NASA SP-7037(247)

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 247)

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in December 1989 in

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

National Aeronautics and Space Administration
Office of Management
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INTRODUCTION

This issue of *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 437 reports, journal articles and other documents originally announced in December 1989 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

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

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

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

An annual cumulative index will be published.

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

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TYPICAL REPORT CITATION AND ABSTRACT

NASA SPONSORED

ON MICROFICHE

ACCESSION NUMBER → **N89-10029*#** North Carolina State Univ., Raleigh. Dept. of ← CORPORATE SOURCE
Mechanical and Aerospace Engineering.

TITLE → **A TRANSONIC INTERACTIVE BOUNDARY-LAYER THEORY FOR LAMINAR AND TURBULENT FLOW OVER SWEPT WINGS Final Report**

AUTHORS → SHAWN H. WOODSON and FRED R. DEJARNETTE
Washington Oct. 1988 82 p

CONTRACT NUMBER → (Contract NCC1-22) — PUBLICATION DATE

REPORT NUMBERS → (NASA-CR-4185; NAS 1.26:4185) Avail: NTIS HC A05/MF A01 ← PRICE CODE

COSATI CODE → CSCL 01A — AVAILABILITY SOURCE

A 3-D laminar and turbulent boundary-layer method is developed for compressible flow over swept wings. The governing equations and curvature terms are derived in detail for a nonorthogonal, curvilinear coordinate system. Reynolds shear-stress terms are modeled by the Cebeci-Smith eddy-viscosity formulation. The governing equations are descretized using the second-order accurate, predictor-corrector finite-difference technique of Matsuno, which has the advantage that the crossflow difference formulas are formed independent of the sign of the crossflow velocity component. The method is coupled with a full potential wing/body inviscid code (FLO-30) and the inviscid-viscous interaction is performed by updating the original wing surface with the viscous displacement surface calculated by the boundary-layer code. The number of these global iterations ranged from five to twelve depending on Mach number, sweep angle, and angle of attack. Several test cases are computed by this method and the results are compared with another inviscid-viscous interaction method (TAWFIVE) and with experimental data.
Author

TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT

NASA SPONSORED

ON MICROFICHE

ACCESSION NUMBER → **A89-12562*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

TITLE → **EFFICIENT VIBRATION MODE ANALYSIS OF AIRCRAFT WITH MULTIPLE EXTERNAL STORE CONFIGURATIONS**

AUTHOR → M. KARPEL (NASA, Langley Research Center, Hampton, VA; Israel Aircraft Industries, Ltd., Lod) Journal of Aircraft (ISSN 0021-8669), ← JOURNAL TITLE
vol. 25, Aug. 1988, p. 747-751. refs

A coupling method for efficient vibration mode analysis of aircraft with multiple external store configurations is presented. A set of low-frequency vibration modes, including rigid-body modes, represent the aircraft. Each external store is represented by its vibration modes with clamped boundary conditions, and by its rigid-body inertial properties. The aircraft modes are obtained from a finite-element model loaded by dummy rigid external stores with fictitious masses. The coupling procedure unloads the dummy stores and loads the actual stores instead. The analytical development is presented, the effects of the fictitious mass magnitudes are discussed, and a numerical example is given for a combat aircraft with external wing stores. Comparison with vibration modes obtained by a direct (full-size) eigensolution shows very accurate coupling results. Once the aircraft and stores data bases are constructed, the computer time for analyzing any external store configuration is two to three orders of magnitude less than that of a direct solution. Author

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 247)

JANUARY 1990

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AERONAUTICS (GENERAL)

A89-52614*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
APPLICATION OF ARTIFICIAL INTELLIGENCE (AI) PROGRAMMING TECHNIQUES TO TACTICAL GUIDANCE FOR FIGHTER AIRCRAFT
JOHN W. MCMANUS and KENNETH H. GOODRICH (NASA, Langley Research Center, Hampton, VA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 851-858. refs
(AIAA PAPER 89-3525) Copyright

A research program investigating the use of Artificial Intelligence (AI) programming techniques to aid in the development of a Tactical Decision Generator (TDG) for Within-Visual-Range (WVR) air combat engagements is discussed. The application of AI methods for development and implementation of the TDG is presented. The history of the Adaptive Maneuvering Logic (AML) program is traced and current versions of the (AML) program is traced and current versions of the AML program are compared and contrasted with the TDG system. The Knowledge-Based Systems (KBS) used by the TDG to aid in the decision-making process are outlined and example rules are presented. The results of tests to evaluate the performance of the TDG against a version of AML and against human pilots in the Langley Differential Maneuvering Simulator (DMS) are presented. To date, these results have shown significant performance gains in one-versus-one air combat engagements.
Author

A89-52950
AHS NATIONAL SPECIALISTS' MEETING ON THE ROTARY WING AIRCRAFT CONCEPTUAL DESIGN PROCESS, ATLANTA, GA, APR. 3-5, 1989, PROCEEDINGS
Meeting sponsored by AHS. Alexandria, VA, American Helicopter Society, 1989, 725 p. No individual items are abstracted in this volume.

This volume contains the viewgraphs and charts for papers presented at the April 1989 AHS National Specialists' Meeting. Topics covered include the development history of VSTOL aircraft; future operational requirements and market opportunities for helicopters; the presentation of requests for proposals (RFPs) in military and commercial programs; weight and cost methods; and technology assessment of rotors and propellers, engines and drive systems, structures and materials, flight controls, avionics, and cockpit equipment. Consideration is given to vertiports and ATC, the problems of new development programs, industry presentations of point-design solutions to military and commercial RFPs, the advanced counter-air fighter, and techniques for improving the conceptual-design process for rotorcraft. T.K.

A89-52975
CLOSING THE GAP
GRAHAM WARWICK Flight International (ISSN 0015-3710), vol. 136, Sept. 2, 1989, p. 34-37.
Copyright

An evaluation is made of the MiG-29 air-superiority fighter, Su-27 long-range interceptor, and Su-25 close ground-support/antiinsurgency aircraft. it is noted that some measure of the shortcomings of the radars employed by the former two aircraft is compensated for by the use of an IR search/track system located at the base of the windscreen. This passive sensor, which scans like radar and is not an imaging device, has its output displayed on a small CRT in the upper left-hand corner of the Su-27 and MiG-29. The radar, the IR sensor, and a helmet-mounted sight are interlinked. Each of the three aircraft incorporates an internal 30 mm cannon, but carries surprisingly little ammunition by Western standards. The MiG-29's primary armament is the AA-10A 'Alamo' medium-range AAM; the substantially larger Su-27 can carry as many as 10 AAMs. O.C.

A89-53334#
ROTORCRAFT RESEARCH AND TECHNOLOGY ADVANCES AT MBB
HELMUT B. HUBER (Messerschmitt-Boelkow-Blohm GmbH, Munich, Federal Republic of Germany) Aeronautical Society of India and Indian Institute of Technology, Annual General Meeting, 14th, Madras, India, Dec. 19-21, 1988, Paper. 20 p.
(MBB-UD-0537-88-PUB)

The most important applied research and technology demonstration programs being undertaken at MBB are reviewed. The areas addressed include aerodynamics and dynamics, advanced composite applications to new rotor systems and airframe structures, active control technologies and their integration, advanced development tools, and new rotorcraft configurations. Various systems under development are shown and/or diagrammed. C.D.

A89-54472#
AEROSPACE INDUSTRY IN INDIA - PAST, PRESENT AND FUTURE
I. M. CHOPRA (Hindustan Aeronautics, Ltd., Bangalore, India) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 41, Mar.-May 1989, p. 237-241.

Important milestones in the history of India's aeronautics industry are discussed. Consideration is given to the design and development of the HF-24 Marut aircraft. Advanced light helicopters which will use the latest hingeless rotor both for the main rotor and the tail rotor are described as well as light combat aircraft.
K.K.

N89-28485# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.).
ACTIVITIES REPORT IN AEROSPACE RESEARCH IN GERMANY, F.R. Annual Report, 1987
Sep. 1988 101 p In GERMAN Previously announced in IAA as A89-32775 Report contains color illustrations
(ISSN-0070-3966; ETN-89-94382) Avail: NTIS HC A06/MF A01

The activities of the FRG aerospace research organization DFVLR for 1987 are reported. In the research field of aeronautics, investigations were performed on Compas (a planning and decision aid for air traffic controllers) and on a delta wing (a contribution to the International Vortex Flow Experiment). Space-related activities were the German Front Experiment 1987 (an example for the mesoscale probing of the atmosphere) and wind tunnel testing of reentry bodies in the hypersonic range. In the field of energy technology, renewable energy sources for Baden-Wuerttemberg were investigated. Photographs, drawings, and diagrams are provided, and an English summary is given for each section. ESA

02

AERODYNAMICS

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

A89-51625

THIN AEROFOIL WITH MULTIPLE SLOTTED FLAP

T. S. PATEL, T. A. DERBASI, and A. N. HASSANEN (Al-Fateh University, Tripoli, Libya) Rozprawy Inzynierskie (ISSN 0035-9408), vol. 36, no. 1, 1988, p. 3-14. refs

Copyright

The paper deals with the problem of a thin airfoil with multiple slotted movable hinge flaps. Two particular cases are considered: (1) assuming no gaps exist at the hinges and (2) considering the existence of slots. The conventional assumptions of small angle of attack, small flap deflection, and small camber are omitted. Author

A89-51678

THEORETICAL STUDY ON THE UNSTEADY AERODYNAMIC CHARACTERISTICS OF AN OSCILLATING CASCADE WITH TIP CLEARANCE - IN THE CASE OF A NONLOADED CASCADE

TOSHINORI WATANABE (Tokyo University of Agriculture and Technology, Koganei, Japan) and SHOJIRO KAJI (Tokyo, University, Japan) JSME International Journal, Series II (ISSN 0914-8817), vol. 32, Aug. 1989, p. 368-374. refs

