NOx, O2, and CO2. Results show that the engine performance achieved with ETBE (either blended or neat) was equivalent to that with hydrocarbon fuels. Thermal

efficiency was slightly higher for ETBE. However, the lower emission rates of the reactive components with ETBE yields a net effect of lesser effect on air quality. Author

N91-12566# Federal Aviation Administration, Atlantic City, NJ.
FLIGHT TESTING WITH ETHANOL IN TURBOPROP ENGINES
KEITH J. BIEHL and PAUL S. DEMKO In AIAA, Proceedings of the 1990 AIAA/FAA Joint Symposium on General Aviation Systems p 56-65 May 1990
Avail: NTIS HC/MF A17

Limited flight testing was conducted to evaluate the performance characteristics and functional suitability when operating on a blend of 10 percent ethanol alcohol with JP-4 jet fuel. Of the 37 hour flight test effort, 20.3 hours were conducted with ethanol blended fuel in the starboard PT6A-41 engine of a Beechcraft King Air 200. Data collection was conducted at 6,000 foot intervals from ground level up to 30,000 feet utilizing steep climb to interval altitudes, continuous climbs and endurance cruise profiles. Ethanol fuel blending was not conducted before flight but rather during flight utilizing a separate onboard ethanol tank with associated fuel lines and mixing valves. This procedure allowed for consistent control of the desired 10 percent fuel mixture and allowed for a stable mixture with no possibility of phase separation. While a noticeable power reduction was present when operating with an ethanol mixture, no detrimental conditions were noted. In addition, an engine hot section inspection was performed both before and after flight test operations were completed. No degradation of components were noted by the overhaul facility and the only fuel related part change was a fuel control unit diaphragm. This part change was accomplished during the post flight test inspection as a precaution only. Author

N91-12823# Oak Ridge National Lab., TN. Metals and Ceramics Div.

CERAMIC TECHNOLOGY FOR ADVANCED HEAT ENGINES PROJECT Semiannual Progress Report, Apr. - Sep. 1989

Aug. 1990 518 p
(Contract DE-AC05-84OR-21400)
(DE91-001004; ORNL/TM-11489) Avail: NTIS HC/MF A22

The Ceramic Technology For Advanced Heat Engines Project was developed by the Department of Energy's Office of Transportation Systems (OTS) in Conservation and Renewable Energy. This project, part of the OTS's Advanced Materials Development Program, was developed to meet the ceramic technology requirements of the OTS's automotive technology programs. Significant accomplishments in fabricating ceramic components for the Department of Energy (DOE), National Aeronautics and Space Administration (NASA), and Department of Defense (DOD) advanced heat engine programs have provided evidence that the operation of ceramic parts in high-temperature engine environments is feasible. However, these programs have also demonstrated that additional research is needed in materials and processing development, design methodology, and data base and life prediction before industry will have a sufficient technology base from which to produce reliable cost-effective ceramic engine components commercially. An assessment of needs was completed, and a five year project plan was developed with extensive input from private industry. The objective of the project is to develop the industrial technology base required for reliable ceramics for application in advanced automotive heat engines. The project approach includes determining the mechanisms controlling reliability, improving processes for fabricating existing ceramics, developing new materials with increased reliability, and testing these materials in simulated engine environments to confirm reliability. Although this is a generic materials project, the focus is on structural ceramics for advanced gas turbine and diesel engines, ceramic bearings and attachments, and ceramic coatings for thermal barrier and wear applications in these engines. DOE

N91-13318*# Wichita State Univ., KS. Dept. of Aerospace Engineering.

EDGE DELAMINATION OF COMPOSITE LAMINATES SUBJECT TO COMBINED TENSION AND TORSIONAL LOADING

STEVEN J. HOOPER *In* Hampton Univ., NASA/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1990 p 58-59 Sep. 1990
 Avail: NTIS HC/MF A07 CSCL 11/4

Delamination is a common failure mode of laminated composite materials. Edge delamination is important since it results in reduced stiffness and strength of the laminate. The tension/torsion load condition is of particular significance to the structural integrity of composite helicopter rotor systems. Material coupons can easily be tested under this type of loading in servo-hydraulic tension/torsion test stands using techniques very similar to those used for the Edge Delamination Tensile Test (EDT) delamination specimen. Edge delamination of specimens loaded in tension was successfully analyzed by several investigators using both classical laminate theory and quasi-three dimensional (Q3D) finite element techniques. The former analysis technique can be used to predict the total strain energy release rate, while the latter technique enables the calculation of the mixed-mode strain energy release rates. The Q3D analysis is very efficient since it produces a three-dimensional solution to a two-dimensional domain. A computer program was developed which generates PATRAN commands to generate the finite element model. PATRAN is a pre- and post-processor which is commonly used with a variety of finite element programs such as MCS/NASTRAN. The program creates a sufficiently dense mesh at the delamination crack tips to support a mixed-mode fracture mechanics analysis. The program creates a coarse mesh in those regions where the gradients in the stress field are low (away from the delamination regions). A transition mesh is defined between these regions. This program is capable of generating a mesh for an arbitrarily oriented matrix crack. This program significantly reduces the modeling time required to generate these finite element meshes, thus providing a realistic tool with which to investigate the tension torsion problem.

Author

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ENGINEERING

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

A91-12956

LASER MATERIAL PROCESSING - EMERGING TECHNOLOGY IN GAS TURBINE ENGINE INDUSTRIES

REZA K. MOSAVI (Chromalloy American Corp., Research and Technology Div., Saint Louis, MO) *IN: The use of lasers in manufacturing; Aerospace Technical Conference and Exposition, Anaheim, CA, Sept. 25-28, 1989, Compilation of Papers. Warrendale, PA, Society of Automotive Engineers, Inc., 1989, p. 25-29.*

(SAE PAPER 892260) Copyright

The emergence of laser material processing as a new manufacturing technology in gas turbine engine industries is discussed. Laser material processing applications, such as drilling, welding, and cutting, with their advantages over traditional material processing, are presented. Author

A91-13046*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

OPTICAL MEASUREMENT OF UNDUCTED FAN BLADE DEFLECTIONS

A. P. KURKOV (NASA, Lewis Research Center, Cleveland, OH) *ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 112, Oct. 1990, p. 751-758. Previously announced in STAR as N88-29142. refs*

(ASME PAPER 89-GT-298) Copyright

A nonintrusive optical method for measuring unducted fan (or propeller) blade deflections is described and evaluated. The measurement does not depend on blade surface reflectivity. Deflection of a point at the leading edge and a point at the trailing edge in a plane nearly perpendicular to the pitch axis is obtained with a single light beam generated by a low-power, helium-neon laser. Quantitative analyses are performed from taped signals on a digital computer. Averaging techniques are employed to reduce random errors. Measured static deflections from a series of high-speed wind tunnel tests of a counterrotating unducted fan model are compared with available, predicted deflections, which are also used to evaluate systematic errors. Author

A91-13053#

PSEUDO-HIGH-SPEED BALANCING

F. F. EHRICH (GE Aircraft Engines, Lynn, MA) *ASME, Transactions, Journal of Vibration and Acoustics (ISSN 0739-3717), vol. 112, Oct. 1990, p. 418-426.*

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A procedure is presented by means of which high speed balance corrections can be conducted in three or more planes on rotors of simple and conventional low-speed balance machines. The procedure involves the specification of a balancing rule in which, for N balance planes, a sequence of J low speed balance steps is specified. At each of these steps, some fraction of the measured two-plane unbalance vectors is applied to one or two of the other balance correction planes, before final correction is made on the last two correction planes themselves. The analytically derived balancing factors are designed in such a way as to null the vibration response of the rotor that is excited by each of the specified generic unbalance distributions. O.C.

A91-13056#

THEORETICAL AND EXPERIMENTAL STUDIES ON SQUEEZE FILM STABILIZERS FOR FLEXIBLE ROTOR-BEARING SYSTEMS USING NEWTONIAN AND VISCOELASTIC LUBRICANTS

B. HALDER, A. MUKHERJEE, and R. KARMAKAR (Indian Institute of Technology, Kharagpur, India) *ASME, Transactions, Journal of Vibration and Acoustics (ISSN 0739-3717), vol. 112, Oct. 1990, p. 473-482. refs*

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A combination of a squeeze film damper and a plane journal bearing is studied as a stabilizing scheme. The damper is made to play the role of a stabilizer to postpone the instability threshold speeds of flexible rotors. Both Newtonian and viscoelastic fluids are used in the rotor-bearing system. Dynamics of the system is theoretically analyzed using bond graphs. Analysis reveals that the use of a Newtonian fluid in the stabilizer largely improves the high speed stability range. However, viscoelastic stabilizing fluid has a detrimental effect on highly flexible rotors. Experimental investigations, conducted on a flexible rotor (natural frequency, 30 Hz), confirm the theoretical findings. In addition, experiments indicate that though the use of viscoelastic stabilizing fluids leads to instability in flexible rotors, the growth of large amplitude whirl is postponed to very high speeds. Author

A91-13229

COMPUTATION OF INCOMPRESSIBLE STERN FLOW WITH SEPARATION USING EXPLICIT RUNGE-KUTTA FINITE-VOLUME SCHEME

CHENG-WEN LIN (U.S. Navy, David W. Taylor Naval Ship Research and Development Center, Bethesda, MD) *IN: Numerical methods in laminar and turbulent flow; Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 1. Swansea, Wales, Pineridge Press, 1989, p. 423-431. refs*

Copyright

A91-13245

IMPULSIVELY STARTED AND SUDDENLY STOPPED VISCOUS FLOW PAST A CIRCULAR CYLINDER

XUEGENG WANG and CHARLES DALTON (Houston, University, TX) *IN: Numerical methods in laminar and turbulent flow;*

12 ENGINEERING

Proceedings of the Sixth International Conference, Swansea, Wales, July 11-15, 1989. Volume 6, Part 1. Swansea, Wales, Pineridge Press, 1989, p. 679-689. refs

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A finite-difference study of the unsteady flow past a circular cylinder has been made using vorticity and streamfunction as the dependent variables. The two cases considered have been impulsively started and suddenly stopped flows. The impulsive start analysis has yielded results which agree quite closely with existing results from both calculations and experiments. The suddenly stopped analysis produced results which can be explained in terms of induced-velocity effects from existing wake vortices. Author

A91-13377

OPTIMUM DESIGN OF CUTOUTS IN LAMINATED COMPOSITE STRUCTURES

S. VELLAICHAMY, B. G. PRAKASH (Aeronautical Development Agency, Bangalore, India), and S. BRUN (AMDBA, Colomiers, France) Computers and Structures (ISSN 0045-7949), vol. 37, no. 3, 1990, p. 241-246. refs

Copyright

Cutouts in aircraft structural components such as wing spars and ribs are commonly encountered in practice. While in certain cases these cutouts are provided to facilitate fuel flow, to pass hydraulic or electrical lines, etc., in other cases they are the means of lightening the structure. For a given elliptical cutout area, loading and laminate construction, optimum design of the cutout is attempted, based on linear analysis. The design involves the selection of aspect ratio and orientation of the ellipse such that the value of the maximum failure criterion around the circumference of the hole is a minimum. The effect of the hole on the critical buckling load is also studied. Author

A91-13501

EXPERIMENTAL STUDIES OF FLOW MICROSTRUCTURE IN THE BLADING OF AXIAL-FLOW TURBOMACHINES (REVIEW) [EKSPERIMENTAL'NYE ISSLEDOVANIYA MIKROSTRUKTURY POTOKA V PROTOCHNOI CHASTI OSEVYKH TURBOMASHIN /OBZOR/]

E. P. DYBAN and E. IA. EPIK (AN USSR, Institut Tekhnicheskoi Teplofiziki, Kiev, Ukrainian SSR) Promyshlennaia Teplotekhnika (ISSN 0204-3602), vol. 12, no. 4, 1990, p. 3-25. In Russian. refs

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Experimental data on flow microstructure in the blading of axial-flow turbines are presented to show that such flows are characterized by the presence of various types of perturbations, such as increased turbulence, periodic velocity fluctuations, secondary flows, and separations. The importance of laboratory studies modeling individual factors, such as turbulence superposed on velocity fluctuations of specified form, is emphasized. It is also noted that such research is important for the refinement of methods for calculating transfer processes in the flow path of turbines. V.L.

A91-13502

HEAT TRANSFER AND HYDRODYNAMICS AT THE END SURFACES OF CURVILINEAR TURBINE PASSAGES AND NOZZLE RINGS [TEPLOOBMEN I GIDRODINAMIKA NA TORTSEVOI POVERKHNOSTI KRIVOLINEINYKH KANALOV I SOPLOVYKH APPARATOV TURBIN]

A. A. KHALATOV, A. A. KASHCHENKO, and S. A. KHALATOV (AN USSR, Institut Tekhnicheskoi Teplofiziki; Kievskii Politekhnikeskii Institut, Kiev, Ukrainian SSR) Promyshlennaia Teplotekhnika (ISSN 0204-3602), vol. 12, no. 4, 1990, p. 30-38. In Russian.

Copyright

Results of an experimental study of the hydrodynamics and heat transfer at the end surface of curvilinear turbine passages and nozzle rings of commensurable height and width are reported. Data are obtained which characterize velocity distribution at the outer edge of the boundary layer and local heat transfer coefficients. A similarity equation for heat transfer in curvilinear passages and nozzle rings is derived with allowance for the effects

of current line curvature, three-dimensional nature of the flow, longitudinal pressure gradient, and downward and upward flows. V.L.

A91-13503

TEMPERATURE FIELDS OF GAS TURBINE BLADES DURING THE SPRAYING OF HEAT-RESISTANT COATINGS [TEMPERATURNYE POLIA LOPATOK GAZOVOI TURBINY PRI NAPYLENII ZHAROSTOIKIKH POKRYTII]

M. L. ZHADKEVICH, V. G. LISIENKO, B. SH. STATNIKOV, and D. A. ISHCHENKO (AN USSR, Institut Elektrosvarki, Kiev, Ukrainian SSR; Ural'skii Politekhnikeskii Institut, Sverdlovsk, USSR) Promyshlennaia Teplotekhnika (ISSN 0204-3602), vol. 12, no. 4, 1990, p. 72-76. In Russian. refs

Copyright

A method is presented for calculating temperature fields during the deposition of heat-resistant coatings on the blades of gas turbines by the vacuum evaporation-condensation method. The problem of stationary heat conduction is solved using the superposition principle and the locally one-dimensional method. For constructing grids in regions with curvilinear boundaries, the combined method is used to determine the conformal coordinates. Examples of calculations are presented. V.L.

A91-13505

POSSIBILITIES OF SMALL-PASSAGE SYSTEMS OF INTERNAL CONVECTIVE BLADE COOLING FOR GAS TURBINES [VOZMOZHNOСТИ MELKOKANAL'NYKH SISTEM VNUTRENNEGO KONVEKTIVNOGO OKHLAZHDENIYA LOPATOK GAZOVYKH TURBIN]

V. N. KLIMENKO (AN USSR, Institut Tekhnicheskoi Teplofiziki, Kiev, Ukrainian SSR) Promyshlennaia Teplotekhnika (ISSN 0204-3602), vol. 12, no. 4, 1990, p. 93-98. In Russian.

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The hydraulic and thermal characteristics of turbine blades with small-passage cooling systems are analyzed. It is shown that a generalized hydraulic characteristic can be derived for the cooling systems of gas turbine blades of different dimensions. The initial thermal efficiency of blade cooling is shown to be practically independent of the cooling passage diameter. At the cooling passage outlet, the required cooling efficiency can be obtained only through an increase in air flow rate. The cooling systems described here provide sufficient blade cooling for initial gas temperatures of 1900-1950 K with air flow rates equal to 3 percent of the gas flow rate. V.L.

A91-13640

FEATURES CHARACTERIZING THE PROVISION OF AZIMUTH RESOLUTION FOR A SYNTHETIC-APERTURE RADAR WHILE GENERATING RADAR IMAGES OF FLIGHT VEHICLES [OSOBENNOSTI OBESPECHENIYA AZIMUTAL'NOGO RAZRESHENIYA RLS S SINTEZIROVANNOI APERTUROI PRI FORMIROVANII RLI LETATEL'NYKH APPARATOV]

A. I. ALEKSEEV, A. S. KUZNETSOV, and V. D. NOVAK Radiotekhnika (ISSN 0033-8486), Aug. 1990, p. 14-16. In Russian. refs

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A91-14228

DYNAMIC SUBSTRUCTURING ANALYSIS OF COMPOSITE STRUCTURES WITH NONLINEAR LINKS

HAIYAN HU, YUEFENG LI, and AZHOU ZHANG (Nanjing Aeronautical Institute, People's Republic of China) Chinese Journal of Aeronautics (ISSN 1000-9361), vol. 3, Aug. 1990, p. 168-177. refs

Copyright

On the basis of component test data for linear component impulse response functions, a dynamic substructuring approach is presently used to meet vibration-control requirements in the case of a composite structure consisting of two linear components coupled by nonlinear vibration isolators. Three different interfacial integration dynamic equations are proposed, in conjunction with a procedure for the transformation of the dynamic equations of

integral type into ordinary differential equations. With its emphasis on response variations after component coupling, this approach is especially valuable in vibration-isolation design problems where excitation is not determinable. O.C.

A91-14332**NICKEL-ALLOY CONSUMABLE SELECTION FOR SEVERE SERVICE CONDITIONS**

S. KISER (Welding Products Co., Newton, NC) *Welding Journal* (ISSN 0043-2296), vol. 69, Nov. 1990, p. 30-35.

Copyright

Welds which provide long-term satisfactory operation in harsh environments and conform to many service constraints are discussed. It is noticed that, more stringent requirements within the general framework of metallurgical compatibility, mechanical properties, physical properties, and corrosion properties necessitate alterations in the welding procedures. The following applications, imposing stringent requirements, are mentioned: aerospace gas turbines requiring expansion coefficients of both base and weld metal to be closely controlled; parts from heat-cured epoxy resin composites requiring welding of low-expansion alloys for the curing molds; and welding of nickel 200 requiring modification with aluminum and titanium to combat the formation of porosity. In some cases, the requirements are so stringent that new materials have to be invented. B.P.

A91-14422**OPTIMUM DESIGN OF COMPOSITE WING STRUCTURES BY A REFINED OPTIMALITY CRITERION**

INE-WEI LIU and CHIEN-CHANG LIN (National Chungshing University, Taichung, Republic of China) *Composite Structures* (ISSN 0263-8223), vol. 17, no. 1, 1991, p. 51-65. refs

Copyright

Techniques for the optimization of composite wing structures are investigated. The refined optimality criterion technique presented in this paper is an algorithm combining a criterion based on the Kuhn-Tucker conditions and the technique of fully stressed design. The main advantages of this method are the generality of use, the efficiency in computation, and the capability of identifying automatically the set of critical constraints. Sensitivity analysis of constraints is based on the virtual load principle. This method is especially suitable for optimum design of large-scale structures. A modular type computer program, ARS 5 (Automatic Resizing System 5), is developed in accordance with the finite element method, refined optimality criterion, sensitivity analysis and Fortran-77 language for the optimization of composite wing structures subjected to sizes, stresses, displacements, twist and buckling constraints. Numerical results for a triple-spars composite wing structure reveal that the present technique is quite efficient and reliable. Author

A91-14445*# McDonnell-Douglas Corp., Saint Louis, MO.**BUCKLING ANALYSIS AND TEST CORRELATION OF HAT STIFFENED PANELS FOR HYPERSONIC VEHICLES**

WENDY C. PERCY (McDonnell Douglas Corp., Saint Louis, MO) and ROGER A. FIELDS (NASA, Flight Research Center, Edwards, CA) *AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990, 8 p.* (AIAA PAPER 90-5219) Copyright

The paper discusses the design, analysis, and test of hat stiffened panels subjected to a variety of thermal and mechanical load conditions. The panels were designed using data from structural optimization computer codes and finite element analysis. Test methods included the grid shadow moire method and a single gage force stiffness method. The agreement between the test data and analysis provides confidence in the methods that are currently being used to design structures for hypersonic vehicles. The agreement also indicates that post buckled strength may potentially be used to reduce the vehicle weight. Author

A91-14462*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, OH.**PDCR BASED HIGH TEMPERATURE STATIC STRAIN GAGE**

JIH-FEN LEI (NASA, Lewis Research Center; Sverdrup Technology, Inc., Cleveland, OH) and W. D. WILLIAMS (NASA, Lewis Research Center, Cleveland, OH) *AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990, 8 p.* refs (AIAA PAPER 90-5236) Copyright

The program at NASA Lewis Research Center to develop a high temperature static strain gage system for the hypersonic vehicle and turbine engine research has emphasized a palladium-13 wt pct chromium (PdCr) alloy. Gages made from this alloy are being developed in both fine wire and thin film form. The wire gage system had platinum wire as a temperature compensator and was coated with a special alumina and zirconia mixture overcoat. This PdCr compensated wire gage responded linearly to the imposed strain to at least 1000 microstrain. The apparent strain varied within 300 microstrain from room temperature to 800 C with a reproducibility within 50 microstrain between thermal cycles to 800 C. The sputtered thin film PdCr strain gage, whose size was 8 x 8 mm and 10 microns thick, has demonstrated the possibility of extending the use of the PdCr strain gage to a temperature of approximately 1000 C. Author

A91-14470#**SMART SENSOR/SUBSYSTEM DESIGN CONCEPT**

GENE ESPIRITU SANTO (Rockwell International Corp., Rocketdyne Div., Canoga Park, CA) *AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990, 7 p.* (AIAA PAPER 90-5246) Copyright

This paper examines 'smart' design concepts of sensors for hypersonic propulsion systems and the use of microcontrollers at the component level to enhance calibration, compensation, diagnostics, and health/condition monitoring. Particular consideration is given to a smart transducer/subsystem concept which involves the use of solid state and/or other type of sensing elements combined with digital processing electronics, all integrated into the same package. Diagrams illustrating the principle of the smart sensor/subsystem concept and the electronic architecture of a smart pressure transducer and smart valve elements are presented. I.S.

A91-14753**ON THE COUPLING OF VISCOUS AND INVISCID MODELS FOR COMPRESSIBLE FLUID FLOWS VIA DOMAIN DECOMPOSITION**

ROLAND GLOWINSKI (Houston, University, TX; Paris VI, Universite; INRIA, Le Chesnay, France), JACQUES PERIAUX (Dassault Aviation, Saint-Cloud; INRIA, Le Chesnay, France), and G. TERRASSON (Dassault Aviation, Saint-Cloud, France) *IN: International Symposium on Domain Decomposition Methods for Partial Differential Equations, 3rd, Houston, TX, Mar. 20-22, 1989, Proceedings, Philadelphia, PA, Society for Industrial and Applied Mathematics, 1990, p. 64-97.* Research supported by California Institute of Technology, Fairchild Foundation, and LNCC of Rio de Janeiro. refs

(Contract DRET-86-175; NSF DMS-88-22522; NSF INT-86-12680) Copyright

The coupling between the Navier-Stokes equations modeling compressible viscous flows with the time-dependent full potential equation modeling compressible potential flows is studied. The coupling is done through a domain-decomposition procedure with overlapping; such an approach takes advantage of operator-splitting techniques for the time discretization of the above equations. Numerical results obtained from finite-element approximations are presented showing that the present method provides a good quality-matching technique. Author

A91-15041#**SHOCK WAVE/TURBULENT BOUNDARY LAYER INTERACTIONS INDUCED BY A SINE-SHAPED PROTUBERANCE**

NOBUMI SAIDA and HIDEAKI NAMBA *Japan Society for Aeronautical and Space Sciences, Journal* (ISSN 0021-4663), vol. 38, no. 438, 1990, p. 345-351. In Japanese, with abstract in English. refs

This paper presents an experimental study of shock wave/turbulent boundary layer interaction induced by a sine-shaped three dimensional protuberance. The experiments were carried out in a 8 x 10 sq cm supersonic wind tunnel at a free stream Mach number of 1.98. It was found that, the upstream influence length and the maximum surface pressure decrease with the decrease of H/D, whereas the minimum pressure at the rear is insensitive to H/D. At the rear part of the model a pair of vortices appears. This is surrounded by a separation line which moves backward with the decrease of H/D. Author

A91-15395

PREDICTION OF DANGEROUS DAMAGE IN SPECIMENS AND THIN-WALLED STRUCTURAL ELEMENTS UNDER CYCLIC LOADING [PROGNOZIROVANIIE OPASNOGO POVREZHENIIA V OBRATSAKH I TONKOSTENNYKH ELEMENTAKH KONSTRUKTSII PRI TSIKLICHESKOM NAGRUZHENII]

V. V. BULANOV, A. I. POTAPOV, and A. G. SUSLOVA Defektoskopiia (ISSN 0130-3082), no. 10, 1990, p. 3-6. In Russian.

Copyright

A procedure for predicting fatigue cracks in flat metallic specimens under symmetric cycling loading of different stress amplitudes is presented. Experiments are conducted to determine the delamination of three-layer composite panels for aircraft. The results show that the number of cycles obtained through calculations is greater than the number obtained experimentally and that the error is within the allowable limits. A criterion for nondestructive evaluation of parts subjected to cyclic deformation is defined and the relationship between the degree of failure and the critical parameter makes the prediction of failures possible.

B.P.

A91-16018#

ANALYSIS OF DYNAMIC BEHAVIOUR OF 2K-H PLANETARY GEARING

ZONGDE FANG, YUNWEN SHEN, and ZHENDONG HUANG (Northwestern Polytechnical University, Xian, People's Republic of China) Northwestern Polytechnical University, Journal (ISSN 1000-2758), vol. 8, Oct. 1990, p. 361-371. In Chinese, with abstract in English. refs

The Fourier method described by Kubo (1986) for a simple gear system is improved and used to enhance the planetary gear system of an aircraft engine. A new method is derived to obtain an analytical solution in order to simplify the calculation. In employing this methodology the vibration and dynamic load distribution on each branch, the floating locus of sun gears, the effects of various types of runout errors, and the exciting function of tooth errors require only one solution and a single computer program. R.E.P.

A91-16026

THERMAL STRUCTURES CONFERENCE, 1ST, UNIVERSITY OF VIRGINIA, CHARLOTTESVILLE, NOV. 13-15, 1990, PROCEEDINGS

Charlottesville, VA, University of Virginia Light Thermal Structures Center, 1990, 415 p. For individual items see A91-16027 to A91-16047.

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The present conference discusses aerobrake-maneuver vehicle aerothermodynamics, aerothermal issues in the structural design of high speed vehicles, laser surface-alloying of superlight metals with ceramic surfaces, high-temperature Al alloys for supersonic and hypersonic vehicles, advanced metallics for high temperature airframes, novel materials for engine applications, and the development status of computational methods for high temperature structural design. Also discussed are a transient thermal-structural analysis using adaptive unstructured remeshing and mesh movement, the FEM thermoviscoplastic analysis of aerospace structures, hot-structures testing techniques, a thermal-structural analysis of a carbon-carbon/refractory metal heat pipe-cooled leading edge, dynamic effects in thermoviscoplastic structures,

microlevel thermal effects in metal-matrix composites (MMCs), thermomechanical effects in the plasma spray manufacture of MMC monotapes, and intelligent HIP processing. O.C.

A91-16033* National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

TRANSIENT THERMAL-STRUCTURAL ANALYSIS USING ADAPTIVE UNSTRUCTURED REMESHING AND MESH MOVEMENT

PRAMOTE DECHAUMPHAI (NASA, Langley Research Center, Hampton, VA) and KENNETH MORGAN (Imperial College of Science, Technology, and Medicine, London, England) IN: Thermal Structures Conference, 1st, Charlottesville, VA, Nov. 13-15, 1990, Proceedings. Charlottesville, VA, University of Virginia Light Thermal Structures Center, 1990, p. 149-168. refs

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An adaptive unstructured remeshing technique is applied to transient thermal-structural analysis. The effectiveness of the technique, together with the finite element method and an error estimation technique, is evaluated by two applications which have exact solutions: (1) the steady-state thermal analysis of a plate subjected to a highly localized surface heating, and (2) the transient thermal-structural analysis of a simulated convectively cooled leading edge subjected to a translating heat source. These applications demonstrate that the remeshing technique significantly reduces the problem size as well as the analysis solution error as compared to the results produced using standard structured meshes. Author

A91-16034* Lockheed Engineering and Sciences Co., Hampton, VA.

FINITE-ELEMENT THERMO-VISCOPLASTIC ANALYSIS OF AEROSPACE STRUCTURES

AJAY PANDEY (Lockheed Engineering and Sciences Co., Hampton, VA), PRAMOTE DECHAUMPHAI (NASA, Langley Research Center, Hampton, VA), and EARL A. THORNTON (Virginia, University, Charlottesville) IN: Thermal Structures Conference, 1st, Charlottesville, VA, Nov. 13-15, 1990, Proceedings. Charlottesville, VA, University of Virginia Light Thermal Structures Center, 1990, p. 169-189. refs

Copyright

The time-dependent thermo-viscoplastic response of aerospace structures subjected to intense aerothermal loads is predicted using the finite-element method. The finite-element analysis uses the Bodner-Partom unified viscoplastic constitutive relations to determine rate-dependent nonlinear material behavior. The methodology is verified by comparison with experimental data and other numerical results for a uniaxially-loaded bar. The method is then used (1) to predict the structural response of a rectangular plate subjected to line heating along a centerline, and (2) to predict the thermal-structural response of a convectively-cooled engine cowl leading edge subjected to aerodynamic shock-shock interference heating. Compared to linear elastic analysis, the viscoplastic analysis results in lower peak stresses and regions of plastic deformations. Author

A91-16035* National Aeronautics and Space Administration, Hugh L. Dryden Flight Research Facility, Edwards, CA.

TECHNIQUES FOR HOT STRUCTURES TESTING

V. MICHAEL DEANGELIS and ROGER A. FIELDS (NASA, Flight Research Center, Edwards, CA) IN: Thermal Structures Conference, 1st, Charlottesville, VA, Nov. 13-15, 1990, Proceedings. Charlottesville, VA, University of Virginia Light Thermal Structures Center, 1990, p. 191-215. refs

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Hot structures test techniques developed and applied by the Aerostructures Branch of the NASA Ames Research Center, Dryden Flight Research Facility, are presented. Topics covered include the data acquisition and control of testing, the quartz lamp heater systems, current strain and temperature sensors, and hot structures test techniques used to simulate the flight thermal environment in the laboratory. Author

A91-16039* McDonnell-Douglas Corp., Saint Louis, MO.
BUCKLING ANALYSIS AND TEST CORRELATION OF HIGH-TEMPERATURE STRUCTURAL PANELS

WENDY P. TEARE (McDonnell Douglas Corp., Saint Louis, MO) and ROGER A. FIELDS (NASA, Flight Research Center, Edwards, CA) IN: Thermal Structures Conference, 1st, Charlottesville, VA, Nov. 13-15, 1990, Proceedings. Charlottesville, VA, University of Virginia Light Thermal Structures Center, 1990, p. 271-282.
 Copyright

This paper focuses on the design, analysis, and test of a high temperature structural panel, constructed of Ti-6-4, subjected to a variety of thermal and mechanical load conditions. A follow-on panel, constructed of TMC, is also discussed in less detail. The design constraints and test set-up are discussed, as well as the test methods that were used: the grid shadow moire method and a single gage force stiffness method. The agreement between the test data and analysis for this test program provides confidence in the methods that are currently being used to design structures for hypersonic vehicles. The agreement also suggests that postbuckled strength may potentially be used to reduce the vehicle weight.
 Author

A91-16040* General Electric Co., Cincinnati, OH:
METHODS FOR PREDICTING CRACK GROWTH IN ADVANCED STRUCTURES

R. H. VAN STONE and K. S. KIM (GE Aircraft Engines, Cincinnati, OH) IN: Thermal Structures Conference, 1st, Charlottesville, VA, Nov. 13-15, 1990, Proceedings. Charlottesville, VA, University of Virginia Light Thermal Structures Center, 1990, p. 283-300. refs
 (Contract F33615-84-C-532; NAS3-23940)
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Damage tolerance design and analysis is widely used in fracture critical military aircraft engine components. Linear elastic fracture mechanics techniques have been developed and verified. These are used to predict the crack propagation lives of complex geometries under mission cycling conditions. Research on methods necessary for the prediction of elevated temperature crack growth in advanced structures is reviewed. These include environmentally assisted time-dependent crack growth, non-linear fracture mechanics parameters for thermal mechanical fatigue crack growth, and finite element modeling of crack growth in composites.
 Author

A91-16045* Virginia Univ., Charlottesville.
INTELLIGENT PROCESSING OF INTERMETALLIC COMPOSITE CONSOLIDATION

H. N. G. WADLEY, D. M. ELZEY, L. M. HSIUNG, Y. LU, J. M. DUVA (Virginia, University, Charlottesville) et al. IN: Thermal Structures Conference, 1st, Charlottesville, VA, Nov. 13-15, 1990, Proceedings. Charlottesville, VA, University of Virginia Light Thermal Structures Center, 1990, p. 359-381. Research supported by DARPA and GE Aircraft Engines. refs
 (Contract NAGW-1692)
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Intermetallic composites based upon titanium aluminide matrices and silicon carbide or aluminum oxide fibers are emerging candidates for future hypersonic vehicle airframes and engines. To tailor the properties of these 'engineered' materials for specific application, to increase process yield, and to reduce costs, 'intelligent processing of materials' (IPM) control strategies are being explored for their processing. Recent progress is evaluated in the development of predictive process models, advanced sensors and control methodologies (the components of the IPM approach) for the critical near net-shape consolidation process step of continuous fiber reinforced intermetallic composite manufacture.
 Author

A91-16221
BOUNDARY ELEMENT ANALYSIS OF THERMAL STRESS INTENSITY FACTORS FOR CUSP CRACKS

KANG YONG LEE (Yonsei University, Seoul, Republic of Korea) and YOUN HO CHO (Engineering Fracture Mechanics (ISSN

0013-7944), vol. 37, no. 4, 1990, p. 787-798. Research supported by the Korea Research Foundation. refs
 Copyright

In case that the body with a cusp crack is under uniform heat flow, thermal stress-intensity factors (SIFs) are calculated by using the BEM with a linearized body-force term. The crack surface is under an insulated or fixed-temperature condition, and the types of cracks are symmetric lip and airfoil cusps. Numerical values of thermal SIFs for Griffith cracks in finite bodies and cusp cracks in infinite bodies are proved to be in good agreement (within + or - 5 percent) when compared with the previous numerical and exact solutions, respectively. The thermal SIFs for symmetric lip and airfoil cusp cracks in finite bodies are calculated about various effective crack lengths, configuration parameters, and heat flow directions. With the same crack surface thermal boundary conditions, heat flow directions and crack lengths, there are no appreciable differences in variations of thermal SIFs for symmetric lip and airfoil cusp cracks. The signs of thermal SIFs for each cusp crack are changed with each crack surface thermal boundary condition.
 Author

A91-16317
AUTO-CORRELATION MEASUREMENTS IN THREE-DIMENSIONAL FLUID FLOW DATASETS

A. J. BRAND (Delft, Technische Universiteit, Netherlands) and L. HESSELINK (Stanford University, CA) Experiments in Fluids (ISSN 0723-4864), vol. 10, no. 1, Oct. 1990, p. 55-57. Research supported by NWO. refs
 Copyright

A three-dimensional autocorrelation function is proposed as a tool for the analysis of three-dimensional fluid flow data sets. The theory is presented, together with an example illustrating the concept. Time- and space-evolving data sets obtained from visualizations of the flow around a half-span delta wing (with 30-cm chord and 50-deg sweep angle) at an angle of attack of 40 deg and with a mean flow velocity of 3 m/sec were analyzed. Visualization pictures were digitized by a scanning microdensitometer into 12-bit images with a resolution of about 1 mm. The processed slices show that the regions with strong vortical motion could be easily detected, but it was difficult to determine the cross-stream velocity components.
 I.S.