Copyright

This paper describes a theoretical analysis based on potential flow. By use of the vortex lattice method, calculations were performed to obtain unsteady aerodynamic forces acting on oscillating blades with tip clearances. Calculated damping forces in the case of large tip clearance showed good agreement with the experimental data. When the clearance was small, however, a discrepancy was found between the experimental and analytical results. This discrepancy was thought to be ascribable to the viscous effect of the flow near the blade tips. To explain the experimental data it was necessary to apply a model such that each blade should retain finite circulation at the extremity of its tip. From the calculated results for various reduced frequencies it was confirmed that aerodynamic characteristics found in the experimental study could be applied equally to the wide range of reduced frequencies. Author

A89-51679

SECONDARY FLOW CONTROL AND LOSS REDUCTION IN A TURBINE CASCADE USING ENDWALL FENCES

TATSUO KAWAI, TSUTOMU ADACHI (Tsukuba, University, Japan), and SHUJI SHINOKI (Sumitomo Electric Industries, Ltd., Itami, Japan) JSME International Journal, Series II (ISSN 0914-8817), vol. 32, Aug. 1989, p. 375-387. refs

Copyright

An attempt to control secondary flow was made in order to improve turbine aerodynamic performance. Boundary layer fences were attached to endwalls of a linear turbine rotor cascade. Measurements of total pressure losses and three-dimensional flow velocities were taken for 5 different heights and 7 different pitchwise locations of the fences. It was found that the fences were most effective when they were 1/3 of the inlet boundary layer thickness high and located half a pitch away from the blades. These optimum fences reduced streamwise vorticities, the thickness of the endwall loss region, secondary kinetic energy, and the maximum underturning by half. Moreover, they diminished the secondary loss by 22 percent, and the gross loss, including kinetic energy dissipation, by 25 percent. A critical fence height above which the fences trap the pressure side legs of horseshoe vortices was found, and the optimum fences proved to be fences of the minimum critical height. Author

A89-51756

SYMBOLIC EIGENVALUE ANALYSIS FOR ADAPTIVE STEPSIZE CONTROL IN PNS SHOCK STABILIZATION

DOUGLAS D. CLINE and GRAHAM F. CAREY (Texas, University, Austin) Computers and Fluids (ISSN 0045-7930), vol. 17, no. 4, 1989, p. 527-535. refs

Copyright

Parabolized Navier-Stokes (PNS) solution techniques for high speed compressible flow involve marching in a 'time like' spatial coordinate but have been observed in practice to be sensitive to flow conditions and require stabilization by numerical dissipation techniques. In this study, an eigenvalue analysis is developed for shock stability. Using the algebraic symbolic manipulator MACSYMA, an explicit closed-form solution for the shock system eigenvalues is developed. This is then applied on the evolving shock contour to determine the stability limit on the PNS stepsize. Numerical experiments confirm the validity of the approach and demonstrate thaqt the approach can be implemented explicitly to yield an adaptive stepsize algorithm and thereby a more robust PNS scheme. Author

A89-51760* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

PREDICTION OF SECONDARY SEPARATION IN SHOCK WAVE BOUNDARY-LAYER INTERACTIONS

C. C. HORSTMAN (NASA, Ames Research Center, Moffett Field, CA) Computers and Fluids (ISSN 0045-7930), vol. 17, no. 4, 1989, p. 611-614. refs

Copyright

A complex three-dimensional shock-wave/turbulent boundary layer interaction at Mach 4 has been investigated experimentally and computationally, using two turbulence models with substantial refinement. With the use of a fine grid model, secondary flow separation was successfully computed, and grid changes did not improve agreement with experiment for the extent of upstream influence. The use of a non-isotropic turbulence model gave a slight improvement in upstream influence, but the size of the interaction was still significantly less than in the experiment. C.E.

A89-52043

ANALYSIS OF REATTACHMENT DURING RAMP DOWN TESTS

ANDREW J. NIVEN, RODERICK A. MCD. GALBRAITH, and DAVID G. F. HERRING (Glasgow, University, Scotland) (European Rotorcraft Forum, 14th, Milan, Italy, Sept. 20-23, 1988) Vertica (ISSN 0360-5450), vol. 13, no. 2, 1989, p. 187-196. Research supported by the Department of Trade and Industry and Ministry of Defence of England. refs

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The paper considers the reattachment of the flow over the upper surface of an aerofoil undergoing a constant negative pitch rate motion, from an incidence well above the static stall value. Experimental data from a variety of aerofoils tested using the University of Glasgow facilities have been recorded. All data were collected at an effective Mach and Reynolds numbers of 0.11 and 1.5x10 to the 6th, respectively. Various improvements for future work are noted, and the predominant features of the reattachment process are discussed. Finally a preliminary attempt at predicting the collected reattachment data was made. Author

A89-52307#

COMPUTATION OF THE DETACHED SHOCK SHAPE IN A SUPERSONIC OR TRANSONIC CASCADE

YAONAN HUA (Chinese Academy of Sciences, Institute of

Engineering Thermophysics, Beijing, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, July 1989, p. 223-227, 290. In Chinese, with abstract in English. refs

A method is presented for determining the shape of the detached shock and the flowfield in the supersonic entrance region on an arbitrary stream surface of revolution. The equation of characteristics and the corresponding equation of compatibility are derived. The shape of the detached shock obtained is taken as the initial-value curve to calculate the flowfield in the supersonic entrance region by means of the method of characteristics. As an application of the present method, three stream surface of revolution in a transonic compressor rotor have been calculated. The results show that the method is effective and useful to determine rapidly the shape of the detached shock wave as well as the flowfield parameters in the supersonic entrance region.
Author

A89-52308#
SOLUTION FOR TWO-DIMENSIONAL INVISCID TRANSONIC CASCADE FLOWS WITH MULTIPLE-GRID ALGORITHM
CHUNHUA SHENG and LICHENG WANG (Nanjing Aeronautical Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, July 1989, p. 228-232, 291. In Chinese, with abstract in English. refs

This paper gives an efficient form of multiple-grid scheme and presents a prediction-correction method for processing the boundary conditions on a solid wall. The convergency and the stability of the scheme can be further improved by using local time stepping and residual smoothing. Two-dimensional inviscid transonic cascade flows are calculated. The comparison between the calculated and the measured results shows that this scheme possesses a very fast convergence speed and satisfactory accuracy.
Author

A89-52309#
APPLICATION OF UPWIND FACTOR METHOD TO TRANSONIC CASCADE CALCULATION
LICHENG WANG, HUIMIN ZHANG, and XIAOLING LU (Nanjing Aeronautical Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, July 1989, p. 233-236, 291. In Chinese, with abstract in English.

The upwind factor method is extended to treating the two-dimensional transonic flows. The Navier-Stokes equations with k-sigma turbulence model are discretized in a nonorthogonal body-fitted coordinate system, and the upwind factor method is employed to ensure the numerical stability of the scheme. The maximum local time step is determined by the criterion that the coefficients in discretized equations must be nonnegative. The numerical experiments are carried out for DFVLR transonic cascade for inlet Mach number of 0.82 and 1.05. The numerical results are compared with the experimental data and with the results calculated with a four-stage Runge-Kutta time stepping scheme of an Euler code.
Author

A89-52316#
ACTIVE CONTROL OF INLET DISTORTED FLOW FIELD IN COMPRESSOR INLET
LIPING XU (Beijing University of Aeronautics and Astronautics, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, July 1989, p. 262-264, 293. In Chinese, with abstract in English. refs

The feasibility of alleviating the destabilizing effect of the inlet circumferential total pressure distortion on an axial compressor by active control of individually adjustable inlet guide vanes (LAIGV) has been qualitatively analyzed under the parallel compressor hypothesis. The result shows that when the distortion is quasi-steady, it is possible to use the actively controlled LAIGV with a relatively simple proportional control scheme to adjust the flow angle, and thus to prevent the compressor entering the unstable state. For a typical blade setting, the angular adjustment of LAIGV needed to cope with 10 percent total pressure distortion is of only few degrees.
Author

A89-52481
NUMERICAL SIMULATION AND HYDRODYNAMIC VISUALIZATION OF TRANSIENT VISCOUS FLOW AROUND AN OSCILLATING AEROFOIL
O. DAUBE, L. TA PHUOC, A. DULIEU (CNRS, Laboratoire d'Informatique pour la Mecanique et les Sciences de l'Ingenieur, Orsay, France), M. COUTANCEAU, K. OHMI (Poitiers, Universite, France) et al. International Journal for Numerical Methods in Fluids (ISSN 0271-2091), vol. 9, Aug. 1989, p. 891-920. refs
(Contract DRET-84-34-020-000)
Copyright

Unsteady viscous flow around a large-amplitude and high-frequency oscillating aerofoil is examined in this paper by numerical simulation and experimental visualization. The numerical method is based on the combination of a fourth-order Hermitian finite difference scheme for the stream function equation and a classical second-order scheme to solve the vorticity transport equation. Experiments are carried out by a traditional visualization method using solid tracers suspended in water. The comparison between numerical and experimental results is found to be satisfactory. Time evolutions of the flow structure are presented for Reynolds numbers of 3,000 and 10,000. The influence of the amplitude and frequency of the oscillating motion on the dynamic stall is analyzed.
Author

A89-52483
NAVIER-STOKES COMPUTATION OF TRANSONIC VORTICES OVER A ROUND LEADING EDGE DELTA WING
BERNHARD MUELLER (Forsvarsdepartementet, Flygtekniska Forsoksanstalten, Bromma, Sweden) and ARTHUR RIZZI (Forsvarsdepartementet, Flygtekniska Forsoksanstalten, Bromma; Kungliga Tekniska Hogskolan, Stockholm, Sweden) International Journal for Numerical Methods in Fluids (ISSN 0271-2091), vol. 9, Aug. 1989, p. 943-962. Research supported by Styrelsen for Teknisk Utveckling, U.S. Navy, University of Minnesota, and NSF. refs
Copyright

A three-dimensional Navier-Stokes solver has been developed to simulate laminar compressible flow over quadrilateral wings. The finite-volume technique is employed for spatial discretization, with a novel variant for the viscous fluxes. An explicit three-stage Runge-Kutta scheme is used for time integration, taking local time steps according to the linear stability condition. The code is applied to compute primary and secondary separation vortices at transonic speeds over a 65-deg-swept delta wing with round leading edges and cropped tips. The results are compared with experimental data and Euler solutions, and Reynolds-number effects are investigated.
Author

A89-52484
ON TVD DIFFERENCE SCHEMES FOR THE THREE-DIMENSIONAL EULER EQUATIONS IN GENERAL CO-ORDINATES
YOKO TAKAKURA (Fujitsu, Ltd., Scientific Systems Dept., Tokyo, Japan), TOMIKO ISHIGURO, and SATORU OGAWA (National Aerospace Laboratory, Chofu, Japan) International Journal for Numerical Methods in Fluids (ISSN 0271-2091), vol. 9, Aug. 1989, p. 1011-1024. refs
Copyright

An improved treatment for the Harten-Yee and Chakravarthy-Osher TVD numerical flux functions in general co-ordinates is presented. The proposed formulation is demonstrated by a series of numerical experiments for three-dimensional flows around the ONERA-M6 wing. The numerical results indicate that it is important to use a suitable artificial compression parameter in order to obtain more accurate solutions around the leading edge of the wing. The two TVD numerical fluxes give excellent results: they capture the shock wave without numerical oscillations, they capture the rapid expansion around the leading edge sharply, they have self-adjusting mechanisms regarding numerical viscosity and they also have robustness.
Author

A89-52485
ANALYSIS OF INCOMPRESSIBLE MASSIVELY SEPARATED VISCOUS FLOW USING UNSTEADY NAVIER-STOKES EQUATIONS
K. N. GHIA, G. A. OSSWALD, and U. GHIA (Cincinnati, University, OH) International Journal for Numerical Methods in Fluids (ISSN 0271-2091), vol. 9, Aug. 1989, p. 1025-1050. refs
Copyright
The unsteady incompressible Navier-Stokes equations are formulated in terms of vorticity and streamfunction in generalized curvilinear orthogonal coordinates to facilitate analysis of flow configurations with general geometries. The numerical method developed solves the conservative form of the vorticity transport equation using the alternating direction implicit method, whereas the streamfunction equation is solved by direct block Gaussian elimination. The method is applied to a model problem of flow over a backstep in a doubly infinite channel, using clustered conformal coordinates. One-dimensional stretching functions, dependent on the Reynolds number and the asymptotic behavior of the flow, are used to provide suitable grid distribution in the separation and reattachment regions, as well as in the inflow and outflow regions. Author

A89-52498* Massachusetts Inst. of Tech., Cambridge.
CALCULATIONS OF INLET DISTORTION INDUCED COMPRESSOR FLOW FIELD INSTABILITY
R. CHUE, E. M. GREITZER, C. S. TAN (MIT, Cambridge, MA), T. P. HYNES, and J. P. LONGLEY (Cambridge, University, England) International Journal of Heat and Fluid Flow (ISSN 0142-727X), vol. 10, Sept. 1989, p. 211-223. refs
(Contract NSG-3208)
Copyright
Calculations of the onset of flow instability are carried out for low-speed multistage axial compressors operating with asymmetric inlet flow. The modeling of the fluid dynamic interaction between the spoiled and unspoiled sectors of the compressor is the most important feature of the calculation procedure. The calculations show that annulus average slope of the compressor pressure rise characteristic equal to zero is a useful approximate stability criterion for situations where the dynamics of the compressor flow field do not couple strongly to the compression system or the structure of the imposed distortion is not similar to that of the eigenmodes of the flow in the compressor annulus. This criterion is employed to investigate the relationship between the present model and the 'parallel compressor' model. Calculations are also presented for cases when compressor and compressor system are closely coupled, and situations in which the compressor is subjected to a rotating distortion. These first-of-a-kind computations, and the accompanying description of the physical mechanisms, show that the stability of the flow in the compressor can be adversely affected if the temporal or spatial structure of the distortion is such that resonant type responses can be evoked either from the compressor or from compressor/compression system interactions. C.E.

A89-52843
A THREE-DIMENSIONAL BOUNDARY LAYER IN FINITE-SPAN THIN WINGS [PROSTRANSTVENNYI POGRANICHNYI SLOI NA TONKIKH KRYL'IAKH KONECHNOGO RAZMAKHA]
A. D. KHON'KIN and V. I. SHALAEV Akademiia Nauk SSSR, Doklady (ISSN 0002-3264), vol. 307, no. 2, 1989, p. 312-315. In Russian.
Copyright
The wings of many aircraft can be treated as thin wings, with cruising flight characterized by small angles of attack. In view of this fact, perturbation methods are commonly used in calculating the aerodynamic characteristics of aircraft in the context of a nonviscous flow model. Here, it is shown that, under these conditions, the statement and solution of three-dimensional boundary layer problems is also significantly simplified and reduced to that of solving a set of two-dimensional problems. The approach proposed here makes it possible to obtain some new analytical results. V.L.

A89-52852
A SECOND-ORDER FINITE-DIFFERENCE SCHEME FOR CALCULATING THREE-DIMENSIONAL SUPERSONIC FLOWS OF AN IDEAL GAS [KONECHNO-RAZNOSTNAIA SKHEMA VTOROGO PORIADKA DLIA RASCHETA TREKHMERNYKH SVERKHZVUKOVYKH TECHENII IDEAL'NOGO GAZA]
M. K. AUKIN and R. K. TAGIROV Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki (ISSN 0044-4669), vol. 29, July 1989, p. 1057-1066. In Russian. refs
Copyright
An explicit second-order finite-difference scheme for calculating three-dimensional stationary supersonic flows of an inviscid gas is proposed, and some methodological features of the scheme are discussed. Results of calculations for conical flows and a submerged jet are found to be in good agreement with the results obtained by using some well-known second-order schemes. Examples of calculations for complex three-dimensional supersonic flows are presented. V.L.

A89-52945
EVOLUTION OF AXISYMMETRIC WAKES FROM ATTACHED AND SEPARATED FLOWS
H. C. CHEN and V. C. PATEL (Iowa, University, Iowa City) IN: Turbulent shear flows 6; International Symposium, 6th, Toulouse, France, Sept. 7-9, 1987, Selected Papers. Berlin and New York, Springer-Verlag, 1989, p. 215-231. refs
(Contract N00014-83-K-0136)
Copyright
The Reynolds-averaged Navier-Stokes equations, together with a two-layer turbulence model, have been solved to study the evolution of the near and far wake of elongated axisymmetric bodies, such as a prolate spheroid, with attached or separated flow at the tail. Supplemental calculation with the body in a circular duct were also performed to determine the effects of wind-tunnel blockage in the experiments. The results are examined in the light of experimental data and theories for turbulent near and far wakes. Is is found that the numerical solutions reproduce most of the essential features of the theory and experiments. Author

A89-53367#
APPLICATION OF COMPOUND COMPRESSIBLE FLOW TO NONUNIFORMITIES IN HYPERSONIC PROPULSION SYSTEMS
MARK J. LEWIS and DANIEL E. HASTINGS (MIT, Cambridge, MA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 5, Sept.-Oct. 1989, p. 626-634. Research supported by Charles Stark Draper Laboratory, Inc. refs
Copyright
An analytical model is presented to study the propagation of the forebody boundary layer inside the engine channel of a hypersonic engine, based on a compound compressible one-dimensional streamtube method. It is shown that the compound compressible flow model can be greatly simplified in the hypersonic regime to study the effects of nonuniform flow inside a supersonic combustion ramjet. It is found that even a small boundary layer can produce noticeable changes in freestream properties inside the inlet. In the combustor models, freestream Mach number is generally increased, and so static pressure and temperature are decreased. These effects reduce the combustion reaction rate relative to that expected in a uniform flow and therefore reduce the total heat release and increase losses inside the engine.
Author

A89-53570
A REGULAR PERTURBATION METHOD FOR SUBCRITICAL FLOW OVER A TWO-DIMENSIONAL AIRFOIL
YUE-KUEN KWOK (West Virginia University, Morgantown) IMA Journal of Applied Mathematics (ISSN 0272-4960), vol. 43, no. 1, 1989, p. 71-81. refs
Copyright
This paper presents a renewal of the classical Janzen-Rayleigh perturbation method or the so-called M-squared series expansion method for solving a steady inviscid irrotational subcritical flow over a two-dimensional airfoil. It seeks a regular perturbation

expansion of the state variables in terms of a power series in the free-stream Mach number M of the flow. The method is computerized so that it can treat bodies of arbitrary shapes, and the perturbation series is extended up to the fourth-order approximation. To facilitate the computation, the particular integrals of successive-order equations are found by MACSYMA. The literal operations of routine algebra of extending the series are then performed by FORTRAN. The order of accuracy is M to the 6th in the fourth-order approximation, which is generally higher than most approximation methods. However, divergence of the perturbation series is apparent when the free-stream Mach number increases beyond the critical Mach number. Author

A89-53830*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

TRANSITION FLIGHT EXPERIMENTS ON A SWEPT WING WITH SUCTION

D. V. MADDALON (NASA, Langley Research Center, Hampton, VA), F. S. COLLIER, JR. (High Technology Corp., Hampton, VA), L. C. MONTOYA (NASA, Flight Research Center, Edwards, CA), and R. J. PUTNAM (PRC Kentron, Inc., Hampton, VA) IUTAM, Symposium on Laminar-Turbulent Transition, 3rd, Toulouse, France, Sept. 11-15, 1989, Paper. 11 p. refs

Flight boundary-layer transition experiments were conducted on a 30-degree swept wing with a perforated leading-edge suction panel. The transition location on the panel was changed by systematically varying the location and amount of suction. Transition from laminar to turbulent flow was due to leading-edge turbulence contamination or crossflow disturbance growth and/or Tollmien-Schlichting disturbance growth, depending on flight condition and suction variation. Amplification factor correlations with transition location were made for various suction configurations using a state-of-the-art linear stability theory which accounts for body and streamline curvature and compressibility. Author

A89-53926#

NUMERICAL SIMULATION OF ROLLING UP OF LEADING/TRAILING-EDGE VORTEX SHEETS FOR SLENDER WINGS

XIE-YUAN YIN, NAN XIA, and GUO-HUA DENG (University of Science and Technology of China, Hefei, People's Republic of China) AIAA Journal (ISSN 0001-1452), vol. 27, Oct. 1989, p. 1313-1318. refs

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A simple, two-dimensional discrete vortex model is used to compute the rolling up of leading/trailing edge vortex sheets, as well as their interactions, in the cases of both delta and double-delta wing planforms. The numerical results thus obtained indicate that a trailing-edge vortex having a sense of circulation opposite that of the leading-edge vortices can be rolled up for both types of wing. In addition, two separated leading-edge vortices, inboard and outboard, can be formed over a double-delta wing surface; the vortices are separated from each other at small angles of attack, but the inboard vortex merges with the outboard one when the angles of attack are increased. O.C.