A91-16334
TOWARDS A PROBABILISTIC LIFETIME PREDICTION MODEL FOR AIRCRAFT ENGINE DISKS [AUF DEM WEG ZU EINEM PROBABILISTISCHEN LEBENSDAUERMODELL FUER FLUGTURBINENSCHNEIBEN]

HELLMUT FISCHMEISTER, UWE QUADFASEL, VOLKER BANHARDT (Max-Planck-Institut fuer Metallforschung, Stuttgart, Federal Republic of Germany), ANGELIKA BRUECKNER-FOIT, HEIKE JAECKELS (Karlsruhe, Universitaet, Federal Republic of Germany) et al. Zeitschrift fuer Metallkunde (ISSN 0044-3093), vol. 81, Oct. 1990, p. 707-714. In German. refs
 (Contract BMFT-03-M-3007-K2; BMFT-03-M-3007-H; BMFT-03-M-3007-G7; BMFT-03-M-3007-L5)
 Copyright

The lifetime distribution of high-strength components subjected to fatigue loading depends on the probability that a crack is initiated from an inclusion and propagates stably until it exceeds a critical size and causes catastrophic failure. An analysis of crack growth data obtained from fatigue tests with smooth specimens is given in terms of an effective stress intensity factor. An attempt is made to derive information about the cyclic growth of small cracks by a comparison of the sizes of the actual fracture initiating defects with back-extrapolated initial crack depths. The conceptual framework for a probabilistic model is outlined, which would allow taking into account the individual characteristics of the material, including its microstructure and defect population.
 Author

A91-16427
THERMAL STRESSES III

RICHARD B. HETNARSKI, ED. (Rochester Institute of Technology, NY) Amsterdam, North-Holland (Mechanics and Mathematical

12 ENGINEERING

Methods: Thermal Stresses. Volume 3), 1989, 583 p. No individual items are abstracted in this volume.

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This volume contains chapters on thermoelastic contact problems, thermoelastic stability, inelastic constitutive relationships and applications to some thermomechanical processes involving phase transformations, generalized thermoelasticity and its applications, and thermal stresses in shells. Special attention is given to boundary conditions and mathematical methods used to solve thermoelastic contact problems, numerical methods used to investigate thermoelastic stability, and analyses of some engineering processes with phase transformation. Consideration is also given to formulations of the initial boundary value problems in the L-S and G-L theories, potential temperature disturbances in homogeneous and isotropic bodies, geometrical equations of the theory of shells, and selected thermal problems of shells. I.S.

A91-16552

NONDESTRUCTIVE TESTING OF AGING AIRCRAFT

D. J. HAGEMAIER (Douglas Aircraft Co., Long Beach, CA) IN: FAA Aging Aircraft Workshop, Valley Forge, PA, Oct. 9-13, 1989; Proceedings. Columbus, OH, American Society for Nondestructive Testing, Inc., 1990, p. 4-12. refs

Copyright

A U.S. commercial aircraft airframe manufacturer has developed a supplemental inspection document (SID) program for fatigue-crack detection, in conjunction with a corrosion-control program for aging aircraft. Attention is presently given to the implementation of nondestructive testing (NDT) in the SID program, with emphasis on corrosion and stress-corrosion crack detection. In addition to the more common corrosion phenomena expected in aging aircraft, encompassing pitting, intergranular corrosion, exfoliation, galvanic corrosion, microbial corrosion, and stress-corrosion cracking, searches must also be conducted for filiform, thermogalvanic, fatigue-induced, fretting-induced, and erosion-induced corrosion. Hidden corrosion can be addressed via X-ray and thermal neutron radiography, ultrasound, eddy currents, and acoustic emission NDT methods. O.C.

A91-16553

NONDESTRUCTIVE INSPECTION OF AGING AIRCRAFT

STEPHEN N. BOBO (DOT, Transportation Systems Center, Cambridge, MA) IN: FAA Aging Aircraft Workshop, Valley Forge, PA, Oct. 9-13, 1989, Proceedings. Columbus, OH, American Society for Nondestructive Testing, Inc., 1990, p. 18-33.

Copyright

The FAA has concerned itself with emerging technologies for the inspection tasks required by a growing fleet of aging aircraft; resources have accordingly been allocated to evaluate novel techniques on actual aircraft. Efforts are being formulated toward the standardization of characterizations and reports for aircraft structure flaws, as well as the evaluation of optimum eddy current procedures for lap-joint inspection and the development of neutron radiography for structural corrosion. It is also expected that optical interference methods will be useful in large-area microstrain measurements, and that IR imaging will be applicable to thermal diffusion measurements. Attention is given to the case of pressure testing of a B-727 aircraft. O.C.

A91-16698#

5-INCH-SIZE LIQUID CRYSTAL FLAT PANEL DISPLAY EVALUATION TEST BY FLIGHT SIMULATOR

HIROYASU KAWAHARA, AKIRA WATANABE, KAORU WAKAIRO (National Aerospace Laboratory, Chofu, Japan), TOMOYUKI UDAGAWA, YOICHIRO KURIHARA (Yokogawa Electric Corp., Musashino, Japan) et al. IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 168-175.

(AIAA PAPER 90-3144) Copyright

An evaluation test is conducted on the function, performance, and display format of a 5x5 inch flat panel display (FPD) in a flight simulator. The FPD utilizes a color liquid crystal panel that

is compact and lightweight and has excellent visibility. The simulator evaluation test is carried out in sequence with the conventional takeoff and landing to altitude, and then conversion to STOL procedures for flight path and subsequent approach and landing. It is shown that the liquid crystal display could be employed as a satisfactory indicator for aircraft instrumentation. R.E.P.

A91-16704#

THE USE OF FUNCTION GENERATION IN THE REAL-TIME SIMULATION OF STIFF SYSTEMS

R. M. HOWE and K. C. LIN (Michigan, University, Ann Arbor) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 217-224. Research supported by General Dynamics Corp. refs

Copyright

A function generation method is proposed to simulate stiff dynamic systems. The equations of the fast subsystem are integrated off-line over a time period that will be employed as the step-size for the on-line integration of the slow subsystem. A time-shift scheme is also introduced in which the frame times for the fast subsystem are shifted half an integration step with respect to the integer frame times for the slow subsystems. Three practical examples show that the function generation method has speed and accuracy advantages over conventional integration of all state equations with a common step size. It is also shown that the time-shift scheme, nonlinear flight control, airframe/landing gear, and tracked vehicle can enhance the accuracy of the function generation method. R.E.P.

A91-16712#

IMPLEMENTATION OF A SECURE MULTI-PROJECT LABORATORY FACILITY

DAVID M. DRAFFIN and JOHN S. BACHA (Boeing Integrated Technology Development Laboratories, Seattle, WA) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 284-292. refs

(AIAA PAPER 90-3163) Copyright

A secure, multiproject facility named the Integrated Technology Development Laboratories (ITDL) has been built. This paper gives some background information on how the ITDL came into existence, along with methods developed to provide for security and laboratory operations. Some details are discussed on the types of resources that are shared between projects, the software design, the hardware design, the power and ground, the communications system, and the configuration management needed to support secure, rapid configuration changes. The facility organization and logistics are also outlined. Author

A91-16746#

INVESTIGATION OF AEROELASTICITY USING NUMERICAL SIMULATION [SIMULATION NUMERIQUE EN AEROELASTICITE]

CH. SOIZE (ONERA, Chatillon-sous-Bagneux, France) (Colloque d'Aerodynamique Appliquee, 27th, Marseille, France, Oct. 15-17, 1990) ONERA, TP no. 1990-167, 1990, 21 p. In French. refs (ONERA, TP NO. 1990-167)

An overview of numerical simulation methods in aeroelasticity is presented in order to determine the current limitations of the models and the desired improvements. The main objective is to demonstrate the present and future aeroelasticity requirements for unsteady aerodynamics from the experimental and numerical standpoints, for structural dynamics and experimental identification, and for the direct coupling method. The numerical method elements that are utilized for unsteady aerodynamic and dynamic analyses of structures to solve coupled aerodynamics/structure/systems problems are presented. Then, examples are given that demonstrate aeroelastic numerical simulations. R.E.P.

A91-16796

HOLOGRAPHIC NON DESTRUCTIVE TESTING OF COMPOSITE MATERIALS FOR AERONAUTICAL STRUCTURES
 PIERINO DELVO, M. LUCIANA RIZZI (CISE Tecnologie Innovative S.p.A., Milan, Italy), PIETRO FERRARO, and CLAUDIO SABATINO (Aeritalia S.p.A., Naples, Italy) IN: 1989 SEM Spring Conference on Experimental Mechanics, Cambridge, MA, May 29-June 1, 1989, Proceedings. Bethel, CT, Society for Experimental Mechanics, Inc., 1989, p. 714-719.

Copyright

Holographic Interferometry can be successfully used for detection and interpretation of defects as delaminations, debonds and non-adherence in composite materials. This paper shows the results obtained by applying this technique as NDT tool to aircraft structures made of composite materials. Particular attention will be devoted to the various kinds of stresses which must be induced into the test pieces to evaluate the defects with complete reliability. Author

A91-16827

REVIEW OF NDE METHODOLOGY OF ADHESIVE BOND STRENGTH DETERMINATION

GLENN M. LIGHT and HEGEON KWUN (Southwest Research Institute, San Antonio, TX) IN: NDE of adhesive bonds and bondlines; Proceedings of the 1989 ASNT Fall Conference, Valley Forge, PA, Oct. 9-13, 1989. Columbus, OH, American Society for Nondestructive Testing, Inc., 1989, p. 7-27. refs (Contract DLA900-84-C-0910)

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This presentation describes the various bond strength measurement methods that have been tested and how well they have worked. These methods include sonics, ultrasonics, acoustic emission, optical holography, X-ray and neutron radiography, thermography, and nuclear magnetic resonance. Each of these methods has had some limited success in detecting debond conditions. However, at the present time, it appears that only the sonic and ultrasonic methods have the capability to potentially determine the strength of the bond. Author

A91-16838

FILMLESS AND REAL-TIME APPLICATIONS OF HOLOGRAPHY

WESLEY F. LARKIN (Pratt and Whitney Group, East Hartford, CT) IN: NDE of adhesive bonds and bondlines; Proceedings of the 1989 ASNT Fall Conference, Valley Forge, PA, Oct. 9-13, 1989. Columbus, OH, American Society for Nondestructive Testing, Inc., 1989, p. 115-119.

Copyright

New electronic methods for applications to hologram interferometry and to the inspection of bonded components are presented. In the present study, the parts inspected are compressor rings and stators with brazed, bonded, or plasma-sprayed abrasible seals. It is shown that, with a computer-based filmless system, costly film and fluids and their inherent maintenance are eliminated. K.K.

A91-16839* National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.

ADHESIVE BOND EVALUATION USING PHASE SENSITIVE DETECTION TECHNIQUES

ALPHONSO C. SMITH (NASA, Langley Research Center, Hampton, VA) and HAESUK YANG (Chung-Ang University, Seoul, Republic of Korea) IN: NDE of adhesive bonds and bondlines; Proceedings of the 1989 ASNT Fall Conference, Valley Forge, PA, Oct. 9-13, 1989. Columbus, OH, American Society for Nondestructive Testing, Inc., 1989, p. 129-143. refs

Copyright

Quadrature phase detection techniques have been used to monitor the amplitude and phase of a toneburst ultrasonic wave normally reflected from adhesively-bonded steel/rubber interface. The measured phase change values of the reflected signals were found to correlate with variations in sample preparation. It was determined that measured phase shift changes were larger for

samples with weaker bonds as manifested by smaller measured values of the applied tensile loads at failure. A model calculation which incorporates the concept of interfacial strength into the usual problem of wave propagation in multi-layered isotropic elastic media was used to deduce a bond-quality parameter from an experimentally measured phase shift. Author

A91-16991

ELECTRICAL AND OPTICAL INTERCONNECTS FOR AERONAUTICAL SYSTEMS [INTERCONNEXIONS ELECTRIQUES ET OPTIQUES POUR MATERIELS AERONAUTIQUES]

PIERRE NICOLE (Dassault Electronique, Saint-Cloud, France) L'Onde Electrique (ISSN 0030-2430), vol. 70, Nov.-Dec. 1990, p. 32-36. In French.

Copyright

In response to the increasing problems due to the interconnects of electronic systems on different geometrical scales, a study is presented of the possibilities offered by guided or free space optical transmissions. Emphasis is placed upon the consequences of increasing numbers of electronic systems in aeronautical equipment. Several promising solutions are suggested. Finally, a review of the technologies and techniques under study points to the areas where concerted efforts should be made in the field of passive and active components of electrical systems. R.E.P.

N91-11950# Naval Research Lab., Washington, DC.

MANUAL FIRE SUPPRESSION METHODS ON TYPICAL MACHINERY SPACE SPRAY FIRES Interim Report

H. W. CARHART, J. T. LEONARD, E. K. BUDNICK, R. J. OUELLETTE, and J. H. SHANLEY, JR. 31 Jul. 1990 130 p Prepared in cooperation with Hughes Associates, Inc., Wheaton, MD (AD-A225311; NRL-MR-6673) Avail: NTIS HC/MF A07 CSCL 13/12

A series of tests was conducted to evaluate the effectiveness of Aqueous Film Forming Foam (AFFF), potassium bicarbonate powder (PKP) and Halon 1211, alone and in various combinations, in extinguishing spray fires. The sprays were generated by JP-5 jet fuel issuing from an open sounding tube, and open petcock, a leaking flange or a slit pipe, and contacting an ignition source. The results indicate that typical fuel spray fires, such as those simulated in this series, are very severe. Flame heights ranged from 6.1 m (20 ft) for the split pipe to 15.2 m (50 ft) for the sounding tube scenario. These large flame geometries were accompanied by heat release rates of 6 MW to greater than 50 MW, and hazardous thermal radiation levels in the near field environment, up to 9.1 m (30 ft) away. Successful suppression of these fires requires both a significant reduction in flame radiation and delivery of a suppression agent to shielded areas. Of the nine suppression methods tested, the 95 gpm AFFF hand line and the hand line in conjunction with PKP were particularly effective in reducing the radiant flux. GRA

N91-11992# United International Engineering, Inc., Albuquerque, NM.

HARDENING SURVEILLANCE ILLUMINATION USING

AIRCRAFT ANTENNAS Final Report, Mar. 1989 - Jan. 1990

J. P. DONOHUE and C. D. TAYLOR Jun. 1990 139 p (Contract F29601-88-C-0001; AF PROJ. 3763) (AD-A225143; WL-TR-90-27) Avail: NTIS HC/MF A07 CSCL 20/15

Aircraft maintenance depots and main operating bases need to be able to perform quick checks of the electromagnetic pulse (EMP) hardness of their systems without removing them from service for any length of time. Preliminary tests have shown that the onboard HF antennas of the EMP Test-Bed Aircraft (EMPTAC) may be capable of providing the HF excitation required to effectively monitor the EMP hardness of aircraft systems. The surface current and charge distributions on the EMPTAC which result from swept frequency excitation of the HF radio antennas are computed over a range of 0.5 to 100 MHz using various antenna drive configurations. The computational analysis is performed by using

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two separate frequency-dependent techniques: the method-of-moments technique and the physical optics approximation. These calculations are then compared with the excitation provided from an overhead plane wave and with measured data from EMPTAC tests. GRA

N91-12002# Naval Postgraduate School, Monterey, CA. Dept. of Electrical and Computer Engineering.