A89-53928#

CONSTRUCTING A CONTINUOUS PARAMETER RANGE OF COMPUTATIONAL FLOWS

H. THOMAS SHARP and L. SIROVICH (Brown University, Providence, RI) AIAA Journal (ISSN 0001-1452), vol. 27, Oct. 1989, p. 1326-1331.

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A method which can be used to describe the solution of a nonlinear system of partial differential equations is presented. The method was applied to supersonic flow over an airfoil. However, the generality of the method suggests that it is possible to achieve more versatile and efficient use of flow computations by mode changes to already existing flow codes. K.K.

A89-53930#

COMBUSTION-RELATED SHEAR-FLOW DYNAMICS IN ELLIPTIC SUPERSONIC JETS

K. C. SCHADOW, E. GUTMARK, S. KOSHIGOE, and K. J. WILSON (U.S. Navy, Naval Weapons Center, China Lake, CA) AIAA Journal (ISSN 0001-1452), vol. 27, Oct. 1989, p. 1347-1353. refs

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An elliptic jet having an aspect ratio of 3:1 was studied and compared to a circular jet at three Mach numbers: M = 0.15, 1, and 1.3. Hot-wire measurements and schlieren photography were employed in this study. The superior mixing characteristics of an elliptic jet relative to a circular jet, which were found in previous works on subsonic jets, prevail in the sonic jet and are further augmented by the shock structures of the supersonic underexpanded jet. The major and minor axes switch at a distance of 3 diameters from the nozzle, and the spreading rate of the minor axis side is twice that of a subsonic jet. The experimental data are supported by results of the linear instability analysis of the supersonic elliptic jet. This analysis shows that the initial vortices are bending at the major axis side in a process similar to that which occurs in a subsonic elliptic jet. Author

A89-53931*# Virginia Polytechnic Inst. and State Univ., Blacksburg.

TURBULENCE MODELING IN A HYPERSONIC INLET

W. F. NG, K. AJMANI, and A. C. TAYLOR, III (Virginia Polytechnic Institute and State University, Blacksburg) AIAA Journal (ISSN 0001-1452), vol. 27, Oct. 1989, p. 1354-1360. Previously cited in issue 18, p. 2995, Accession no. A88-44705. refs

(Contract NAG3-676)

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A89-53934#

EULER CORRECTION METHOD FOR TWO- AND THREE-DIMENSIONAL TRANSONIC FLOWS

THONG Q DANG and LEE-TZONG CHEN (Douglas Aircraft Co., Long Beach, CA) AIAA Journal (ISSN 0001-1452), vol. 27, Oct. 1989, p. 1377-1386. Research supported by McDonnell Douglas Independent Research and Development Program. Previously cited in issue 08, p. 1042, Accession no. A87-22684. refs

(Contract N00167-85-C-0134)

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A89-53944#

UNSTEADY VORTICAL DISTURBANCES AROUND A THIN AIRFOIL IN THE PRESENCE OF A WALL

G. A. GEBERT and H. M. ATASSI (Notre Dame, University, IN) AIAA Journal (ISSN 0001-1452), vol. 27, Oct. 1989, p. 1448-1451. refs

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The Sears (1941) function originally derived for the unsteady lift generated when a gust is convected by an incompressible inviscid flow around an airfoil is presently extended to include the effect of a wall located under the airfoil. The fluctuating aerodynamic forces in question occur in such engineering problems as wings during takeoff and landing, ships in restricted waters, and structures in ground transportation. An effort is made to determine the unsteady velocity field downstream of the airfoil. O.C.

A89-53947#

DIFFERING DEVELOPMENT OF THE VELOCITY PROFILES OF THREE-DIMENSIONAL TURBULENT BOUNDARY LAYERS

H. PFEIL and T. AMBERG (Darmstadt, Technische Hochschule, Federal Republic of Germany) AIAA Journal (ISSN 0001-1452), vol. 27, Oct. 1989, p. 1456-1459. Research supported by DFG. refs

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An analysis of three-dimensional turbulent boundary-layer data shows that, even for small crossflow, the velocity profiles of the main-flow and crossflow components deviate distinctly from simple descriptive profile models when the streamlines are not congruent. It is presently demonstrated that these deviations can be accurately characterized by additional, correlated distributions. O.C.

A89-53949#
TRANSONIC FLOWS WITH VORTICITY TRANSPORT AROUND SLENDER BODIES
GOETZ H. KLOPFER and DAVID NIXON (Nielsen Engineering and Research, Inc., Mountain View, CA) AIAA Journal (ISSN 0001-1452), vol. 27, Oct. 1989, p. 1461-1464.
Copyright
A technique is derived for compressible flows which is similar to that for incompressible flows. The vorticity transport equations are derived from Crocco's equation; it is found that, for slender bodies, the flow is isentropic to a first approximation, and only the crossflow vorticity is significant. This method does not require discrete vortices, but rather computes a vorticity field, and thereby avoids the need for vortex-element tracking. Since, in the incompressible limit, the standard formulation is recovered, this theory may be regarded as a unifying theory for all speed ranges. O.C.

A89-54129#
STUDY ON BOUNDARY LAYER OF HYPERSONIC INLETS
QIANLIE GUAN and JUNBO XING (31st Research Institute, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), Aug. 1989, p. 19-25, 79, 80. In Chinese, with abstract in English.
A very thick forebody boundary layer existing in front of a hypersonic inlet is studied. The temperature within the boundary layer is very high and the mass flux very low. The presence of the boundary layer displaces the shock wave outward, so that the real geometric wedge angle should be equal to that of the theoretical compression angle minus the equivalent angle of displacement thickness of the boundary layer. In the range of Mach 6 to Mach 8, the boundary layer loss is about 40-50 percent of the total pressure loss of the inlet. C.D.

A89-54373
WATER TUNNEL FLOW VISUALIZATION ON A HYPERSONIC CONFIGURATION
LURA KERN and GREGORY NOFFZ (California, University, Los Angeles) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 476-488. refs
Copyright
Low-speed and high-speed flow visualization results were obtained using models of a hypersonic aircraft. Low-speed visualizations performed in a water tunnel using a three-dimensional model containing dye emitting ports revealed vortex formation and shedding. The model was tested for a range of sideslip angles and angles of attack. Employing the mathematical analogy between shock waves in the air and free-surface water waves, shock formations off the vehicle were simulated by placing models representing two-dimensional projections of a hypersonic aircraft in a free-surface channel flow. The analogy was found to provide accurate results for low Mach numbers, but to break down at higher Mach numbers. R.R.

A89-54484
DEVELOPMENT ALONG DIFFERENT PATHS [ENTWICKLUNG AUF VERSCHIEDENEN WEGEN]
H. J. HENNING Luft- und Raumfahrt (ISSN 0173-6264), vol. 10, 3rd Quarter, 1989, p. 39, 40, 42. In German.
Copyright
The development of electronic control methods in the FRG, the UK, and the U.S. is discussed. The emphasis given to flow control and acceleration control in British engines and to rotational control in U.S. engines is pointed out. The transition from hydromechanical to electronic controllers is reviewed. C.D.

A89-54486#
CALCULATION OF THE EFFECT OF THE LOCATION OF THE JET-ENGINE AIR INLETS ON THE AIR FLOW IN FRONT OF THE INLETS [ANALIZA OBLICZENIOWA WPLYWU USYTUOWANIA WLOTOW SILNIKOW ODRZUTOWYCH NA PRZEPLYW POWIETRZA W STREFIE PRZEDWLOTOWEJ]
LUCJAN MADEJ, STEFAN SZCZECINSKI, and ZDZISLAW WOJCIECHOWSKI Technika Lotnicza i Astronautyczna (ISSN 0040-1145), vol. 44, Jan. 1989, p. 7-10. In Polish. refs
A mathematical model for analyzing the effect of the location of the air inlets in jet engines on the distribution of air flow streamlines and velocities in front of the inlets is presented. Calculation results are given. B.J.

A89-54535
CALCULATION OF TRANSONIC FLOW PAST THE TAIL SECTION OF A PLANE OR AXISYMMETRIC BODY [RASCHET TRANSZVUKOVOGO OBTEKANIIA KORMOVOI CHASTI PLOSKOGO ILI OSESIMMETRICHNOGO TELA]
S. A. SHCHERBAKOV Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki (ISSN 0044-4669), vol. 29, Sept. 1989, p. 1367-1379. In Russian. refs
Copyright
Based on a modified version of Godunov's finite difference scheme, a method is developed for calculating transonic flow of an ideal gas past the tail section of a plane or axisymmetric oblong body with steep angles and bends of the generatrix. Use is made of difference grids adapted to flow characteristics, and the new version of the scheme is implemented. Formulas for calculating transonic flow at a distance from the body are obtained using a linear approximation. V.L.

A89-54614
THEORY FOR SEPARATED FLOW AROUND THE TRAILING EDGE OF A THIN PROFILE [K TEORII OTRYVNOGO OBTEKANIIA ZADNEI KROMKI TONKOGO PROFILIA]
G. L. KOROLEV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), July-Aug. 1989, p. 55-59. In Russian. refs
Copyright
Nonsymmetrical flow past the trailing edge is investigated theoretically for the case of flow separation. Numerical solutions are obtained for equations describing the interaction region located near the trailing edge. It is shown that a solution for this region exists up to a certain angle of attack. It is also noted that the friction on the upper surface at the very end of the trailing edge remains positive under all flow conditions. The nonuniqueness of solutions to the equations in the case of separated flow is demonstrated. V.L.

A89-54619
SEPARATED FLOW PAST A CONCAVE CONICAL WING OF LARGE TRANSVERSE CURVATURE AT SMALL ANGLES OF ATTACK [OTRYVNOE OBTEKANIE VOGNUTOGO KONICHESKOGO KRYLA S BOL'SHOI POPERECHNOI KRIVIZNOI POD NEBOL'SHIMI UGLAMI ATAKI]
V. L. BORSHCH and V. V. KRAVETS Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), July-Aug. 1989, p. 130-136. In Russian. refs
Copyright
Laminar flow past a wing model in the form of a circular half-cone with an angle of taper of 34 deg was modeled numerically in the context of a quasi-conical approximation for three-dimensional Navier-Stokes equations. Under such an assumption, the displacement of external nonviscous flow due to intense flow separation beyond the leading edges leads to flow patterns similar to those observed in the case of V-shaped wings with a bend in the transverse profile. A weak secondary separation is shown to occur under primary separation regions at nonzero angles of attack. V.L.

A89-54624
CONSTRUCTION OF GENERAL-PURPOSE SUPERSONIC NOZZLES OF CONICAL CROSS SECTION [POSTROENIE UNIVERSAL'NYKH SVERKHZVUKOVYKH SOPEL S KONICHESKIM TECHENIEM]
I. S. ZORINA, M. IU. KURSHAKOV, and I. V. CHIRKOV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), July-Aug. 1989, p. 183-186. In Russian.
Copyright
A solution is presented for the problem of calculating the profile of the supersonic section of nozzles, producing flows from a source, that are self-similar with respect to the isentropic index. A function is obtained which approximates the geometry of nozzles with angles of the conical section up to 15 deg. The accuracy of the approximation is supported by calculations for the direct nozzle problem. V.L.

A89-54625
OPTIMAL PERMEABILITY OF WIND TUNNEL WALLS AT LOW SUPERSONIC VELOCITIES [OPTIMAL'NAIA PRONITSAEMOST' STENOK AERODINAMICHESKOI TRUBY PRI MALYKH SVERKHZVUKOVYKH SKOROSTIAKH]
V. M. NEILAND Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), July-Aug. 1989, p. 187-189. In Russian.
Copyright
The interaction of oblique shock and rarefaction waves at free-stream Mach of 1 or greater with the porous walls of a wind tunnel is investigated theoretically. Conditions are determined under which these perturbations are not reflected from the tunnel walls and therefore do not affect flow around the model. The theoretical conclusions reached here are supported by experimental data. V.L.

N89-28486* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LOW-SPEED STATIC AND DYNAMIC FORCE TESTS OF A GENERIC SUPERSONIC CRUISE FIGHTER CONFIGURATION
DAVID E. HAHNE Washington Oct. 1989 35 p
(NASA-TM-4138; L-16599; NAS 1.15:4138) Avail: NTIS HC A03/MF A01 CSCL 01A
Static and dynamic force tests of a generic fighter configuration designed for sustained supersonic flight were conducted in the Langley 30- by 60-foot tunnel. The baseline configuration had a 65 deg arrow wing, twin wing mounted vertical tails and a canard. Results showed that control was available up to C sub L,max (maximum lift coefficient) from aerodynamic controls about all axes but control in the pitch and yaw axes decreased rapidly in the post-stall angle-of-attack region. The baseline configuration showed stable lateral-directional characteristics at low angles of attack but directional stability occurred near alpha = 25 deg as the wing shielded the vertical tails. The configuration showed positive effective dihedral throughout the test angle-of-attack range. Forced oscillation tests indicated that the baseline configuration had stable damping characteristics about the lateral-directional axes. Author

N89-28487# Midwest Research Inst., Golden, CO. Solar Energy Research Inst.
THREE-DIMENSIONAL AIRFOIL PERFORMANCE MEASUREMENTS ON A ROTATING WING
C. P. BUTTERFIELD Jun. 1989 6 p Presented at the European Wind Energy Conference and Exhibition, Glasgow, Scotland, 10 Jul. 1989
(Contract DE-AC02-83CH-10093)
(DE89-009443; SERI/TP-217-3505; CONF-890717-2) Avail: NTIS HC A02/MF A01
The objective of this comprehensive research program was to study the effects of Horizontal Axis Wind Turbine (HAWT) blade rotation on aerodynamic behavior below, near, and beyond stall. The flow angle sensor used to measure Angle Of Attack (AOA) is described along with how the sensor was calibrated, and results are given of pressure integrations on the blade. Aerodynamic, load, flow visualization, and inflow measurements were made on a 10-m, three-bladed, downwind HAWT. A video camera was mounted on the rotor to record video images of tufts attached to the low pressure side of a constant-chord, zero-twist blade. Load measurements were made using strain gages mounted every 10 percent of the blade's span. Pressure taps were located at 32 chordwise positions and revealed pressure distributions comparable with wind tunnel data. Inflow was measured using a vertical plane array of eight propvane and five triaxial (U-V-W) prop-type anemometers located 10 m upwind in the predominant wind direction. Results show evidence of stall hysteresis and unsteadiness at high AOA. Correlations with analytical predictions and wind tunnel tests show good agreement at low AOA and poor agreement at high AOA. DOE

N89-28488# General Dynamics Corp., Fort Worth, TX.
SMALL SCALE MODEL TESTS IN SMALL WIND AND WATER TUNNELS AT HIGH INCIDENCE AND PITCH RATES. VOLUME 1: TEST PROGRAM AND DISCUSSION OF RESULTS Final Report, Sep. 1985 - Sep. 1988
ATLEE M. CUNNINGHAM, JR., TODD BUSHLOW, JOHN R. MERCER, TIM A. WILSON, and STEVE N. SCHWOERKE Apr. 1989 144 p
(Contract N00014-85-C-0419)
(AD-A208647) Avail: NTIS HC A07/MF A01 CSCL 01/1
Volume 1 presents the test program, correlations with other data, and discussions of the specific objectives of this investigation. In general it was shown that the small scale wind tunnel and water tunnel test techniques do provide reasonable dynamic force and moment data for a wide variety of planforms and conditions. The force testing of small-scale models in either a small wind tunnel or a water tunnel was investigated as an inexpensive and quick means to obtain meaningful dynamic force and moment data representative of rapidly maneuvering full-scale aircraft. Force tests of flat-plate semi-span models were conducted in the General Dynamics Aerodynamic Development Facility (ADF) which is a small 14x14 in. low speed wind tunnel. Oscillatory model motions up to 48 deg (peak to peak) amplitude were tested at frequencies of 1 to 3 Hz. Force tests of flat and three-dimensional full span models were conducted in the General Dynamics Hydroflow Facility (HFF) which is a horizontal flow water tunnel with a 24x24 in. test section. Pitch/pulse model motions were tested for conditions similar to those tested in the ADF. GRA

N89-28489# Aeronautical Research Labs., Melbourne (Australia).
COMPARISON OF FLOW-VISUALISED VORTICES WITH COMPUTED GEOMETRY OVER THIN DELTA WINGS
L. D. MACLAREN Feb. 1989 6 p
(AD-A209083; ARL-FLIGHT-MECH-TM-409) Avail: NTIS HC A02/MF A01 CSCL 01/1
The vortex flow patterns over thin delta wings were photographed during experiments in a vertical water tunnel making use of appropriate flow visualization techniques. The flow geometry for these wings was also calculated using the VORSBA vortex flow computer program. A comparison is made between the calculated and experimental results and discrepancies between them are discussed. GRA

N89-28490# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
GLIDER GROUND EFFECT INVESTIGATION M.S. Thesis
NATHAN H. JONES May 1989 131 p
(AD-A209152; AFIT/GAE/ENY/89J-2) Avail: NTIS HC A07/MF A01 CSCL 01/3
This research used glider flight tests and optimized glider simulations to evaluate the aerodynamics of ground effect and to determine the optimum flight profile for maximum gliding range in gliders. A series of 122 sorties were flown in the Grob G-103 Twin II and the Let L-13 Blanik gliders on a specially designed very low altitude speed course. Radar tracking data were used to determine the glider position and velocity, and a 3 degree of freedom glider performance simulation was used to determine the glider parasite and induced drag coefficients in ground effect. Lifting

line derived predictions of ground effect induced drag reduction developed by Dr. Sighard Hoerner were found to be accurate at altitudes above 20 percent wingspan but were up to 16 percent too optimistic at low altitudes. A revised prediction of ground effect induced drag reduction was developed based on the flight test data, and this revised prediction was used along with a turbulent boundary layer wind model in two optimization algorithms to develop the optimum flight profiles for maximum range gliding flight.
GRA

N89-28492# National Aerospace Lab., Tokyo (Japan). Structural Mechanics Div.
SOME COMPUTATIONS OF UNSTEADY NAVIER-STOKES FLOW AROUND OSCILLATING AIRFOIL/WING
JIRO NAKAMICHI Oct. 1988 25 p
(NAL-TR-1004T; ISSN-0389-4010) Avail: NTIS HC A03/MF A01
Unsteady Navier-Stokes calculations around an airfoil/wing are demonstrated. 2D transonic flutter simulations are performed about the NACA 64A010 airfoil using not only a diagonal form of a Beam-Warming scheme but also a non-diagonal form. The effects of time accuracy of the algorithms on the flutter boundaries are checked by comparing two results. 3D unsteady computations around an oscillating wing in elastic motions are also carried out and the obtained results are compared with experimental data. It is found that the diagonal form of a Beam-Warming scheme is efficient in predicting the flutter boundaries of airfoils where the flow is not separated. It is also demonstrated that the present 3D code gives results in agreement with experimental data and it can be used for 3D flutter simulation programs in a similar manner to 2D programs.
Author