AN ELECTROMAGNETIC RADOME MODEL USING AN INTERACTIVE MICRO-COMPUTER FINITE ELEMENT ALGORITHM M.S. Thesis

ROBERT JOHNSTON VINCE Dec. 1989 175 p
(AD-A225370) Avail: NTIS HC/MF A08 CSCL 17/9

The goal of this thesis was to develop and validate a set of microcomputer programs using, in part, a previously written finite-element algorithm to analyze the perturbation of an incident electromagnetic field as it penetrates a missile radome. An interactive program was developed to design the radome structure using aerodynamic shaping functions and provide structure and material files as input to the finite-element code. A second program was developed to use the spherical harmonic expansion coefficients provided by the finite-element code to assemble the electromagnetic fields within the radome core and to display the fields that appear across a planar antenna with three-dimensional graphics for any orientation of the antenna. Algorithms were included which compare the computed field components to the theoretical incident plane wave for each stipulated angles of incidence, in order to determine the perturbation due to the presence of the radome. Validation of the computational method was attempted by analyzing the perturbation indicated for an ideal radome with relative permittivity of unity. The attempted validation showed phase errors in the computed fields which were minimal for axial incidence, but became significant for highly canted incidence. GRA

N91-12023# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (Germany, F.R.). Hubschrauber und Flugzeuge.

THE ELECTRIC POWER FEEDING ON SIGNAL/ELECTRIC POWER SUPPLY CIRCUITS, AS A PROCESS FOR THE SIMULATION OF EXTERNAL RADIO-FREQUENCY INTERFERENCES [DIE STROMEINSPEISUNG AUF SIGNAL-/STROMVERSORGUNGSKREISE ALS VERFAHREN ZUR SIMULATION EXTERNER HOCHFREQUENZSTOERUNGEN]

ALFRED BRENNER Aug. 1989 4 p In GERMAN Presented at Internationalen Fachmesse und Kongress fuer Elektronische Vertraeglichkeit, Karlsruhe, Fed. Republic of Germany, 19 Oct. 1988
(MBB/FE324/S/PUB/378; ETN-90-97847) Copyright Avail: NTIS HC/MF A01

When designing and checking modern aircrafts, the electromagnetic interference environment in power station range has to be considered. On account of the geometrical dimensions of planes, the airframe and the cabling in resonance take up a great deal of the interference activity. The drawbacks of the classical methods being outlined, a new process for the simulation of external high frequency disturbances was developed: the Bulk Current Injection Test (BCIT). Its principles are reported, it is shown that for the determination of an improvement factor the method is very useful, as well as for relative measurements. But the BCIT method takes a lot of time, even using computers. ESA

N91-12035 Newcastle-upon-Tyne Univ. (England).

THE EFFECT OF ROTATIONAL OSCILLATION ON VORTEX SHEDDING FOR A CIRCULAR CYLINDER IN UNIFORM FLOW Ph.D. Thesis

DANNY NGAR MAN KWAN 1989 308 p
Avail: Univ. Microfilms Order No. BRDX89722

Force measurements were carried out for cylinders with rotational oscillation about their longitudinal axes in a uniform flow over ranges of oscillating amplitudes and frequencies. The behavior of the hydrodynamic forces as functions of the amplitude and reduced velocity are close to those of the classic transverse

oscillation. Lock-on at the fundamental and higher harmonics were observed in rotational oscillations. High frequency motion was found to suppress the natural vortex formation; it also results in the shedding of vortices at the driving frequency with reduction in the mean drag force and high oscillatory drag component. Low frequency oscillation demonstrates the absence of sub-harmonic lock-on with the resultant forces near the rigid cylinder values. Flow visualization studies of the wake show that the primary lock-on characteristics for transverse oscillation are reproduced in rotational oscillation. The results confirm the claim by many researchers that the transverse oscillation of a cylinder, in a uniform flow over the primary lock-on, is analogous to a cylinder with rotational oscillation about its axis. Tests on a cylinder with trip wires show a shift in the mean lift force. A simple discrete vortex model was developed and simulates correctly many of the flow characteristics for a rigid cylinder at high Reynolds number. The model combines the techniques of surrounding the cylinder with ring vortices and the efficient Cloud-in-Cell algorithm. It was also extended to include the effect of rotational oscillation and gives satisfactory agreement with experimental measurements over the primary and post-lock-on range. Dissert. Abstr.

N91-12043# Arizona State Univ., Tempe. Dept. of Mechanical and Aerospace Engineering.

THREE-DIMENSIONAL UNSTEADY SEPARATION AT LOW REYNOLDS NUMBERS Final Report

HELEN L. REED Jul. 1990 292 p
(Contract N00014-86-K-0066)
(AD-A225167) Avail: NTIS HC/MF A13 CSCL 20/4

A procedure was generated to analyze the boundary layer on airfoils experiencing unsteady flight conditions and to predict the changes in the performance characteristics during off-design. The method predicts the flow in the boundary-layer region near the separation bubble using the incompressible Navier-Stokes equations with boundary conditions from inviscid and laminar boundary-layer solutions. The rate at which the separation bubble develops and decays is of primary interest in this study. Unsteady surface-pressure-coefficient distributions and velocity profiles are presented. The experimental effort involved the study of three-dimensional unsteady separation under low-Reynolds-number conditions. The test geometry consisted of channel with a suction patch on the opposite wall. Contributions from the numerical effort include a novel, robust adaptive-rigid technique for incompressible flow. Additional contributions from the experiments include a database for comparison with theory computations. GRA

N91-12069# European Space Agency, Paris (France).

EQUIPMENT AND METHODS EMPLOYED FOR CALIBRATION OF THE SENSORS AND MEASUREMENT LINES IN THE ATTAS FLIGHT TEST PLATFORM

RUDOLF OLIVA and DIETER OTTO (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany, F.R.) Aug. 1990 93 p Transl. into ENGLISH of Einrichtungen und Verfahren zum Kalibrieren von Sensoren und Messketten im Flugversuchstraeger ATTAS (Brunswick, Fed. Republic of Germany, DFVLR), Dec. 1988 94 p Original language document was announced as N90-12007

(ESA-TT-1208; DFVLR-MITT-89-06; ETN-90-98014) Avail: NTIS HC/MF A05

A description of installations responsible for testing and calibration are presented. The fitting of the installations and the corresponding calibration methods are described. Proposals for improving calibration installations and methods are given. ESA

N91-12070# Deutsche Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Abt. fuer Systemtechnik und Navigation.

INVESTIGATION OF THE DYNAMIC BEHAVIOR AND THE FREQUENCY RESPONSE OF THE LASER GYRO GG 1342

HELMUT NIEDERSTRASSER Jan. 1990 95 p In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-1236)
(DLR-FB-90-22; ISSN-0171-1342; ETN-90-98044) Copyright

Avail: NTIS HC/MF A05; DLR, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 33 Deutsche marks

The dynamic behavior of a laser gyro under angular vibrations and constant angular rates on a single axis test table is investigated. The frequency response was studied and the measurement rate was described by power spectral densities. The hybrid angular velocity reference system was composed of an inductosyn, a tachometer and a linear accelerometer. The measurement characteristics were discussed including the measurement noise and the disorder reaction notion. The adaptability of a laser gyro to inertial navigation and flight control is demonstrated. ESA

N91-12086 Council for National Academic Awards (England). **SIMULATION AND DETECTION OF TRANSVERSE CRACKS IN ROTORS. Ph.D. Thesis**

ROBERTO F. DENORONHA 1989 222 p
Avail: Univ. Microfilms Order No. BRDX89765

The detection of transverse cracks in rotors of turbo-generator units through vibration monitoring is examined. A crack model was developed using three dimensional finite element (FE) simulations. Static analyses of how a vertical bending load affects the crack opening and the local flexibility were also performed. The 3D FE mesh was generated using IDEAS and the resulting model analyzed through ABAQUS. The results from the static analysis allowed the stiffness matrix of a rotor beam element with a transverse crack at the center to be calculated. An unbalance response program was modified to work with the cracked finite element and to solve the system of equations through step-by-step integration. Different parameters were analyzed to establish the sensitivity of a rotor containing a crack whereby whirl orbits, displacement, velocity, acceleration, and the unbalance phase angle were all studied in order to determine the best graphical output for detecting the early growth of a breathing crack. Dynamic simulations were undertaken with a finite element representation of a 500 MW generator at an operating speed of 3000 rpm with cracks of 25 and 10 percent of the diameter, located near a retaining ring. Comparisons of the crack model with another available from literature show good agreement in the vertical direction, which is a reassurance for both models, and indicate a better performance of the developed model in the horizontal direction. The simulations indicate that the harmonics of the unbalance phase angle can be a useful aid, since its higher components are more sensitive to the presence of a crack, than conventional displacement components. The technique is capable of sensing the early stages of a crack with the considerable advantage of not being affected by the presence of any other fault condition such as coupling misalignment, rubbing, etc.
Dissert. Abstr.

N91-12125# Wyle Labs., Inc., El Segundo, CA. **EVALUATION OF POTENTIAL DAMAGE TO UNCONVENTIONAL STRUCTURES BY SONIC BOOMS Final Report, Nov. 1988 - Jan. 1990**
LOUIS C. SUTHERLAND, RON BROWN, and DAWN GOERNER
May 1990 274 p
(Contract F08635-89-C-0044; AF PROJ. 3037)
(AD-A225029; WR-89-14; HSD-TR-90-021) Avail: NTIS HC/MF A12 CSCL 01/2

Supersonic operations of U.S. Air Force aircraft cause sonic booms which may be the source of damage to unconventional structures. This problem is addressed in this report by (1) a literature survey of damage prediction and damage assessment techniques for such structures; (2) development of a statistical model for sonic boom overpressures with emphasis on supersonic operating areas (SOAs) employed for air combat maneuver training; (3) development of an analytical model to predict the probability of damage; (4) execution of a limited experimental program at White Sands Missile Range to evaluate response and potential damage of two unconventional structures in support of the prediction model; and finally (5) definition of algorithms for use in the Air Force ASAN computer program for evaluation of the probability of damage to unconventional structures from sonic booms. GRA

N91-12126# California Univ., Berkeley. Dept. of Materials Science and Mineral Engineering.

MODELING OF MICROMECHANISMS OF FATIGUE AND FRACTURE IN HYBRID MATERIALS Final Report, 15 Apr. 1987 - 14 Apr. 1990

L. H. EDELSON, J.-K. SHANG, S. C. SIU, K. T. VENKATESWARARAO, and R. O. RITCHIE 15 Jun. 1990
91 p

(Contract AF-AFOSR-0158-87; AF PROJ. 2306)
(AD-A225042; UCB/R/90/A1065; AFOSR-90-0832TR) Avail:
NTIS HC/MF A05 CSCL 11/6

The obvious benefits of the design of aerospace structures using lighter materials with high specific strengths and stiffnesses had led to the development of numerous reinforced composite metallic and intermetallic materials, which have become serious commercial competitors to traditional monolithic metallic alloys. While significant advances in processing technology have made the fabrication of such hybrid materials more of an economic reality, their widespread use in airframes or other structures has been limited by serious deficiencies in mechanical properties, particularly ductility, toughness and fatigue. This problem is compounded by the lack of fundamental studies which provide a rational basis for the underlying sources of crack-propagation resistance, and in particular which define the critical role of composite microstructure. GRA

N91-12408*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

LOW-G MEASUREMENTS BY NASA

ROGER P. CHASSAY and ARTHUR SCHWANIGER *In its*
Measurement and Characterization of the Acceleration Environment on Board the Space Station 48 p Aug. 1990
Avail: NTIS HC/MF A99 CSCL 22/1

NASA has utilized low-g accelerometers on a variety of flights for over ten years. These flights have included aircraft parabolas, suborbital trajectories, and orbital missions. This large quantity of data has undergone only limited in-depth analyses. Highlights of this low-g data are presented along with brief discussion of the instruments used and the circumstances of the data collection.

Author

N91-12538# Tohoku Univ., Sendai (Japan). Dept. of Mechanical Engineering.

NUMERICAL SIMULATIONS OF TRANSONIC CASCADE FLOW AND THEIR VISUALIZATIONS

SATORU YAMAMOTO and HISAAKI DAIGUJI *In* NAL, Proceedings of the 7th NAL Symposium on Aircraft Computational Aerodynamics p 155-160 1989 *In* JAPANESE; ENGLISH summary

Avail: NTIS HC/MF A14

Researchers propose implicit time-marching finite-difference methods for solving the three-dimensional compressible Euler and Navier-Stokes equations which were composed of the momentum equations of contravariant velocities. By using these methods, such boundary conditions as the solid wall b.c. and the periodic b.c. for 3-D impeller flows can be treated easily. An TVD upwind scheme and a two-equation k-epsilon turbulence model were also employed. The purpose is to first visualize the computer results of the 3-D compressor cascade flow by using 3-D Computer Graphic (CG) techniques such as the particle paths, oil flows and time lines, and second to extend methods for obtaining steady-state solutions to a numerical method for solving the unsteady cascade flow such as a turbine stator-rotor interaction. Author

N91-12549# Kawasaki Heavy Industries Ltd., Kagamihara (Japan).

THE ROLE OF COMPUTATIONAL FLUID DYNAMICS IN AERONAUTICAL ENGINEERING. 7: A SIMPLE ANALYSIS METHOD OF SEPARATING FLOWS

TAKASHI UCHIDA and EIJI SHIMA *In* NAL, Proceedings of the 7th NAL Symposium on Aircraft Computational Aerodynamics p 225-229 1989 *In* JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A14

It is important to develop simple analysis methods of flows for aircraft design. A simple analysis method of two dimensional separating flow is described. The method is based on potential flow theory and experimental data. The results of this method are compared with then calculated by a Navier-Stokes code. Agreement between the former results and the latter is good. Author

N91-12557# National Aerospace Lab., Tokyo (Japan).

ON THE NUMERICAL SIMULATIONS OF FLOW AROUND A BODY OF COMPLEX CONFIGURATIONS

SATORU OGAWA, YASUHIRO WADA, TOMIKO ISHIGURO, and YOKO TAKAKURA *In its* Proceedings of the 7th NAL Symposium on Aircraft Computational Aerodynamics p 279-284. 1989 In JAPANESE; ENGLISH summary Prepared in cooperation with Fujitsu Ltd., Tokyo, Japan
Avail: NTIS HC/MF A14

The grid embedding scheme is used to solve the whole flowfields around the combined configuration of the Hope, H-II rocket and rocket booster designed by the National Space Development Agency (NASDA). Three computational grids are overlapped with each other and the solutions are combined by interpolation at the boundaries. The Harten type Total Variation Diminishing (TVD) scheme is used to solve the Euler equations for hypersonic flow from $M = 1.3$ to 2.5, and it is shown the results of numerical simulation using the present methods are reasonable. Author

N91-12558# National Aerospace Lab., Tokyo (Japan).

VERIFICATION OF NUMERICAL SIMULATION CODES FOR HYPersonic VISCOUS FLOW AROUND A SPACE PLANE

YUKIMITSU YAMAMOTO, HARUHIKO ARAKAWA, and RYUJI YOSHIDA (Mitsubishi Heavy-Industries Ltd., Tokyo, Japan) *In its* Proceedings of the 7th NAL Symposium on Aircraft Computational Aerodynamics p 285-293 1989 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A14

Recent progress of super computers and numerical schemes enables us to use computational fluid dynamics (CFD) as the main tool for designing the optimum configuration of the hypersonic vehicles. However, before using CFD for such purposes, verification of the CFD code is necessary. In the present study, a flux-split upwind TVD Navier-Stokes code was applied to the hypersonic flow around space planes proposed by the National Aerospace Laboratory (NAL). Numerical results are compared with experiments in the hypersonic wind tunnel at NAL and accuracy and reliability of the present code are examined. Through these comparisons, it is demonstrated that the present code gives excellent agreements with experimental data on surface pressure distributions and aerothermodynamic heating. Author

N91-12562# National Aerospace Lab., Tokyo (Japan).

FINITE ELEMENT SOLUTION OF NAVIER-STOKES FLOW AROUND AEROFOILS: ACTIVE USE OF BLOCK TRIDIAGONAL MATRIX

MASASHI SHIGEMI *In its* Proceedings of the 7th NAL Symposium on Aircraft Computational Aerodynamics p 313-320 1989 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A14

A finite element method which is designed to solve the incompressible Navier-Stokes equations through the application of the penalty function method has been proved to be robust and reliable. A shortcoming of this approach is its expensiveness; it requires long computation time and large memory area. This is because a large system of linear equations has to be solved repeatedly by this method. This system of linear equations has a band structure, and a structure as a block tridiagonal matrix. An efficient method to solve it is shown here. In this new method, all elements of the coefficient matrix are not evaluated at a stretch, but evaluated block by block. Since all block matrices, which are subsets of the global coefficient matrix, share the same memory area and are stored in it one by one, the memory area necessarily becomes small. The basic method applied here to solve the system of linear equations is the LU-decomposition of the coefficient

matrices and subsequent forward and backward substitutions. Such operations as the LU-decomposition, forward substitution and backward substitution are conducted not in the element level but in the block matrix level. This method gives a theoretically exact solution. To improve the efficiency of the solution, it is possible to introduce an approximation into the procedure when flows around a thin obstacle such as an airfoil are concerned. Author

N91-12578# Computer Technology Associates, Inc., McKee City, NJ.