N89-28493*# California Polytechnic State Univ., San Luis Obispo.
ANALYSIS OF LEADING EDGE SEPARATION USING A LOW ORDER PANEL METHOD Final Report
DORAL R. SANDLIN Sep. 1989 26 p
(Contract NCC2-226)
(NASA-CR-185892; NAS 1.26:185892) Avail: NTIS HC A03/MF A01
An examination of the potential flow computer code VSAERO to model leading edge separation over a delta wing is examined. Recent improvements to the code suggest that it may be capable of predicting pressure coefficients on the body. Investigation showed that although that code does predict the vortex roll-up, the pressure coefficients have significant error. The program is currently unsatisfactory, but with some additional development it may become a useful tool for this application.
Author

N89-28494# Institut Franco-Allemand de Recherches, Saint-Louis (France).
STUDY OF THE WING-VORTEX INTERACTION IN THREE DIMENSIONAL FLOWS (INCOMPRESSIBLE INVISCID FLOW) [ETUDE DE L'INTERACTION AILE/TOURBILLON EN TRIDIMENSIONNEL (ECOULEMENT INCOMPRESSIBLE SANS VISCOSITE)]
M. SCHAFFAR 16 Aug. 1987 45 p In FRENCH Original contains color illustrations
(ISL-R-123/87; ETN-89-94856) Avail: NTIS HC A03/MF A01
The use of horseshoe vortices on the wing and of a turbulent network for the wake, permitted treatment in three dimensions of the case of a thin wing for steady flow and unsteady flow (incident wing with upstream vortex). For steady flow and large spans the calculated lift is close to the two dimensional value. For the unsteady case the variations in lift along the path of the vortex are described.
ESA

N89-28495# Institut Franco-Allemand de Recherches, Saint-Louis (France).
PROFILE-VORTEX INTERACTIONS [INTERACTION PROFIL/TOURBILLON]
J. HAERTIG, CH. JOHE, and M. SCHAFFAR 3 Nov. 1987 49 p In FRENCH
(Contract DRET-85-031)
(ISL-R-125/87; ETN-89-94858) Avail: NTIS HC A03/MF A01
The time evolution of the lift coefficient of a profile exposed to incident vortices is calculated by a perfect fluid two dimensional method and compared to experimental results obtained in a hydrodynamic channel. The unsteady turbulent field is analyzed using laser anemometry. The results are in good agreement with the theoretical model adopted, except for the case when the vortex path is too close to the profile.
ESA

N89-28497# National Aeronautical Lab., Bangalore (India). Computational and Theoretical Fluid Dynamics Div.
FLOW CALCULATION OVER A DELTA-WING USING THE THIN-LAYER NAVIER-STOKES EQUATIONS
ANAND KUMAR Jun. 1989 9 p Presented at the International Symposion on CFD, Nagoya (Japan), 28-31 Aug. 1989
(PD-CF-8924) Avail: NTIS HC A02/MF A01
A 3D laminar thin-layer Navier-Stokes solver is developed which employs finite volume spatial discretisation and Runge-Kutta time integration. The code is applied to compute vortex flow over a round leading edge delta wing, and the results are compared with experiment and an Euler simulation.
Author

N89-28498*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CORRELATION OF PUMA AIRLOADS: EVALUATION OF CFD PREDICTION METHODS
ROGER C. STRAWN, ANDRE DESOPPER, JUDITH MILLER, and ALAN JONES (Royal Aerospace Establishment, Farnborough, England) Aug. 1989 22 p
(NASA-TM-102226; A-89223; NAS 1.15:102226; USAAVSCOM-TM-89-A-001) Avail: NTIS HC A03/MF A01 CSCL 01/1
A cooperative program was undertaken by research organizations in England, France, Australia and the U.S. to study the capabilities of computational fluid dynamics codes (CFD) to predict the aerodynamic loading on helicopter rotor blades. The program goal is to compare predictions with experimental data for flight tests of a research Puma helicopter with rectangular and swept tip blades. Two topics are studied. First, computed results from three CFD codes are compared for flight test cases where all three codes use the same partial inflow-angle boundary conditions. Second, one of the CFD codes (FPR) is iteratively coupled with the CAMRAD/JA helicopter performance code. These results are compared with experimental data and with an uncoupled CAMRAD/JA solution. The influence of flow field unsteadiness is found to play an important role in the blade aerodynamics. Alternate boundary conditions are suggested in order to properly model this unsteadiness in the CFD codes.
Author

N89-28499# Technische Univ., Delft (Netherlands). Inst. for Wind Energy.
THE ANGLES OF THE KOLIBRIE ROTOR TIPVANES ON THE RODS AND ON THE BLADES
A. BRUINING Delft University Press Oct. 1988 24 p Sponsored by the Netherlands Ministry of Economic Affairs
(IW-R515; ISBN-90-627-5496-1; ETN-89-95428) Copyright Avail: NTIS HC A03/MF A01
The data of the adjusted angles of the tipvanes used on the Kolibrie rotor blades and rods, are reported. Two measuring methods are applied: one method is based on determining the chord vector and the span wise vector of the tipvane. The other method is based on the angles of the mounting parts of the tipvanes. The theoretical background and the measurement procedure are not included. Due to the unreliability of the position of the chord vector and the span wise vector the results from the first method are not used. Calculations are carried out with the data from the second method, based on the angles of the mounting parts of the tipvanes.
ESA

N89-28500# Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.
WIND TUNNEL TESTS OF 16 PERCENT THICK AIRFOIL WITH 30 PERCENT TRAILING EDGE FLAP AT HIGH ANGLES OF ATTACK AND WITH FLAP ANGLES
SVEN-OLOF RIDDER Dec. 1988 45 p Sponsored by the Swedish National Energy Administration
(FFA-TN-1985-58; ETN-89-94312) Avail: NTIS HC A03/MF A01
Wind tunnel tests are carried out at low speeds. The test program includes high negative flap angles and an angle of attack range of 180 deg. The test Reynolds number is 2,200,000. The test results indicate that it is impossible to overcome the strong driving tangential force of the basic section by means of any of the trailing edge devices investigated. ESA

N89-28501 British Aerospace Public Ltd. Co., Preston (England). Military Aircraft Div.
A DETAILED SURVEY OF THE FLOW PASSING THROUGH AN ASYMMETRIC CONTRACTION AND PARALLEL DUCT
M. T. STICKLAND 16 Nov. 1988 44 p
(BAE-WWT-RP-RES-AXR-000194-PT-A; ETN-89-94958) Avail: British Aerospace Public Ltd. Co., Preston Lancs PR4 1AX, United Kingdom
A research program was undertaken to reduce or remove an undesirable flow effect in a transonic wind tunnel. The effect is a four lobe swirl appearing in the working section. An experimental study was carried out in the wind tunnel using a model of the contraction and square duct, and existing software was used to numerically simulate the phenomena. The physical simulation was quite successful in reproducing the flow perturbation, while the numerical simulation failed. The flow anomaly is found not to be a problem with the normal types of test work carried out in the tunnel, but it casts serious doubts on the tunnel value in duct code validation work. ESA

N89-28502 British Aerospace Public Ltd. Co., Preston (England). Military Aircraft Div.
A DETAILED SURVEY OF THE FLOW PASSING THROUGH AN ASYMMETRIC CONTRACTION AND PARALLEL DUCT
M. T. STICKLAND 16 Nov. 1988 179 p
(BAE-WWT-RP-RES-AXR-000194-PT-B; ETN-89-94959) Avail: British Aerospace Public Ltd., Preston Lancs, PR4 1AX, United Kingdon
A research program was undertaken to reduce or remove an undesirable flow effect in a transonic wind tunnel. The effect is a four lobe swirl appearing in the working section. An experimental study was carried out in the wind tunnel using a model of the contraction and square duct, and existing software was used to numerically simulate the phenomena. The physical simulation was quite successful in reproducing the flow perturbation, while the numerical simulation failed. The flow anomaly is found not to be a problem with the normal types of test work carried out in the tunnel, but it casts serious doubts on the tunnel value in duct code validation work. ESA

N89-28505# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany, F.R.). Abteilung Messphysik.
EVALUATION OF LDA 3-COMPONENT VELOCITY DATA ON A 65 DEG DELTA WING AT M = 0.85 AND FIRST RESULTS OF AN ANALYSIS
S. N. SESHADRI and KARL-ALOYS BUETEFISCH Mar. 1989 67 p
(DFVLR-FB-89-19; ISSN-0171-1342; ETN-89-95314) Avail: NTIS HC A04/MF A01; DFVLR, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, 21 DM
The laser Doppler anenometry (LDA) three-component velocity data obtained for a 65 deg sweptback, cropped delta wing at a free stream Mach number of 0.85 is analyzed with the aid of a menu driven computer program. The program was developed to process the LDA data employing a linear or a weighted quadratic interpolation technique to compute velocities in the vortex core or at any other field point where no measurement data is available. Basic results obtained using the two techniques to compute velocities in the vortex core or at any other field point polation scheme are presented. Limited analysis related to the structure of the vortex and the development of the leeside flow field is made. A good correlation of LDA results with surface results obtained through oil flow/static pressure is found. Existence of a shock wave located above the vortex core is indicated. The weighted quadratic interpolation theory is concluded to give preferable results to these produced by linear technique. ESA

N89-29305*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
BOUNDARY-LAYER MEASUREMENTS ON A TRANSONIC LOW-ASPECT RATIO WING
EARL R. KEENER May 1985 40 p
(NASA-TM-88214; A-86133; NAS 1.15:88214) Avail: NTIS HC A03/MF A01 CSCL 01/1
Tabulations and plots are presented of boundary-layer velocity and flow-direction surveys from wind-tunnel tests of a large-scale (0.90 m semi-span) model of the NASA/Lockheed Wing C. This wing is a generic, transonic, supercritical, highly three-dimensional, low-aspect-ratio configuration designed with the use of a three-dimensional, transonic full-potential-flow wing code (FLO22). Tests were conducted at the design angle of attack of 5 deg over a Mach number range from 0.25 to 0.96 and a Reynolds number range of 3.4x10 to the 6th power. Wing pressures were measured at five span stations, and boundary-layer surveys were measured at the midspan station. The data are presented without analysis. Author

N89-29306# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics Panel.
SPECIAL COURSE ON AEROTHERMODYNAMICS OF HYPERSONIC VEHICLES
Jun. 1989 336 p Course held in Rhode-Saint-Genese, Belgium, 30 May - 3 Jun. 1988; sponsored by AGARD and the Von Karman Inst. of Fluid Dynamics
(AGARD-R-761; ISBN-92-835-0515-8) Copyright Avail: NTIS HC A15/MF A01
This AGARD Fluid Dynamics Panel/von Karman Institute Special Course was inspired by new ventures in the hypersonic domain moving forward on both sides of the Atlantic-HERMES in Europe and the NASP (X-30) in the United States. Following the review of basic principles including real gas effects, a series of lectures were presented on experimental and computational methods specific to hypersonic flows. Stress was placed on measurement techniques developed primarily for flows with heat transfer, chemical reactions, strong shocks, and compressible boundary layers. Both surface measurements and flow field measurements including species concentration techniques, were discussed. The same spirit governed the lecture on computational methods: stress was placed on the new problems in CFD posed by high speeds and chemical reactions. The course finished with state of the art reviews onthree critical flow problems: transition to turbulence; ininteractions between shocks and boundary layers; and shock/shock impingement.