SUMMARY OF THE FAA LOW DATA RATE VOICE CODEC EVALUATION AND DEMONSTRATION PROGRAM

MARKUS R. GRABLE *In* AIAA, Proceedings of the 1990 AIAA/FAA Joint Symposium on General Aviation Systems p 364-372 May 1990
Avail: NTIS HC/MF A17

The Federal Aviation Administration's (FAAs) low data rate voice coder/decoder (CODEC) evaluation and demonstration program is summarized. This program will assess the performance and operational characteristics of low data rate voice digitizing equipment in an aeronautical satellite link environment for air traffic control (ATC) applications. A concern of the FAA is to achieve acceptable voice performance for ATC in the most efficient manner. The FAA will recommend a low data rate voice CODEC standard for inclusion to Aeronautical Mobile Satellite Service (AMSS) voice communications based on the program results. The Phase II CODEC evaluation and results are focused upon. Author

N91-12603# Tohoku Univ., Sendai (Japan). Dept. of Mechanical Engineering.

AN IMPLICIT TIME-MARCHING METHOD FOR THE THREE-DIMENSIONAL NAVIER-STOKES EQUATIONS OF CONTRAVARIANT VELOCITY COMPONENTS

HISAAKI DAIGUJI and SATORU YAMAMOTO *In* 'NAL, Proceedings of the 6th NAL Symposium on Aircraft Computational Aerodynamics p 77-83 Dec. 1988 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A12

The implicit time-marching finite-difference method for solving the three-dimensional compressible Euler equations developed by the authors is extended to the Navier-Stokes equations. The distinctive features of this method are to make use of momentum equations of contravariant velocities instead of physical boundaries, and to be able to treat the periodic boundary condition for the three-dimensional impeller flow easily. These equations can be solved by using the same techniques as the Euler equations, such as the delta-form approximate factorization, diagonalization and upstreaming. In addition to them, a simplified total variation diminishing scheme by the authors is applied to the present method in order to capture strong shock waves clearly. Finally, the computed results of the three-dimensional flow through a transonic compressor rotor with tip clearance are shown. Author (NASDA)

N91-12609# National Aerospace Lab., Tokyo (Japan). Computational Sciences Div.

ON A NEW DIFFERENCE SCHEME-ATVD2

SATORU OGAWA, TOMIKO ISHIGURO, YASUHIRO WADA, and YOKO TAKAKURA (Fujitsu Ltd., Tokyo, Japan) *In its* Proceedings of the 6th NAL Symposium on Aircraft Computational Aerodynamics p 121-125 Dec. 1988 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A12

A new difference scheme is proposed which is constructed by applying the modified flux method proposed by Harten for the second order accuracy total variation diminishing (TVD2) second-order accuracy uniformly non oscillatory (UNO2) scheme. The numerical experiment of the ONERA-M6 wing test case shows the solutions of the proposed scheme without artificial compression. The parameters almost coincide with those of the Harten-Yee TVD scheme and the Chakravarthy-Osher TVD scheme with a maximum value of the artificial compression parameter. This fact shows that the proposed scheme is more accurate than other TVD schemes in multi-dimensional problems. It is also shown that

the dependence of solutions on the artificial compression parameter is little in comparison to previous TVD schemes.

Author (NASDA)

N91-12610# Kawasaki Heavy Industries Ltd., Kobe (Japan).
THE ROLE OF COMPUTATIONAL FLUID DYNAMICS IN AERONAUTICAL ENGINEERING Report No. 6

TAKUJI KISHIMOTO and TAKASHI UCHIDA /in NAL, Proceedings of the 6th NAL Symposium on Aircraft Computational Aerodynamics p 127-132 Dec. 1988 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A12

Numerical analyses by solving Euler/Navier-Stokes Equations has been used in practical aeronautical engineerings. Here, the results of two dimensional Navier-Stokes analyses of a multiple slotted flap, and a three dimensional wing design problem using Euler analyses are shown.
Author (NASDA)

N91-12614# Tokyo Univ. (Japan). Inst. of Space and Aeronautical Science.

UPWIND DIFFERENCING FOR VISCOUS FLOW COMPUTATIONS

KOZO FUJII, SUSUMU TAKANASHI, and KISA MATSUSHIMA (Fujitsu Ltd., Tokyo, Japan) /in NAL, Proceedings of the 6th NAL Symposium on Aircraft Computational Aerodynamics p 159-162 Dec. 1988 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A12

High-resolution upwind differencing has become a popular feature of recently-developed Euler methods for compressible inviscid flow simulations. This feature was straightforwardly extended for the evaluation of convective terms of the Navier-Stokes equations. Recent study of total variation diminishing (TVD) type high-resolution upwind schemes proved that dissipation-like terms introduced by these upwind schemes such as Roe's flux difference splitting automatically become small in the viscous layers. Here, numerical computations using this Roe's upwind scheme with MUSCL interpolation are conducted, and the results are compared with the typical central differencing results. The computed results indicate that the present upwind differencing shows better resolution than the central differencing in both inviscid region and viscous region.
Author (NASDA)

N91-12696*# Draper (Charles Stark) Lab., Inc., Cambridge, MA. Fault-Tolerant Systems Div.

A HIGHLY RELIABLE, AUTONOMOUS DATA COMMUNICATION SUBSYSTEM FOR AN ADVANCED INFORMATION PROCESSING SYSTEM

GAIL NAGLE, THOMAS MASOTTO, and LINDA ALGER /in AGARD, Fault Tolerant Design Concepts for Highly Integrated Flight Critical Guidance and Control Systems 11 p Apr. 1990 (Contract NAS1-17666; NAS1-18565)

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Executive CSCL 17/2

The need to meet the stringent performance and reliability requirements of advanced avionics systems has frequently led to implementations which are tailored to a specific application and are therefore difficult to modify or extend. Furthermore, many integrated flight critical systems are input/output intensive. By using a design methodology which customizes the input/output mechanism for each new application, the cost of implementing new systems becomes prohibitively expensive. One solution to this dilemma is to design computer systems and input/output subsystems which are general purpose, but which can be easily configured to support the needs of a specific application. The Advanced Information Processing System (AIPS), currently under development has these characteristics. The design and implementation of the prototype I/O communication system for AIPS is described. AIPS addresses reliability issues related to data communications by the use of reconfigurable I/O networks. When a fault or damage event occurs, communication is restored to functioning parts of the network and the failed or damage components are isolated. Performance issues are addressed by using a parallelized computer architecture which decouples

Input/Output (I/O) redundancy management and I/O processing from the computational stream of an application. The autonomous nature of the system derives from the highly automated and independent manner in which I/O transactions are conducted for the application as well as from the fact that the hardware redundancy management is entirely transparent to the application.

Author

N91-12866# Wright Research Development Center, Wright-Patterson AFB, OH.

INTEGRATED ELECTROMAGNETIC SYSTEM SIMULATOR (IESS) POST RUN ANALYSIS WITH DECALC/DECGRAPH AND A TRUTH DATA FORMATTING PROGRAM WRITTEN IN FORTRAN

DANA L. HOWELL 8 Feb. 1990 112 p LIMITED
REPRODUCIBILITY: Availability: Document partially illegible (AD-A226116; WRDC-TM-90-100-AAAI) Avail: NTIS HC/MF A06 CSCL 20/14

The Analysis and Evaluation Group (WRDC/AAAI-4) has been tasked with integrating the Integrated Communication, Navigation, Identification Avionics (ICNIA) system into the Integrated Electromagnetic System Simulator (IESS) facility and performing Test and Evaluation (T and E) on the ICNIA system. This responsibility has led to the need to examine IESS post run analysis techniques to determine areas that may need enhancement. DECALC and DECGRAPH are Digital Equipment Corporation (DEC) software products that produce accurate graphical representations of data through an integrated spreadsheet/graphics package very similar to the PC-based LOTUS program. This memorandum describes the use of DECALC/DECGRAPH in performing post run analysis of data produced from IESS scenarios. A FORTRAN program is also described which has been written to reformat post run text data from the IESS. This reformatted data output is easier to read and can be imported directly into DECALC and graphed using DECGRAPH. IESS produces a dynamic electromagnetic environment consisting of complex Radio Frequency (RF) waveforms in the 2 MHz to 5 GHz frequency range that closely simulates the environment which occurs during actual flight. Scenarios are defined through a Host processor (VAX 11/7800).
GRA

N91-12902 Princeton Univ., NJ.

SOLUTION OF THE EULER EQUATIONS IN MULTIBODY FLOW FIELDS USING THE OVERLAPPING-MESH METHOD
Ph.D. Thesis

TAKESHI SAKATA 1990 116 p
Avail: Univ. Microfilms Order No. DA9027582

A simple and easily implementable overlapping-mesh method is introduced. This method, consisting of independently generated component grids overlaid on one another and an interpolation scheme for inter-grid communications, requires only a hierarchical grid structure and a no-touch condition for a component grid to the other bodies. An efficient method to set up the overlaps is also developed. Combined with a finite volume, semi-discrete, explicit time-stepping Euler flow solver, this method was applied to two-dimensional two-body flow problems in subsonic and transonic range. In the cases of two parallel NADA0012 airfoils, the symmetric, transonic nature of the flow field is well realized despite the asymmetric mesh arrangement. A strong shock wave that passes through the mesh interfaces as a result of the interaction effect is also well captured, mainly due to the compactness of the bilinear interpolation scheme. The application to an airfoil with a flap poses a severe geometric problem in mesh generation, but minor modifications to the generators yield an excellent agreement with the exact solution. As an alternative approach, a hybrid-mesh method is also introduced. The use of triangular mesh eliminates the ambiguity of interpolations, but it turns out that dissipation requires careful treatment at the mesh interfaces. Preliminary results presented show the areas where extensive future work should be directed. The simplicity and flexibility of the overlapping-mesh method promises further applications to three-dimensional problems of complex geometries.
Dissert. Abstr.

N91-12909# David Taylor Research Center, Bethesda, MD. Dept. of Propulsion and Auxiliary Systems.

A DIFFERENTIAL TURBOMACHINERY EQUATION WITH VISCOUS CORRECTION Thesis - Maryland Univ. Final Report, 1989 - 1990

HERMAN B. URBACH Jul. 1990. 28 p
(AD-A226183; DTRC/PAS-90-45) Avail: NTIS HC/MF A03 CSCL 20/4

A differential turbomachinery equation describing the energy transfer between a fluid and any body moving in that fluid was derived. The derivation is based upon the Coriolis form of the Navier-Stokes Equations. A differential equation for the total relative rothalpy was also obtained. The equalities contain a rigorous viscous correction for the total enthalpy and rothalpy. The differential equation defines the substantial derivative of the total enthalpy at any point in a fluid. This substantial derivative represents the energy transfer rate into or out of the fluid at the point. In order to obtain the total enthalpy transfer between the fluid and the body, it is necessary to integrate over the entire domain. For ideal flow regimes, the integration domain may be restricted entirely within the rotor. For real fluids, viscous coupling requires that regions outside the blade area be considered. One integration of the differential equations, a form of the Euler Turbomachinery Equation with viscous correction is derived. The resultant form contains two distinct work rate terms for the axial and radial components of the flow. The fact that integration yields a result which approximates the classic Euler Turbomachinery Equation constitutes confirmation of the derivation. An application of the equation to an ideal infinite linear cylinder with bound vorticity was developed. The cylinder was made to act like a turbine blade performing work by lifting an ideal airframe against gravity. The integration yielded the expected known result. GRA

N91-12956*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

EXPERIMENTAL AND ANALYTICAL EVALUATION OF EFFICIENCY OF HELICOPTER PLANETARY STAGE

TIMOTHY L. KRANTZ Nov. 1990 20 p Prepared in cooperation with Army Aviation Systems Command, Cleveland, OH (Contract DA PROJ. 1L1-6221147-A) (NASA-TP-3063; E-5268; NAS 1.60:3063; AVSCOM-TR-90-C-001) Avail: NTIS HC/MF A03 CSCL 13/9

The efficiency of a helicopter transmission planetary stage was studied both experimentally and analytically. Experiments were done by using a back-to-back, test-and-slave arrangement. The experiments were a parametric study of the effects of operating conditions on efficiency. In order to enhance the analysis, a model was developed that calculates the power required for the meshing gears to displace oil trapped between the gear teeth. In general, the analysis predicted higher efficiencies than were measured. The results of this study were compared with those of other studies. Author

N91-12966 ESDU International Ltd., London (England). **FATIGUE OF ALUMINUM ALLOY JOINTS WITH VARIOUS FASTENER SYSTEMS Abstract Only**

Jun. 1990 30 p
(ESDU-90009; ISBN-0-85679-735-9; ISSN-0958-0379) Avail: ESDU

ESDU 90009 presents the results of over 350 axial load fatigue tests extracted from the literature on the joints under variable amplitude loading (mainly the FALSTAFF loading sequence although the TWIST sequence was used for a few tests). A medium load transfer joint is one in which between 10 and 30 percent of the axial load is transferred between members, and many chordwise and spanwise joints in aircraft wings fall in that category. Three fastener types are included, assembled with a range of fits from clearance to high interference and with three different interlays. Other factors examined were fastener size, head type (either countersunk or protruding) and material (either titanium alloy or steel). Two plate thicknesses were used. Details of the alloys (DTD 5120, BS L93, 7475-T7351 and 2024-T351) and of the test specimens are included and the influence of the various variables

on the fatigue strength is discussed. Included are data for joints manufactured with a corner crack in the fastener hole; these tests were designed to investigate a repair in which the hole was drilled out but insufficiently to eliminate an existing crack. It is noted that, due to the unequal load distribution from the different stiffnesses of the joined members along adjacent parts of their length, the joints were subjected to bending. The values of this secondary bending could not be determined and no account of it could be taken in the analysis and presentation of the data.

ESDU

N91-12971*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DESIGN AND FABRICATION OF INSTRUMENTED COMPOSITE AIRFOILS FOR A CRYOGENIC WIND TUNNEL MODEL

CLARENCE P. YOUNG, JR., GEORGE C. FIRTH, WILLIAM H. HOLLINGSWORTH, JR., BRUCE M. ADDERHOLDT, and BARRY V. GIBBENS Oct. 1990 28 p
(NASA-TM-102740; NAS 1.15:102740) Avail: NTIS HC/MF A03 CSCL 20/11

Two instrumented horizontal stabilizers and one instrumented vertical stabilizer were designed and fabricated for testing on the Pathfinder 1 (PF-1) Transport Model in the NASA Langley Research Center's National Transonic Facility (NTF). Two different designs were employed: the horizontal stabilizer utilized a metal spar and fiberglass overwrap and the vertical stabilizer was made of all fiberglass. All design requirements were met in terms of design loads, airfoil tolerances, surface finish, orifice hole quality, and proof-of-concept tests. Pressure tubing installation was found to be easier for these concepts as compared to methods used in conventional metallic models. Ease of repair was found to be a principal advantage in that some fabrication problems were overcome by reapplying fiberglass cloth and/or epoxy to damaged areas. Also, fabrication costs were judged to be lower when compared to the more conventional design fabrication costs.

Author

N91-12980*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

STIRLING ENGINE: AVAILABLE TOOLS FOR LONG-LIFE ASSESSMENT

GARY R. HALFORD and PAUL A. BARTOLOTTA 1991 7 p
Presented at the 8th Symposium on Space Nuclear Power Systems, Albuquerque, NM, 6-10 Jan. 1991; sponsored by NASA, New Mexico Univ., Strategic Defense Initiative Organization, DOE, and AF
(NASA-TM-103660; E-5856; NAS 1.15:103660) Avail: NTIS HC/MF A02 CSCL 20/11

A review is presented for the durability approaches applicable to long-time life assessment of Stirling engine hot-section components. The crucial elements are experimental techniques for generating long-time materials property data (both monotonic and cyclic flow and failure properties); analytic representations of slow strain rate material stress-strain response characteristics (monotonic and cyclic constitutive relations) at high temperatures and low stresses and strains; analytic creep-fatigue-environmental interaction life prediction methods applicable to long lifetimes at high temperatures and small stresses and strains; and experimental verification of life predictions. Long-lifetime design criteria for materials of interest are woefully lacking. Designing against failures due to creep, creep-rupture, fatigue, environmental attack, and creep-fatigue-environmental interaction will require considerable extrapolation. Viscoplastic constitutive models and time-temperature parameters will have to be calibrated for the hot-section materials of interest. Analysis combined with limited verification testing in a short-time regime will be required to build confidence in long-lifetime durability models. Author

N91-13312*# Valparaiso Univ., IN. Dept. of Mechanical Engineering.

AN INVESTIGATION OF DESIGN OPTIMIZATION USING A 2-D VISCOUS FLOW CODE WITH MULTIGRID

MICHAEL L. DORIA /n Hampton Univ., NASA/American Society

for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1990 p 46-47 Sep. 1990
 Avail: NTIS HC/MF A07 CSCL 20/4

Computational fluid dynamics (CFD) codes have advanced to the point where they are effective analytical tools for solving flow fields around complex geometries. There is also a need for their use as a design tool to find optimum aerodynamic shapes. In the area of design, however, a difficulty arises due to the large amount of computer resources required by these codes. It is desired to streamline the design process so that a large number of design options and constraints can be investigated without overloading the system. There are several techniques which have been proposed to help streamline the design process. The feasibility of one of these techniques is investigated. The technique under consideration is the interaction of the geometry change with the flow calculation. The problem of finding the value of camber which maximizes the ratio of lift over drag for a particular airfoil is considered. In order to test out this technique, a particular optimization problem was tried. A NACA 0012 airfoil was considered at free stream Mach number of 0.5 with a zero angle of attack. Camber was added to the mean line of the airfoil. The goal was to find the value of camber for which the ratio of lift over drag is a maximum. The flow code used was FLOMGE which is a two dimensional viscous flow solver which uses multigrid to speed up convergence. A hyperbolic grid generation program was used to construct the grid for each value of camber. Author

N91-13331*# Wichita State Univ., KS. Dept. of Aerospace Engineering.

AERODYNAMICS SUPPORT OF RESEARCH INSTRUMENT DEVELOPMENT

L. SCOTT MILLER *In* Hampton Univ., NASA/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1990 p 88-89 Sep. 1990
 Avail: NTIS HC/MF A07 CSCL 14/2

A new velocimetry system is currently being developed at NASA LaRC. The device, known as a Doppler global velocimeter (DGV), can record three velocity components within a plane simultaneously and in near real time. To make measurements the DGV, like many other velocimetry systems, relies on the scattering of light from numerous small particles in a flow field. The particles or seeds are illuminated by a sheet of laser light and viewed by two CCD cameras. The scattered light from the particles will have a frequency which is a function of the source laser light frequency, the viewing angle, and most importantly the seed velocities. By determining the scattered light intensity the velocity can be measured at all points within the light sheet simultaneously. Upon completion of DGV component construction and initial check out a series of tests in the Basic Aerodynamic Research (wind) Tunnel (BART) are scheduled to verify instrument operation and accuracy. If the results are satisfactory, application of the DGV to flight measurements on the F-18 High Alpha Research Vehicle (HARV) are planned. The DGV verification test in the BART facility will utilize a 75 degree swept delta wing model. A major task undertaken this summer included evaluation of previous results for this model. A specific series of tests matching exactly the previous tests and exploring new DGV capabilities were developed and suggested. Another task undertaken was to study DGV system installation possibilities in the F-18 HARV aircraft. In addition, a simple seeding system modification was developed and utilized to make Particle Imaging Velocimetry (PIV) measurements in the BART facility. Author

N91-13341*# Florida Inst. of Tech., Melbourne. Dept. of Mechanical and Aerospace Engineering.

COMPUTATIONAL ANALYSIS OF FLOW IN 3D PROPULSIVE TRANSITION DUCTS

PAAVO SEPRI *In* Hampton Univ., NASA/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1990 p 110-112 Sep. 1990
 Avail: NTIS HC/MF A07 CSCL 20/4

A numerical analysis of fully three dimensional, statistically steady flows in propulsive transition ducts being considered for

use in future aircraft of higher maneuverability is investigated. The purpose of the transition duct is to convert axisymmetric flow from conventional propulsion systems to that of a rectangular geometry of high aspect ratio. In an optimal design, the transition duct would be of minimal length in order to reduce the weight penalty, while the geometrical change would be gradual enough to avoid detrimental flow perturbations. Recent experiments conducted at the Propulsion Aerodynamics Branch have indicated that thrust losses in ducts of superelliptic cross-section can be surprisingly low, even if flow separation occurs near the divergent walls. In order to address the objective of developing a rational design procedure for optimal transition ducts, it is necessary to have available a reliable computational tool for the analysis of flows achieved in a sequence of configurations. Current CFD efforts involving complicated geometries usually must contend with two separate but interactive aspects: namely, grid generation and flow solution. The first two avenues of the present investigation were comprised of suitable grid generation for a class of transition ducts of superelliptic cross-section, and the subsequent application of the flow solver PAB3D to this geometry. The code, PAB3D, was developed as a comprehensive tool for the solution of both internal and external high speed flows. The third avenue of investigation has involved analytical formulations to aid in the understanding of the nature of duct flows, and also to provide a basis of comparison for subsequent numerical solutions. Numerical results to date include the generation of two preliminary grid systems for duct flows, and the initial application of PAB3D to the corresponding geometries, which are of the class tested experimentally. Author

N91-13346*# North Carolina State Univ., Raleigh. Dept. of Mechanical and Aerospace Engineering.

ANALYSES OF COMPOSITE FUSELAGE STRUCTURE UNDER VARIOUS LOADING CONDITIONS

FUH-GWO YUAN *In* Hampton Univ., NASA/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1990 p 123-125 Sep. 1990
 Avail: NTIS HC/MF A07 CSCL 20/11

With the characteristics of high strength/weight and stiffness/weight ratios in advanced composite materials, composite plate structures have been successfully applied to secondary load-carrying structural components in the aerospace industry for the past two decades. Recently, filament wound composite shells are being considered for design of primary fuselage structures. To implement the design the structural response under various loading conditions needs to be predicted accurately. Therefore, it is essential to establish a rigorous analytical solution in the area of composite laminated shells. A closed form solution is presented that predicts the response of a composite shell subjected to internal pressure, axial tension, bending, and torsion. The material of the shell is assumed to be general cylindrically anisotropic. Based on the theory of cylindrical anisotropic elasticity coupled partial differential governing equations are developed using Lekhnitskii's stress function approach. The general expressions for the stresses and displacements in the composite cylinders under these loading conditions is discussed. Three examples (45) off-axis unidirectional, (45/45) unsymmetric, and (45/45)(sub s) symmetric angle-ply fiber-reinforced laminated shells are shown to illustrate the effect of radius-to-thickness ratios, coupling, and stacking sequence. Author

GEOSCIENCES

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

A91-13051#

PREDICTIONS OF AERODYNAMIC PERFORMANCE OF WELLS TURBINES FROM AEROFOIL DATA

S. RAGHUNATHAN (Belfast, Queen's University, Northern Ireland), T. SETOGUCHI, and K. KANEKO (Saga University, Japan) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 112, Oct. 1990, p. 792-795. refs

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Data from Wells turbine tests are correlated with two-dimensional aerofoil data. The correlations show that the performance of the Wells turbine can be predicted from wind-tunnel data of aerofoils. Author

A91-14840*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

THE L-BAND PBMR MEASUREMENTS OF SURFACE SOIL MOISTURE IN FIFE

JAMES R. WANG, JAMES C. SHIUE (NASA, Goddard Space Flight Center, Greenbelt, MD), THOMAS J. SCHMUGGE, and EDWIN T. ENGMAN (USDA, Beltsville Agricultural Research Center, MD) IEEE Transactions on Geoscience and Remote Sensing (ISSN 0196-2892), vol. 28, Sept. 1990, p. 906-914. refs

The NASA Langley Research Center's L-band pushbroom microwave radiometer (PBMR) aboard the NASA C-130 aircraft was used to map surface soil moisture at and around the Konza Prairie Natural Research Area in Kansas during the four intensive field campaigns of FIFE in May-October 1987. There was a total of 11 measurements when soils were known to be saturated. This measurement was used for the calibration of the vegetation effect on the microwave absorption. Based on this calibration, the data from other measurements on other days were inverted to generate the soil moisture maps. Good agreement was found when the estimated soil moisture values were compared to those independently measured on the ground at a number of widely separated locations. There was a slight bias between the estimated and measured values, the estimated soil moisture on the average being lower by about 1.8 percent. This small bias, however, was accounted for by the difference in time of the radiometric measurements and the soil moisture ground sampling. I.E.

A91-11693*# New Hampshire Univ., Durham.

INFRARED THERMAL IMAGING OF ATMOSPHERIC TURBULENCE

DAVID WATT and JOHN MCHUGH In NASA, Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Second Combined Manufacturers' and Technologists' Conference, Part 1 p 349-363 Jul. 1990

Avail: NTIS HC/MF A15 CSCL 04/2

A technique for analyzing infrared atmospheric images to obtain cross-wind measurement is presented. The technique is based on Taylor's frozen turbulence hypothesis and uses cross-correlation of successive images to obtain a measure of the cross-wind velocity in a localized focal region. The technique is appealing because it can possibly be combined with other IR forward look capabilities and may provide information about turbulence intensity. The current research effort, its theoretical basis, and its applicability to windshear detection are described. Author

A91-11769# Technische Univ., Delft (Netherlands).

MATHEMATICAL MODELLING OF FLIGHT IN TURBULENCE AND WINDSHEAR

M. BAARS PUL In its Essays on Stability and Control 37 p

Oct. 1989

Avail: NTIS HC/MF A12

A method to generate 'patchy' atmospheric turbulence and windshear for pilot-in-the-loop, realtime flight simulation is described. The turbulence model generates five uncorrelated, nonGaussian turbulence velocities, which disturb the forces and moments in the equations of motion of the airplane. The wind speed and direction, for the realtime simulation of windshear, are modeled by expressions matched to experimental data. Some examples of thunderstorm shears and microbursts are presented.

ESA

N91-12136*# Wyoming Univ., Laramie. Dept. of Atmospheric Science.

A COMPARISON OF SURFACE SENSIBLE AND LATENT HEAT FLUXES FROM AIRCRAFT AND SURFACE MEASUREMENTS IN FIFE 1987

ROBERT D. KELLY, ERIC A. SMITH, and J. IAN MACPHERSON (National Academy of Sciences - National Research Council, Washington, DC.) 1990 19 p

(Contract NAG5-913)

(NASA-CR-187365; NAS 1.26:187365) Avail: NTIS HC/MF A03 CSCL 08/2

Surface fluxes of sensible and latent heat over a tall-grass prairie in central Kansas, as measured by 22 surface stations during FIFE 1987, are compared with values gained indirectly by linear extrapolation of aircraft-measured flux profiles to the surface. The results of 33 such comparisons covering the period 26 June to 13 October 1987 indicate that the sensible heat flux profiles were generally more linear with less scatter in the measurements at each level than were the latent heat flux profiles, the profile extrapolations of sensible heat flux in general underestimate the surface averages by about 30 percent, with slightly better agreement during periods of small flux, and the profile extrapolations of latent heat flux in general underestimate the surface averages by about 15 percent, with overestimates during periods of small fluxes (dry conditions) and overestimates during periods of large fluxes (moist conditions). Possible origins of the differences between the two sets of measurements are discussed, as directions for further research. Author

N91-13047# Massachusetts Inst. of Tech., Cambridge. Lincoln Lab.

CONTRIBUTIONS TO THE AMERICAN METEOROLOGICAL SOCIETY 16TH CONFERENCE ON SEVERE LOCAL STORMS

M. M. WOLFSON 15 Aug. 1990 54 p Conference held in Kananaskis, Alberta, 22-26 Oct. 1990

(Contract F19628-90-C-0002; DTFA-01-L-83-4-10579)

(AD-A226316; ATC-173; DOT/FAA/NR-90/3) Avail: NTIS HC/MF A04 CSCL 04/2

Eight papers contributed by the Lincoln Laboratory Weather Sensing Group to the American Meteorological Society's 16th Conference on Severe Local Storms, to be held October 22 to 26, 1990 in Kananaskis Provincial Park, Alberta, Canada, are compiled in this volume. The FAA sponsored the summer 1989 field test of the Terminal Doppler Weather Radar (TDWR) system in Kansas City, Missouri to detect wind shear aviation hazards at or near the airport. The papers are based on data collected through the summer 1989 field test and on subsequent analyses and product evaluation. The staff members of Group 43, Weather Sensing, have documented their studies of the following topics: a severe microburst; a prototype microburst prediction product; average summer microburst threat prediction at an airport; microburst asymmetry; the effect of radar viewing angle on the performance of the gust front detection algorithm; a comparison of Low-level Wind Shear Alert System (LLWAS) anemometer-measured winds and Doppler-measured winds; and ASR-9 (Airport Surveillance Radar) adjustment of range-dependent storm reflectivity levels. The final paper is an invited paper for the Conference on microbursts. This paper discusses the precipitation-driven downdraft and the downdraft associated with the vortex, or gust front, at the leading edge of an expanding

thunderstorm outflow as two primary forms of low altitude downdraft phenomena in the microburst problem. GRA

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MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

A91-14436#

THE BYZANTINE GENERALS PROBLEM IN FLIGHT CONTROL SYSTEMS

JOHN G. MCGOUGH (Allied Signal Aerospace Co., Bendix Flight Systems Div., Teterboro, NJ) AIAA, International Aerospace Planes Conference, 2nd, Orlando, FL, Oct. 29-31, 1990. 6 p. refs

(AIAA PAPER 90-5210) Copyright

The Byzantine Generals Problem is described, noting that this scenario is the result of inconsistent data and the inability of the redundancy management algorithms to tolerate the inconsistency. It is pointed out that many highly fault-tolerant systems are extremely vulnerable to Byzantine disagreement (BD) since they demand that redundantly computed variables be identical, while most flight control systems (FCS) exhibit a high degree of robustness which makes them much less vulnerable to the effects of inconsistency. The classical solution, which is theoretically the sole way to guarantee the elimination of BD, is presented. It is pointed out, however, that the cost can be prohibitive as a large number of data exchanges and at least a quadruplex level of redundancy is required. Even a robust FCS can encounter BD, particularly in the areas of clock synchronization, integrator equalization, and mode switching. It is suggested that a well-designed and reasonably robust FCS design will, in most cases, defeat the Byzantine General. L.K.S.

A91-14488

VARIATIONAL AND FINITE ELEMENT METHODS - A SYMBOLIC COMPUTATION APPROACH

ABRAHAM I. BELTZER (Holon Institute for Technological Education, Israel) Berlin and New York, Springer-Verlag, 1990, 265 p. refs

Copyright

A text on the use of a symbolic manipulation code (SMC) approach to variational and finite element methods is presented. Basic information on the SMC is presented, including illustrative examples. Also discussed are basic concepts of variational calculus, Hamilton's principle, and some of the optimization techniques, including an automatic derivation of the governing equations. Both discrete and continuous systems are considered, and examples concerning elasticity and optimal aerodynamic shapes are shown. Direct methods are considered, presenting the method of weighted residual, Rayleigh-Ritz, and others. The use of SMC greatly facilitates calculations. Problems addressed include the analysis of shock absorbers, flow through a duct, and the temperature distribution in a plate. The FEM is considered, restricting the presentation to a linear theory and dealing with the so-called displacement method. C.D.

A91-14751

INTERNATIONAL SYMPOSIUM ON DOMAIN DECOMPOSITION METHODS FOR PARTIAL DIFFERENTIAL EQUATIONS, 3RD, HOUSTON, TX, MAR. 20-22, 1989, PROCEEDINGS

TONY F. CHAN, ED. (California, University, Los Angeles), ROLAND GLOWINSKI, ED. (INRIA, Le Chesnay, France; Houston, University, TX), JACQUES PERIAUX, ED. (Dassault Aviation, Saint-Cloud; INRIA, Le Chesnay, France), and OLOF B. WIDLUND, ED. (New York University, NY) Symposium sponsored by SIAM, Societe

de Mathematiques Appliquees et Industrielles, DOE, NSF, et al.; Philadelphia, PA, Society for Industrial and Applied Mathematics, 1990, 505 p. For individual items see A91-14752 to A91-14761. (Contract DE-FG02-89ER-25071; NSF DMS-88-13744)

Copyright

The theoretical basis, algorithmic implementation, parallelization, and CFD applications of domain-decomposition methods (DDMs) for the solution of PDEs are discussed in reviews and reports. Topics addressed include a unified theory of DDMs for elliptic problems, DD coupling of viscous and inviscid models for compressible flows, a DDM with locally uniform mesh refinement, DD for a boundary-value problem with a shock layer, a DD reduction method, an additive Schwarz algorithm for nonselfadjoint elliptic equations, and interface preconditioning for DD convection-diffusion operators. Consideration is given to multigrid DDMs, parallel multilevel preconditioners, a parallel algorithm for nonlinear convection-diffusion equations, a patched-grid algorithm for complex aircraft configurations, substructuring lattice gases, a combined AIE/EBE/GMRES approach to incompressible flows, and DDMs for reservoir flow problems. T.K.

A91-14859* National Aeronautics and Space Administration, Ames Research Center, Moffett Field, CA.