N89-29308# Maryland Univ., College Park. Dept. of Aerospace Engineering.
INVISCID AND VISCOUS HYPERSONIC AERODYNAMICS: A REVIEW OF THE OLD AND NEW
JOHN D. ANDERSON, JR. *In* AGARD, Special Course on Aerothermodynamics of Hypersonic Vehicles 25 p Jun. 1989 Copyright Avail: NTIS HC A15/MF A01
Both inviscid and viscous hypersonic aerodynamics are reviewed. It is tutorial in manner, and is addressed to students and workers who want to learn the subject, or need to review various aspects of the discipline. Also represented is a survey of hypersonics, contrasting the old with the new. It covers both classical hypersonic considerations as well as the new hypersonics, which is heavily based on computational fluid dynamic methods. High temperature flows are also considered. Author

N89-29312# Calspan Corp., Buffalo, NY.
SPECIES COMPOSITION MEASUREMENTS IN NONEQUILIBRIUM HIGH-SPEED FLOWS
DONALD W. BOYER *In* AGARD, Special Course on Aerothermodynamics of Hypersonic Vehicles 23 p Jun. 1989
Copyright Avail: NTIS HC A15/MF A01

Descriptions of some diagnostic methods for species concentration measurements are reviewed which are applicable to high-speed flows. Some of the theoretical framework was included but only as background to support the descriptions. Referral is intended, of course, to the literature cited, and references therein, for greater detail concerning analysis and implementation. The summaries can help to appraise as well as guide in the selection of a method most suitable for a given flow situation. Some of the methods are not new. The more recent and yet-developing laser techniques have singular advantages by virtue of their ability to interrogate very fast flows, and to be applicable to reactive and hostile environments. However, the techniques can be quite complex both analytically and in their optical requirements and configurations. Author

N89-29316# McDonnell-Douglas Missile Systems Co., Saint Louis, MO.
CHAOTIC RESPONSE OF AEROSURFACES WITH STRUCTURAL NONLINEARITIES Annual Technical Report, 1 Mar. 1988 - 28 Feb. 1989
ANTHONY J. HAUENSTEIN and ROBERT M. LAURENSON Mar. 1989 70 p Sponsored in part by Missouri Univ., Rollo
(Contract F49620-88-C-0047; AF PROJ. 2308)
(AD-A208433; MDC-ATN-E466-014; AFOSR-89-0651TR) Avail: NTIS HC A04/MF A01 CSCL 16/2

An analytical and experimental research activity is being performed to investigate the chaotic response behavior of aerosurfaces containing discrete structural nonlinearities. Chaos is the paradoxical emergence of random-like motion in completely deterministic nonlinear systems. This research is developing an understanding of an aerosurface containing discrete structural nonlinearities. The dynamic behavior of a rigid aerosurface has been investigated analytically and experimentally. The rigid surface analysis and test activities are to be continued. A flexible aerosurface will be designed and fabrication begun during the second year. The third year of the program will move to test and analysis of the flexible aerosurface. Studies were performed for a long range of rigid aerosurface configurations and various root spring stiffnesses and nonlinearities. Test apparatus was designed and fabricated to experimentally demonstrate the nonlinear behavior of a rigid aerosurface containing discrete structural nonlinearities. Wind tunnel testing for the rigid aerosurface configuration was initiated and evaluation of the results of the wind tunnel tests is underway. Initial design and fabrication of the rigid aerosurface dynamic test setup was completed. GRA

N89-29317# Vrije Univ., Brussels (Belgium). Dept. of Fluid Mechanics.
TRANSITION AND TURBULENCE STRUCTURE IN THE BOUNDARY LAYERS OF AN OSCILLATING AIRFOIL Final Technical Report, 1 Jan. 1985 - 31 Dec. 1988
J. DERUYCK, B. HAZARIKA, and CH. HIRSCH 1989 102 p
(Contract DAJA45-85-C-0039)
(AD-A208968; VUB-STR-16; R/D-2835A-AN) Avail: NTIS HC A06/MF A01 CSCL 01/1

Objectives of this investigation were: (1) to identify the conditions under which a sinusoidally oscillating NACA 0012 airfoil operates with a leading edge separation bubble and the conditions under which it operates with leading edge stall; (2) to conduct complete boundary layer and near wake survey in the presence of the leading edge separation bubble; and (3) to investigate the flow near the trailing edge and in the near wake while the airfoil was undergoing leading edge stall. The airfoil oscillates about an axis at 25 percent chord from the leading edge, with a nominal reduced frequency of 0.3 and Reynolds number of 300,000. Experiments were made at 4 to 14, 5 to 15, 6 to 16 and 8 to 18 deg angle of attack. It was found that the most probable cause of leading edge stall was due to the leading edge separation bubble burst which occurred soon after static stall limit was exceeded. Leading edge stall is not due to the rapid upstream movement of the trailing edge separation. The velocity vectors and the Reynolds stress tensors were measured using a slanted rotating single sensor hot-wire. The complete suction side boundary layer profile and the near wake was surveyed at 5 to 15 deg oscillation where no interaction is observed between leading edge and trailing edge flows. GRA

N89-29318# Aeronautical Research Labs., Melbourne (Australia).
FLUTTER CALCULATIONS FOR A MODEL WING USING THE MSC NASTRAN STRUCTURAL ANALYSIS PROGRAM
BETTY EMSLIE Nov. 1988 45 p
(AD-A209244; ARL-STRUC-TM-495; DODA-AR-005-544) Avail: NTIS HC A03/MF A01 CSCL 01/1

Flutter calculations for a semispan model wing with a trailing edge control surface were carried out using the MSC NASTRAN computer program. In order to alter the critical flutter speeds of the model wing, provision was made to allow rods or other masses to be attached at the wing tip. In these calculations aluminum and steel rods were used to modify the flutter characteristics of the model. Eleven configurations of the model wing were considered. For each of the 11 configurations, flutter calculations were carried out for a number of different aileron rotational stiffnesses. GRA

N89-29321*# National Aerospace Lab., Tokyo (Japan). Aircraft Aerodynamics Div.
USE OF HIGH-RESOLUTION UPWIND SCHEME FOR VORTICAL FLOW SIMULATIONS
KOZO FUJII and SHIGERU OBAYASHI (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.) Dec. 1988 16 p Sponsored by NASA
(NASA-CR-185910; NAS 1.26:185910; NAL-TR-1007T; ISSN-0389-4010) Avail: NTIS HC A03/MF A01 CSCL 01/1

For vortical flow simulations at high Reynolds numbers, it is important to keep the artificial dissipation as small as possible since it induces unphysical decay of the vortex strength. One way to accomplish this is to decrease the grid spacing. Another way is to use computational schemes having little dissipation. Here, one of the high-resolution upwind schemes called MUSCL with Roe's average is applied to vortical flow fields. Two examples are considered. One is the leading-edge separation-vortex flow over a strake-delta wing. The other is a high-angle of attack supersonic flow over a spaceplane-like geometry. Comparison with the central difference solutions indicates that the present upwind scheme is less dissipative and thus has better resolution for the vortical flows. Author

N89-29323*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
STOL AND STOVL HOT GAS INGESTION AND AIRFRAME HEATING TESTS IN THE NASA LEWIS 9- BY 15-FOOT LOW-SPEED WIND TUNNEL
ALBERT L. JOHNS Sep. 1989 33 p
(NASA-TM-102101; E-4864; NAS 1.15:102101) Avail: NTIS HC A03/MF A01 CSCL 01/1

Short takeoff and landing (STOL) and advanced short takeoff and vertical landing (STOVL) aircraft are being pursued for deployment near the end of this century. These concepts offer unique capabilities not seen in conventional aircraft: for example, shorter takeoff distances and the ability to operate from damaged runways and remote sites. However, special technology is critical to the development of this unique class of aircraft. Some of the real issues that are associated with these concepts are hot gas ingestion and airframe heating while in ground effects. Over the past nine years, NASA Lewis Research Center has been involved in several cooperative programs in the 9- by 15 Foot Low-Speed Wind Tunnel (LSWT) to establish a database for hot gas ingestion and airframe heating. The modifications are presented that were made in the 9- by 15-Foot LSWT, including the evolution of the ground plane, model support system, and tunnel sidewalls; and flow visualization techniques, instrumentation, test procedures, and test results. The 9- by 15-Foot LSWT tests were conducted at full scale exhaust nozzle pressure ratios. The headwind velocities varied from 8 to 120 kn depending on the concept (STOL or STOVL). Typical compressor-face distortions (pressure and temperature), ground plane contours, and model surface temperature profiles are presented. Author

N89-29324*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SOME EFFECTS OF AERODYNAMIC SPOILERS ON WING FLUTTER
ROBERT V. DOGGETT, JR. Jul. 1989 18 p
(NASA-TM-101632; NAS 1.15:101632) Avail: NTIS HC A03/MF A01 CSCL 01/1