MODELING THE PILOT IN VISUALLY CONTROLLED FLIGHT

WALTER W. JOHNSON (NASA, Ames Research Center, Moffett Field, CA) and ANIL V. PHATAK (Analytical Mechanics Associates, Inc., Sunnyvale, CA) IEEE Control Systems Magazine (ISSN 0272-1708), vol. 10, Aug. 1990, p. 24-26. refs

Copyright

The simplest model for a human operator is a gain with a time delay. However, there have been no comprehensive studies evaluating human control strategies in visually controlled flight. The results of preliminary studies on this topic are described. Human visually guided flight control is important both in low-level flight, where it predominates, and in higher-altitude flights, where instrument failure is always a potential danger. Two general approaches to this problem, one founded on high-order perceptual psychophysics and the other on control systems engineering, are described. Initial results show that the use of control engineering modeling techniques, together with a psychophysical analysis of information in the perspective scene, holds promise for capturing the manual control strategies used during visual flight. I.E.

A91-15151#

ADAPTIVE ROBUST CONTROL FOR CONTINUOUS TIME SYSTEMS AND ITS APPLICATION

HONG WANG and YUQI LIU (Huazhong University of Science and Technology, Wuhan, People's Republic of China) Acta Automatica Sinica (ISSN 0254-4156), vol. 16, July 1990, p. 363-367. In Chinese, with abstract in English.

By combining adaptive control method with robust control method, a sphere-turning-off adaptive control law for SISO unknown systems is proposed. The global stability and the realization of asymptotic regulation are proved. This algorithm is applied to the speed regulation of hydroturbine, and the experimental results show the correctness of the developed theory. Author

A91-16024#

EXPERT COORDINATING CONTROL OF POSITION/FORCE FOR INTERCONNECTED RIGID STRUCTURES

XIAOBIN CAI, GUANZHONG DAI, HONGFA JIANG, and JINGGUO MIAO (Northwestern Polytechnical University, Xian, People's Republic of China) Northwestern Polytechnical University, Journal (ISSN 1000-2758), vol. 8, Oct. 1990, p. 453-461. In Chinese, with abstract in English. refs

The paper examines a system consisting of three interconnected rigid structures: a force control subsystem, an angular rotating control subsystem, and an angular tracking control subsystem. An expert coordinating controller in real time is obtained and used in testing a full-scale variable-sweep aircraft wing. Experimental results are very good, especially for the angular tracking control subsystem. It is shown that the input and output curves become

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distinguishable only when the figure is considerably enlarged.

R.E.P.

A91-16548

THE EFFECT OF HIDDEN DYNAMIC STATES ON FLOQUET EIGENVALUES

DAVID A. PETERS and AY SU (Georgia Institute of Technology, Atlanta) American Helicopter Society, Journal (ISSN 0002-8711), vol. 35, Oct. 1990, p. 72-75. Research sponsored by the U.S. Army. refs

Copyright

It is shown that aerodynamic states, which are often hidden states, have an important effect on blade dynamics and should not be constrained during perturbation Floquet analysis. In some cases, the hidden states do not need to be directly perturbed in the transition matrix. However, it is noted that there are other instances in which hidden states must be directly perturbed or they will contaminate the results.

K.K.

A91-16688#

ADAPTIVE SIMULATOR MOTION SOFTWARE WITH SUPERVISORY CONTROL

M. A. NAHON, L. D. REID, and J. KIRDEIKIS (Toronto, University, Downsview, Canada) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 97-105. Research supported by Aercol, Ltd. and NSERC. refs

(AIAA PAPER 90-3133) Copyright

A flexible motion system for utilization on moving-base simulators is developed which consists of a washout algorithm that combines the best features of the common existing algorithms, controlled by supervisory software. This algorithm is derived as a hybrid of existing classical and adaptive algorithms. A supervisory software system is constructed to permit fast interactive testing and adjustment of motion algorithms. The algorithm is also extended to include automatic changes according to flight phase and conditions, or according to pilot preference.

R.E.P.

A91-16692#

NAVIGATIONAL AND ENVIRONMENTAL SIMULATION ISSUES FOR LARGE-SCALE NETWORKS

JOHN BURNETT, GARY R. GEORGE, and SAMUEL KNIGHT (CAE-Link Corp., Link Flight Simulation Div., Binghamton, NY) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 128-131. refs

(AIAA PAPER 90-3137) Copyright

An examination of the navigation and environmental issues that involve serious technical challenges in the development of combined arms and joint forces large-scale networks is described. The paper focuses on methods to provide uniform environmental models and simulation concepts for new simulators, and the changes required on current devices to support the large-scale networks of the near future. It is concluded that correlated data bases of all types will be required for large-scale networking. Thus, there is a need to define the navigational/environmental requirements for the sea, land, and air simulation communities. This would be part of the mission-critical task analysis for each group with regard to networking.

R.E.P.

A91-16693#

INTERFACING LOW COST NETWORKED FLIGHT SIMULATORS IN A SIMNET ENVIRONMENT

JORGE CADIZ, RUEY OUYANG, MARGARET LOPER, and JACK THOMPSON (Central Florida, University, Orlando, FL) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 132-137. Research supported by the U.S. Army and DARPA. (Contract N61339-89-C-0043)

(AIAA PAPER 90-3138) Copyright

Research being carried out at the Institute for Simulation and Training/University of Central Florida is discussed which focuses on the interconnection of dissimilar networkable simulators. The results of efforts to interconnect two dissimilar simulation networks, namely, the Perceptronics Avionics Situational Awareness Trainer (ASAT) networkable F-16 training device and the DARPA developed SIMNET simulation network, are described. Author

A91-16694#

NETWORKED MODULAR AIRCREW SIMULATION SYSTEMS

DAVID E. POWELL, JAMES W. DILLE, STEVEN D. SWAINE (McDonnell Aircraft Co., Saint Louis, MO), and STEPHEN M. MCGARRY (Bolt, Beranek and Newman, Inc., Cambridge, MA) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 138-145.

(AIAA PAPER 90-3139) Copyright

Large multi-vehicle simulation and training environments are increasingly necessary as the focus of aircraft simulation shifts from the individual to the team, both for the development and testing of advanced aircraft systems and for effective aircrew training. Budget constraints dictate that a solution must incorporate both existing simulators and new low-cost reconfigurable simulators that can serve as a variety of aircraft types. A developing network standard, based on the SIMNET protocols, will allow for the interconnection of the number and variety of simulators required. A recent experiment, the use of SIMNET to network high performance aircraft simulators at the 1989 I/ITSC, has provided valuable insights into the problems faced when interconnecting existing simulators via SIMNET.

Author

A91-16695*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

HIGH PERFORMANCE PROCESSORS FOR REAL-TIME FLIGHT SIMULATION

JEFF I. CLEVELAND, II, STEVEN J. SUDI, and DANIEL J. CRAWFORD (NASA, Langley Research Center, Hampton, VA) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 146-156. refs

(AIAA PAPER 90-3140) Copyright

In order to meet the requirements of the NASA Langley Research Center for simulating the increased complexity and higher performance of modern aircraft, a flight simulation computing system with very high scalar performance is needed. The requirements and proposed response, probable areas of difficulty, planned implementation, and current status and plans are reviewed. A solution utilizing centralized minisupercomputers coupled with a proven real-time network technology will provide engineers and research scientists with the tools required for high-performance flight simulation. Subsequent to testing and verification of the initial simulation, general-purpose configuration management software with a nonconfiguration dependent serial highway driver software will be integrated to support any arbitrary combination of simulation sites.

R.E.P.

A91-16696#

USE OF FLIGHT SIMULATION ACCELERATORS FOR ENHANCED HIGH SPEED COMPUTATIONAL CAPABILITY IN REAL-TIME MANNED FLIGHT SIMULATION

PATRICK K. MORIARTY, CRAIG A. WILSEY, JAN L. WURTS (Lockheed Aeronautical Systems Co., Burbank, CA), ROY B. HOLLSTIEN, and DAVID S. HOLLSTIEN (RDH Simulation, Paso Robles, CA) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 157-164.

(AIAA PAPER 90-3142) Copyright

This paper discusses the development of current applications, and the proposed future applications, of the RDH Simulation Flight Simulation Accelerator (FSA) boards used at Lockheed's Weapon

System Simulation Center (WSSC) at Rye Canyon. The focus of this paper is the two primary current applications of the FSA to real-time manned flight simulation, the P-7A handling qualities simulation, and the real-time aircraft models used in full mission simulation, with emphasis on the net improvements of these configurations with use of the FSA. Special programming considerations made for the FSA during software development, as well as methods for FSA software structure and validation are included. Author

A91-16719*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

ANALYZING TIME DELAYS IN A FLIGHT SIMULATION ENVIRONMENT

R. E. MCFARLAND (NASA, Ames Research Center, Moffett Field, CA) and J. W. BUNNELL (NASA, Ames Research Center; Syre, Moffett Field, CA) IN: AIAA Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990, Technical Papers. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 341-351. refs (AIAA PAPER 90-3174) Copyright

Transport delay in a multirate flight simulation environment is examined. An equivalent systems model is developed that quantifies the contributions of individual components and their sampled-data interactions. Mathematical algorithms used in the discrete implementation are also considered, because they are important elements of a flight simulation system. The equivalent systems model was used to demonstrate the consistency and accuracy of data obtained in the flight simulation facility at Ames Research Center. It showed that effective time delays in simulation models, including delays in scene presentation to the pilot, are considerably less than might be assumed by casual examination of raw data obtained from component-level experiments. Author

A91-16726#
PROBLEMS IN INTEGRATION OF ARTIFICIAL INTELLIGENCE SYSTEMS WITH REAL-TIME SIMULATION

RICHARD D. TEICHGRAEBER (General Dynamics Flight Simulation Laboratory, Fort Worth, TX) AIAA, Flight Simulation Technologies Conference and Exhibit, Dayton, OH, Sept. 17-19, 1990. 6 p. (AIAA PAPER 90-3178) Copyright

The sources of problems arising from coupling together the interface of an expert system to an existing real-time simulator consisting of computers, interface equipment, and other hardware are discussed. Among the problems identified are numerical/symbolic data conversion, communication interfaces, time delays, the use of dissimilar computer/processor systems, different languages and different versions of the same language, different software contractors and philosophies, run-time difficulties, and integration inaccuracies. Consideration is given to incomplete interface design and system definition, insufficient prior development testing of a system in an environment, and validation and verification of an AI system. V.T.

N91-12283# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.

ROBUST AND ADAPTIVE CONTROL Final Report, Jan. 1987 - Dec. 1989

LENA VALAVANI Apr. 1990 13 p
(Contract F08635-87-K-0031; AF PROJ. 2304)
(AD-A224810; AFATL-TP-90-14) Avail: NTIS HC/MF A03
CSCL 12/2

This research deals with fundamental issues in robust and adaptive control, with emphasis on performance and stability robustness under parametric uncertainty and on the potential applications of such advanced control system design methods to the control of high performance vehicles such as the supermaneuverable aircraft and bank-to-turn missiles. GRA

N91-12543# National Aerospace Lab., Tokyo (Japan).
A NEW ALGORITHM FOR GENERATING BLOCK-STRUCTURED GRID AND ITS APPLICATION TO COMPLEX AIRCRAFT CONFIGURATIONS

SUSUMU TAKANSHI and MOTOMU SATO (Meitec Ltd., Japan) *In its Proceedings of the 7th NAL Symposium on Aircraft Computational Aerodynamics* p 189-193 1989 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A14

A grid generation procedure using a simple algorithm is presented. The present method is essentially based on the electrostatic theory. By distributing electric charges at the boundary points, an electro-static vector field is produced inside the region between the inner and outer boundaries. The resulting electric force lines, which all emanate from the grid points on the body, can be utilized as one family of grid lines. The other family of grid lines is easily constructed by regularly-plotting points along the electric force lines. The electric charge distribution is uniquely determined by the appropriate boundary condition, so far as the total amount of charges on each closed-boundary is constant. The practical application of the present method was successfully made to complex aircraft configurations. Author

N91-12545# National Aerospace Lab., Tokyo (Japan).
GENERATION OF 3-D GRID USING BOUNDARY ELEMENT METHOD

MITSUNORI YANAGIZAWA, MASAOKI NAKADATE, YASUHIRO KOSHIOKA, and ATUSHI INOUE (Fuji Heavy Industries Ltd., Utsunomiya, Japan) *In its Proceedings of the 7th NAL Symposium on Aircraft Computational Aerodynamics* p 201-207 1989 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A14

A computational procedure for generating three-dimensional grids around wing-fuselage configurations is presented. Use is made of Green's theorem to obtain the required solution use of the panel methodology. Then the lines of force and equipotential surfaces surrounding the configuration determine a body-conforming orthogonal grid. Application of the method to several test cases shows that the grid for a forebody is made smooth and continuous and that the grid for a civil transport plane is created. A finite-volume Euler solver is adapted to the grid system. Computed inviscid compressible flow solutions about the civil transport plane are present. Author

N91-12564# Ebasco Services, Inc., Lyndhurst, NJ. Corporate Quality Programs Div.

SOFTWARE SUPPLIER EVALUATION AND ASSESSMENT

R. KOSINSKI and J. M. GUSHUE *In AIAA, Proceedings of the 1990 AIAA/FAA Joint Symposium on General Aviation Systems* p 2-15 May 1990
Avail: NTIS HC/MF A17

In the design of general aviation aircraft, current technology involves the use of advanced application software. Advanced software systems are called upon to provide reliable and accurate solutions. Software systems enhance our ability to understand complex forces and processes. Thus, the process of software development and maintenance can't be ignored if the aircraft industry is to rely on these advanced systems for the design of state of the art aircraft and the safety of the flying public. Potential users of advanced application software must establish a level of confidence in the product before it can be applied to engineering and design situations. A software supplier control program can help to provide the necessary level of assurance that advanced application software will perform as required. Software supplier control programs can help enhance our confidence in the software through an evaluation of the supplier's Software Quality Assurance Program (QA), an evaluation of its implementation and an assessment of a supplier's software engineering capability. Supplier evaluations or audits are a proven technique used to examine suppliers' QA programs, and to determine the acceptability and implementation of the program. The software engineering capability assessment is a technique used to assess the capability of an organization to support and use modern software engineering technology. The emphasis of the software engineering capability assessment is on identifying and promoting modern software development and maintenance processes and practices within the

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supplier's organization which, in turn, support desirable quality characteristics in the software and software process. Author

N91-13319*# Elizabeth City State Univ., NC. Dept. of Mathematics and Computer Science.

A THREE-DIMENSIONAL APPLICATION WITH THE NUMERICAL GRID GENERATION CODE: EAGLE (UTILIZING AN EXTERNALLY GENERATED SURFACE)

JOHNNY L. HOUSTON *In* Hampton Univ., NASA/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1990 p 60-61 Sep. 1990

Avail: NTIS HC/MF A07 CSCL 09/2

Program EAGLE (Eglin Arbitrary Geometry Implicit Euler) is a multiblock grid generation and steady-state flow solver system. This system combines a boundary conforming surface generation, a composite block structure grid generation scheme, and a multiblock implicit Euler flow solver algorithm. The three codes are intended to be used sequentially from the definition of the configuration under study to the flow solution about the configuration. EAGLE was specifically designed to aid in the analysis of both freestream and interference flow field configurations. These configurations can be comprised of single or multiple bodies ranging from simple axisymmetric airframes to complex aircraft shapes with external weapons. Each body can be arbitrarily shaped with or without multiple lifting surfaces. Program EAGLE is written to compile and execute efficiently on any CRAY machine with or without Solid State Disk (SSD) devices. Also, the code uses namelist inputs which are supported by all CRAY machines using the FORTRAN Compiler CF177. The use of namelist inputs makes it easier for the user to understand the inputs and to operate Program EAGLE. Recently, the Code was modified to operate on other computers, especially the Sun Spare4 Workstation. Several two-dimensional grid configurations were completely and successfully developed using EAGLE. Currently, EAGLE is being used for three-dimension grid applications.

Author

N91-13343*# Northeastern Univ., Boston, MA. Dept. of Computer Systems Engineering.

IMPROVING SYSTEM RELIABILITY THROUGH FORMAL ANALYSIS AND USE OF CHECKS IN SOFTWARE

MARK E. STAKNIS *In* Hampton Univ., NASA/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1990 p 115-116 Sep. 1990

Avail: NTIS HC/MF A07 CSCL 09/2

Software is playing increasingly important roles in avionics systems. It is widely used in navigation and, in some cases, in control loops that maintain aircraft stability. To guarantee the safety of flight systems, the FAA requires that critical components have a probability of failure no greater than $10(\text{exp } -9)$ per hour of flight. Software is being used to diagnose system components for failure. SIFT (Software Implemented Fault Tolerance) was a computer system developed to study the use of software to check for failure and manage processor reconfiguration. To guarantee that software satisfies its specifications, formal verification can be used. With this a program and its specification are viewed as mathematical objects, and a mathematical proof is used to show that the program and its specification are equivalent. In previous research, a theory of checking was developed to offer assistance in analyzing specifications and designing run-time checks. In the theory, checking is considered abstractly in terms of n-ary relations much like those of relational database theory. Within the theory check are categorized, checks on input and checks on results are considered, and formal attention is given to the minimization and logical combination of checks. The focus is upon input checks and the obstacles in checking input to critical systems. A central concern is with a property referred to as independence. The concern is with circumstances under which it is possible to apply isolated, independent checks to separate sensor inputs and be assure that all illegal input will be properly detected. Presently, independence is being investigated and checked in the context of the GCS (Guidance and Control System). The GCS simulator is intended for testing software that implements control laws for

landing spacecraft. The large number of inputs and their complex interrelationships provide an exciting context in which to investigate independence and the difficulties of supplying input checks.

Author

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PHYSICS

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

A91-15086* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

CORRELATION AUTOREGRESSIVE PROCESSES WITH APPLICATION TO HELICOPTER NOISE

J. C. HARDIN (NASA, Langley Research Center, Hampton, VA) and A. G. MIAMEE (Hampton University, VA) *Journal of Sound and Vibration* (ISSN 0022-460X), vol. 142, Oct. 22, 1990, p. 191-202. refs

(Contract NAG1-768)

Copyright

This paper introduces a new class of random processes $X(t)$, the autocorrelations $R_{xx}(t_1, t_2)$ of which satisfy a linear relation for all t_1 and t_2 in some interval of the time axis. Such random processes are denoted as 'correlation-autoregressive'. This class is shown to include the familiar stationary and periodically correlated processes as well as many other, both harmonizable and nonharmonizable, nonstationary processes. When a process is correlation-autoregressive for all times and harmonizable, its two-dimensional power spectral density is shown to take a particularly simple form. The relationship of such processes to the class of stationary processes is examined. In addition, the application of such processes in the analysis of typical helicopter noise signals is described.

Author

N91-11717# Dornier System G.m.b.H., Friedrichshafen (Germany, F.R.).

INTERIOR NOISE CONTROL PROGRAM FOR THE ADVANCED COMMUTER AIRCRAFT DORNIER 328 AND FIRST RESULTS

I. U. BORCHERS, H. J. HACKSTEIN, M. GRUENEWALD, and C. WEIGWIESER *In* DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 73-83 1989

Avail: NTIS HC/MF A10

A noise control program is described and related first results are presented. Experimental results include selected test data of systematic transmission loss and noise reduction measurements performed on different aircraft fuselage panels and a full scale Dornier 328 test section, respectively. Theoretical results comprise vibration analysis data of fuselage sections of different designs as well as interior noise and related noise reduction spectra predicted for the full scale fuselage test section and the overall aircraft cabin structure. The results were obtained using a finite element code and a propeller interior noise program. Results are in good agreement and provide important inputs for an acoustical tuning of the fuselage structure. Information on the complex vibro-acoustic behavior of the aircraft cabin cavity and the fuselage structure is provided.

ESA

N91-11718# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Technical Acoustics Div.

DLR AIRCRAFT NOISE RESEARCH AND TESTING TECHNIQUES RELATED TO PROPELLER DRIVEN AEROPLANE NOISE CERTIFICATION

HANNO HELLER and WERNER DOBRZYNSKI *In* DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 85-96 1989

Avail: NTIS HC/MF A10

The development of certification procedures relies heavily on

the results of aircraft noise research involving flight tests, and full scale and model scale wind tunnel tests. The most recent versions of the relevant noise certification procedures for regional aircraft, specifically for so called heavy and light propeller driven airplanes, are discussed. Relevant research in the area of propeller noise generation and radiation is described and an outlook on advanced technology propulsion systems (specifically the propfan) and the problems likely to be encountered in establishing corresponding noise certification procedures and noise limits is given. ESA

N91-11719# Motoren- und Turbinen-Union Muenchen G.m.b.H. (Germany, F.R.).

AIRCRAFT ENGINE NOISE

F. KENNEPOHL *In* DGLR, European Forum: The Evolution of Regional Aircraft Technologies and Certification p 97-104 1989 Avail: NTIS HC/MF A10

An overview of the main aircraft engine noise sources is given. Special emphasis is devoted to turbomachinery/rotor noise, which plays an important role in all engine concepts appropriate to regional aircraft, such as turboprops, propellers, or new propfan engine concepts. The noise generating mechanisms, including propagation within the engine, and calculation methods used are described. Noise reduction methods are considered, with emphasis on *cutoff design* of turbomachines. Some noise features of counter rotating propellers and swept rotor blades are mentioned. ESA

N91-12315*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

WAKE GEOMETRY EFFECTS ON ROTOR BLADE-VORTEX INTERACTION NOISE DIRECTIVITY

R. M. MARTIN, MICHAEL A. MARCOLINI, W. R. SPLETTSTOESSER, and K.-J. SCHULTZ (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany, F.R.) Nov. 1990 23 p Original contains color illustrations (NASA-TP-3015; L-16723; NAS 1.60:3015) Avail: NTIS HC/MF A03; 6 functional color pages CSDL 20/1

Acoustic measurements from a model rotor wind tunnel test are presented which show that the directionality of rotor blade vortex interaction (BVI) noise is strongly dependent on the rotor advance ratio and disk attitude. A rotor free wake analysis is used to show that the general locus of interactions on the rotor disk is also strongly dependent on advance ratio and disk attitude. A comparison of the changing directionality of the BVI noise with changes in the interaction locations shows that the strongest noise radiation occurs in the direction of motion normal to the blade span at the time of interaction, for both advancing and retreating side BVI. For advancing side interactions, the BVI radiation angle down from the tip-path plane appears relatively insensitive to rotor operating condition and is typically between 40 and 55 deg below the disk. However, the azimuthal radiation direction shows a clear trend with descent speed, moving towards the right of the flight path with increasing descent speed. The movement of the strongest radiation direction is attributed to the movement of the interaction locations on the rotor disk with increasing descent speed.

Author

N91-12316*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NEAR-FIELD NOISE OF A SINGLE-ROTATION PROPFAN AT AN ANGLE OF ATTACK

M. NALLASAMY, E. ENVIA (Sverdrup Technology, Inc., Brook Park, OH.), B. J. CLARK, and J. F. GROENEWEG Oct. 1990 20 p Presented at the 13th Aeroacoustics Conference, Tallahassee, FL, 22-24 Oct. 1990; sponsored in part by AIAA (NASA-TM-103645; E-5805; NAS 1.15:103645; AIAA-90-3953) Avail: NTIS HC/MF A03 CSDL 20/1

The near field noise characteristics of a propfan operating at an angle of attack are examined utilizing the unsteady pressure field obtained from a 3-D Euler simulation of the propfan flowfield. The near field noise is calculated employing three different procedures: a direct computation method in which the noise field is extracted directly from the Euler solution, and two acoustic-analogy-based frequency domain methods which utilize

the computed unsteady pressure distribution on the propfan blades as the source term. The inflow angles considered are -0.4, 1.6, and 4.6 degrees. The results of the direct computation method and one of the frequency domain methods show qualitative agreement with measurements. They show that an increase in the inflow angle is accompanied by an increase in the sound pressure level at the outboard wing boom locations and a decrease in the sound pressure level at the (inboard) fuselage locations. The trends in the computed azimuthal directivities of the noise field also conform to the measured and expected results. Author

N91-12322# Institut Franco-Allemand de Recherches, Saint-Louis (France).

NOISE PREDICTION FOR A THREE-DIMENSIONAL BLADE/LINE VORTEX INTERACTION

M. SCHAFFAR, J. HAERTIG, and P. GNEMMI 19 Jul. 1990 15 p Presented at Euromech Colloquium 247, Goettingen, Fed. Republic of Germany, 28 Jun. - 1 Jul. 1989 (ISL-CO-226/89; ETN-90-98035) Avail: NTIS HC/MF A03

The vortex lattice method is described and applied in order to predict the aerodynamic loads on a thin one-bladed rotor. A local conformal mapping for each position in span is used to transform the thin blade into a thick one. The pressure coefficients obtained for the thick blade are fed into an acoustic code which is based on Ffowcs-Williams-Hawkings equation. For a first calculation, the blade vortex interaction is simplified: the wake shedded by the previous blades is contracted into a vortex line and the interaction occurs near an azimuth angle of 40 degrees (advancing blade). The calculated noise shows that the horizontal directivity has a maximum in the forward direction and the computed pressure signatures are very similar to the measured signatures found in the literature. ESA

N91-13224# Fichtel und Sachs, Schweinfurt (Germany, F.R.).

INVESTIGATION OF ACTIONS TO REDUCE NOISE EMISSIONS IN ULTRALIGHT AIRCRAFTS

KLAUS KRAPPMANN, KLAUS LUECK, MANFRED MAETHNER, UWE MEINING, and HANS-JUERGEN SCHMID Jan. 1989 145 p In GERMAN; ENGLISH summary Sponsored by Umweltbundesamt (UBA-FB-105-05-303; ETN-90-97890) Avail: NTIS HC/MF A07

Based on a special Fichtel and Sachs flight engine, the prototype of a low noise ultralight drive was developed, while the minimum climb rate of 1,5 m/s could be maintained. The objective was a flyover noise level of 50 dB(A) at a height altitude of 150 m, at maximum engine power. With in depth research work and a great number of actions taken both on the engine and on the airscrew, 60 dB(A) could be achieved. Comparative values measured in a commercial quality label device show how problematic it is to meet the currently established limit of 55 dB(A). It appears that further development work on the drive and the integration into an aerodynamically optimized flight device would allow one to go below the current limit. The objective of 50 dB(A) does not seem achievable at present, if the flight fitness has to be fully maintained. ESA

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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.

A91-14336

THE TWO FACES OF SECTION 105 - AIRLINE SHIELD OR AIRPORT SWORD

CALVIN DAVISON and LORRAINE B. HALLOWAY (Crowell and

17 SOCIAL SCIENCES

Moring, Washington, DC) *Journal of Air Law and Commerce* (ISSN 0021-8642), vol. 56, Fall 1990, p. 93-123. refs
Copyright

Section 105 of the Federal Aviation Act, part of the Airline Deregulation Act of 1978, contains wording which has led to conflicting court interpretations concerning the extent of the airport proprietor's authority. The proprietary powers and rights of airports recognized prior to the adoption of Section 105 are reviewed; the legislative history of Section 105 is examined in an attempt to determine Congress' rationale for promulgating this section; and the case law interpreting Section 105 is analyzed. It is concluded that, while considerable confusion still exists with respect to Section 105, the contours of permissible proprietor actions are beginning to emerge and that proprietors should encounter the least legal resistance in exercising their powers in the areas of ground congestion, terminal access, leasing, reasonable landing fees, and noise and environmental concerns. Proprietors may have more limited powers in such areas as access to airspace, air safety rules, and exclusion of new entrants. L.K.S.

A91-14337 AIRLINE'S RESPONSE TO THE DTPA SECTION 1305 PREEMPTION

DANIEL PETROSKI (Houston Law Review, TX) *Journal of Air Law and Commerce* (ISSN 0021-8642), vol. 56, Fall 1990, p. 125-153. refs
Copyright

Section 1305 of the USC 49, enacted by Congress in 1978, preempts state laws that regulate the rates, routes, and services of interstate air carriers. It is noted that, despite this, the majority of states have enacted unfair trade practice statutes (UTPS) that may directly affect the air carrier's rates, routes, and manner in which they perform their services. These UTPS allow plaintiffs to collect not only their actual damage, but also to receive attorney's fees and two or three times the actual damages as a penalty and, if not preempted by section 1305, would subject title IV air carriers to greater liability than previously encountered under general common law theories of liability. The legislative history of section 1305; the definition of rates, routes, and services; and controversies and questions that surround section 1305 are discussed and courses of action that are available if section 1305 preempts state law actions are investigated. L.K.S.

A91-14575# THE INTERNATIONAL AIR TRANSPORT ASSOCIATION INTO THE 21ST CENTURY

HANS FUGL-SVENDSEN (IATA, Montreal, Canada) *Aeronautical Society of India, Journal* (ISSN 0001-9267), vol. 42, Aug. 1990, p. 249-253.

The rapid growth of civil air traffic, particularly in the Asia and Pacific region, the advent of privatization and deregulation (not only of airlines, but also of airports and air traffic services in several states) and the introduction of highly sophisticated automation on the flight decks of modern airliners by a two-man pilot crew have raised the question of how the industry is coping with this development without a reduction in the safety factors involved. This paper identifies some of the problems and explains how IATA is involved in ensuring that the traveling public can be assured that air travel is still one of the safest modes of travel.

Author

A91-16603 COLLABORATION AMONG ENTERPRISES AND ARTICLE 83 BIS OF THE CHICAGO CONVENTION [LA COLABORACION INTEREMPRESARIA Y EL ARTICULO 83 BIS DE LA CONVENCION DE CHICAGO]

MARIA DELIA BUENO (La Plata, Universidad Nacional, Argentina) *CIDA* (ISSN 0797-0072), no. 12, 1987, p. 69-82. In Spanish. refs
Copyright

An evaluation is made of current practices in the joint use by different commercial aircraft operators of aircraft from their fleets, with reference to the Chicago convention. Difficulties arise from

the fact that registration of the aircraft in question with a given airline entails a host of obligations and responsibilities for that carrier with respect to the aircraft's commercial operation. The sharing of a given aircraft's operation between carriers from different countries can create intractable jurisdictional difficulties. O.C.

N91-13365# Federal Aviation Administration, Washington, DC. Office of Public Affairs.

GUIDE TO FEDERAL AVIATION ADMINISTRATION PUBLICATIONS, 12TH EDITION

May 1990 72 p
(PB90-247297; FAA-APA-PG-12) Avail: NTIS HC/MF A04
CSCL 05/2

The twelfth edition of the Guide to Federal Aviation Administration Publications can help identify and obtain FAA publications, as well as aviation-related publications issued by other Federal agencies. GRA

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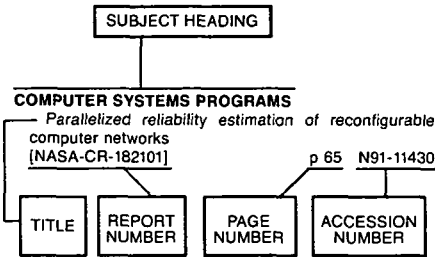
GENERAL

A91-13500 50 YEARS OF JET-POWERED FLIGHT; DGLR-SYMPIOSIUM, MUNICH, FEDERAL REPUBLIC OF GERMANY, OCT. 26, 27, 1989, REPORTS [50 JAHRE TURBOSTRAHLFLUG; DGLR-SYMPIOSIUM, MUNICH, FEDERAL REPUBLIC OF GERMANY, OCT. 26, 27, 1989, VORTRAEGE]

Symposium organized by DGLR; Sponsored by Deutsches Museum, Bundesverband der Deutschen Luftfahrt-, Raumfahrt- und Ausrustungsindustrie, and MTU Motoren- und Turbinen-Union Muenchen GmbH, Bonn, Deutsche Gesellschaft fuer Luft- und Raumfahrt, 1989, 434 p. In German and English. No individual items are abstracted in this volume.
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Various papers on turbojet flight are presented. Individual topics addressed include: development and future prospects of turbojet engines, significance of turbine jet engines for air traffic, concept selection in turbojet engine development, evolution from the Wagner/Mueller RTO experimental device to the Heinkel jet engine He S 30, the path from the first large-series jet engine Junker Jumo 004 and later developments in the U.S.A., the Heinkel-Hirth turbojet engine He s 011, early history of the aircraft gas turbine in Britain, beginning of jet engine development in the U.S.A., jet propulsion in France. C.D.

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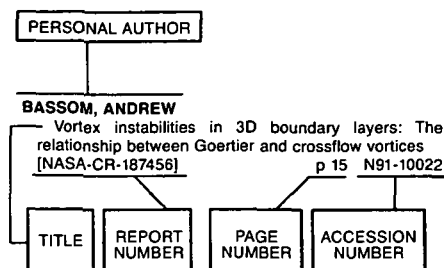
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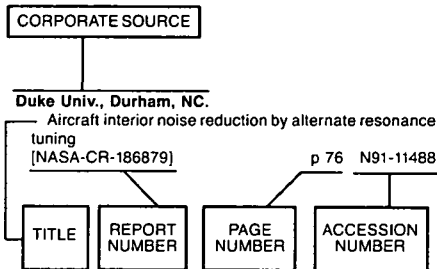
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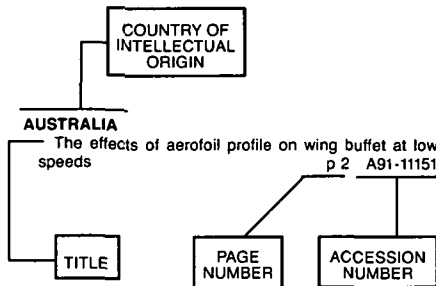
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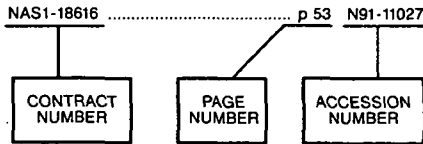
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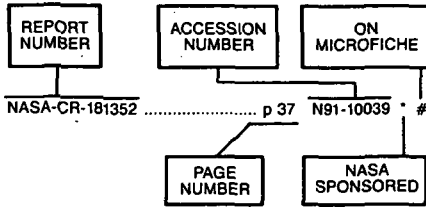


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NEW YORK STATE LIBRARY

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Chapel Hill, NC 27514
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UNIVERSITY LIBRARY

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Documents Department
Logan, UT 84322
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Madison, Memorial Library

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