The effects of deployment angle and size of symmetrically mounted upper-surface and lower-surface spoilers on the flutter characteristics of a simple, paddle-like, low-aspect-ratio, rectangular wing model that was tested at Mach number 0.80 in the Langley Transonic Dynamics Tunnel are presented. The results show that the flutter dynamic pressure is increased by increasing either spoiler deployment angle or spoiler size. For the configurations studied spoiler size was more effective than deployment angle in increasing the flutter dynamic pressure. Author

N89-29325# Centre d'Etudes et de Recherches, Toulouse (France). Dept. Aerothermodynamique.
EXPERIMENTAL INVESTIGATION OF A THREE DIMENSIONAL WAKE IN THE VICINITY OF A WING-BODY JUNCTION
G. PAILHAS and V. JAYARAMAN Mar. 1989 115 p
(Contract STPA-85-95004-35)
(CERT-0A-29/5025-AYD; DERAT-29/5025-20; ETN-89-95278)
Avail: NTIS HC A06/MF A01

The development of a pressure gradient turbulent incompressible wake in the vicinity of a junction between the test section tunnel floor and a constant chord swept wing (i.e., simulated wing-body junction) is studied. Use of a four-wire probe (CTA type) is employed as a measurement technique. Static pressure measurements are made both on either sides of the model and in the wake; flow visualization is carried out to supplement the above information. Mean and fluctuating turbulent velocities and shear stresses are deduced from the hot-wire output. The results indicate that the characteristics of such a complex flow field (dissimilar pressure gradients and three dimensional effects) are different from that of a classical self-preserving two dimensional wake. The flow field around the simulated wing-body junction and its influence on the wake development is discussed. ESA

N89-29326*# Stanford Univ., CA. Dept. of Aeronautics and Astronautics.
CONTROL OF SEPARATED FLOW PAST A CYLINDER USING TANGENTIAL WALL JET BLOWING
SEJONG OH and LEONARD ROBERTS Jul. 1989 34 p
(Contract NCC2-55)
(NASA-CR-185918; NAS 1.26:185918; JIAA-TR-93) Avail: NTIS HC A03/MF A01 CSCL 01/1

A theoretical analysis is conducted to study the effect of a tangential wall jet on the control of two dimensional separated flow past a circular cylinder. For a tangential wall jet, the mathematical model derived previously is used and the vortex cloud method is adopted for the calculation of the external flow field. For certain limiting cases, the governing equations are simplified and closed forms of solutions for the wall jet parameters can be obtained. It is observed that the wall jet is very efficient in reducing drag by delaying the separation point in the range of small blowing strength. The suction force induced by the wall jet is negligible to the drag due to the external stream. However this suction increases the drag when the blowing strength is large. Author

N89-29328*# Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering and Mechanics.
THERMO-VISCOPLASTIC ANALYSIS OF HYPERSONIC STRUCTURES SUBJECTED TO SEVERE AERODYNAMIC HEATING Progress Report, 31 Dec. 1988 - 30 Sep. 1989
EARL A. THORNTON, J. TINSLEY ODEN, W. WOYTEK TWORZYDLO, and SUNG-KIE YOUN (Computational Mechanics Co., Austin, TX.) Oct. 1989 18 p Previously announced in IAA as A89-30713
(Contract NSG-1321)
(NASA-CR-185915; NAS 1.26:185915) Avail: NTIS HC A03/MF A01 CSCL 01/1

A thermoviscoplastic computational method for hypersonic structures is presented. The method employs unified viscoplastic constitutive model implemented in a finite element approach for quasi-static thermal-structural analysis. Applications of the approach to convectively cooled hypersonic structures illustrate the effectiveness of the approach and provide insight into the transient inelastic structural behavior at elevated temperatures. Author

03

AIR TRANSPORTATION AND SAFETY

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

A89-52325
PROPORTIONAL HAZARDS MODELLING OF AIRCRAFT CARGO DOOR COMPLAINTS
A. L. F. LEITAO and D. W. NEWTON (Birmingham, University, England) Quality and Reliability Engineering International (ISSN 0748-8017), vol. 5, July-Sept. 1989, p. 229-238. refs
Copyright

Proportional hazards modelling is a powerful technique which can be used to investigate the effects of various explanatory variables on the life length of equipment. In this paper the analysis of aircraft cargo door complaints is considered, as this can cause serious delay problems. Particular attention is given to the assumptions supporting the application of the model. Consideration is given to problems in the choice of the appropriate basic metric time, definition of covariates and adapting the methodologies to this particular problem. Emphasis is placed upon the validation of the results by attempting several different structures of the dependent variables. Author

A89-52513
ARE THE SOVIETS SET TO MAKE THE BIG TIME?
OLIVER SUTTON Interavia (ISSN 0020-5168), vol. 44, Aug. 1989, p. 772-776.
Copyright

The commercial viability of Soviet-manufactured airliners is evaluated in light of current production airframe production-capacity saturation in both the U.S. and Western Europe, opening opportunities for Soviet airframe manufacturing enterprises capable of delivering aircraft ahead of Western competitors. The Il-96-300 and the Tu-204 airliners are noted to respectively fit into two popular aircraft categories, namely those for the long-range routes that are eventually to be served by the A 340, and those for the medium-range routes currently served by such aircraft as the B 757. Attention is given to Western certification criteria for the Soviet aircraft and the prospects for cooperative efforts with Western manufacturers. O.C.

A89-53474
LIGHTNING PROTECTION TESTING OF THE E-6 WING TIP ANTENNA POD/HF PROBE
G. L. ENOCHSON, S. W. KORMANYOS, and V. L. SEVERSON (Boeing Aerospace, Seattle, WA) IN: IEEE 1989 National

Symposium on Electromagnetic Compatibility, Denver, CO, May 23-25, 1989, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1989, p. 59-64.
Copyright

A brief summary is presented of lightning tests conducted on the US Navy E-6 aircraft wing tip antenna pod/HF probe in accordance with MIL-STD-1757 to demonstrate compliance with MIL-B-5087B lightning protection requirements. The tests were conducted on a 22-ft full-sized electrically representative model of the pod/HF probe. Three types of tests were conducted. Long arc attachment tests (MIL-STD-1757 test method T01) were performed to determine the lightning arc entry angle. Direct effects testing (method T02) was conducted to examine the extent of damage which could result from direct attachment of a high-current lightning strike to the pod. Indirect effects testing (method T05) was conducted to assess the voltage levels induced on equipment cables that result from lightning strike attachment. The waveforms applied, test article configurations, and current injection points were chosen to represent worst-case conditions. Test operations and test results are discussed. I.E.

A89-53793#
AIRCRAFT ICING CAUSED BY LARGE SUPERCOOLED DROPLETS
MARCIA K. POLITOVICH (NOAA, Environmental Science Group, Boulder, CO) Journal of Applied Meteorology (ISSN 0894-8763), vol. 28, Sept. 1989, p. 856-868. refs

The characteristics of aircraft icing environments containing large supercooled droplets are described. Substantial loss in rate of climb capability can result from less than 10 minutes duration in conditions where fewer than 0.1-1 cu cm of droplets 30-400 microns in diameter are present. These conditions are found to have a greater effect than those where the liquid water was confined to smaller droplets. Measurements from research aircraft flying in regions containing these large droplets, located in the Sierra Nevada in California, near Amarillo, Texas, and in northern Arizona are presented. Temperatures ranged from -5.5 to -9.4 C in 13 regions The sizes of the droplets responsible for performance loss varied with each encounter but ranged from tens to hundreds of micrometers, and these were accompanied by few to no ice crystals. Two case studies are examined in further detail, including the weather conditions present at the time of the encounters. The meteorological situations leading to formation of these large droplets provide suitable environments for coalescence growth, or for prolonged depositional growth, and include weak atmospheric instability, warm (temperatures greater than about -15 C) cloud tops, and sufficient moisture. Author

A89-53971* Princeton Univ., NJ.
AN EXPERT SYSTEM FOR WIND SHEAR AVOIDANCE
ROBERT F. STENGEL and D. ALEXANDER STRATTON (Princeton University, NJ) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 1. New York, Institute of Electrical and Electronics Engineers, 1989, p. 349-354. refs
(Contract NAG1-834)
Copyright

A study of intelligent guidance and control concepts for protecting against the adverse effects of wind shear during aircraft takeoffs and landings, with current emphasis on developing an expert system for wind shear avoidance, is reported. 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 development is described of the windshear safety advisor, an expert system for pilot aiding that is based on the FAA Windshear Training Aid, a two-volume manual that presents an overview, pilot guide, training program, and substantiating data providing guidelines for this initial development. The windshear safety advisor expert system contains over 200 rules and is coded in the LISP programming language. I.E.

A89-54802
OBSERVATIONS AND FORECASTS FOR RUNWAY (PAVEMENT) SURFACES
J. R. KELLEY, DAVID C. TRASK, and OLGA HUNT (Surface Systems, Inc., Saint Louis, MO) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 148-153. refs
Copyright

The production of pavement-specific forecasts for use in airports is discussed. Surface sensors that provide data on runway conditions are described and the methods for processing data from these sensors are outlined. Methods for producing runway surface forecasts are considered, including 24-h projections of pavement temperatures, precipitation, pavement conditions, snow accumulation, runway wind speed, air temperature, and wind chill equivalent temperature. Also, a numerical forecasting model specifically for pavement forecasts is outlined. R.B.

A89-54803* Massachusetts Inst. of Tech., Cambridge.
THE INFLUENCE OF ICE ACCRETION PHYSICS ON THE FORECASTING OF AIRCRAFT ICING CONDITIONS
R. JOHN HANSMAN, JR. (MIT, Cambridge, MA) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 154-158. Research supported by FAA. refs
(Contract NGL-22-009-640; NAG3-666)
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The physics which control aircraft ice accretion are reviewed in the context of identifying and forecasting hazardous icing conditions. The severity of aircraft icing is found to be extremely sensitive to temperature, liquid water content and droplet size distribution particularly near the transition between rime and mixed icing. The difficulty in measurement and the variability of these factors with altitude, position and time coupled with variable aircraft sensitivity make forecasting and identifying icing conditions difficult. Automated Pilot Reports (PIREPS) are suggested as one mechanism for improving the data base necessary to forecast icing conditions. Author

A89-54804
MEASUREMENTS OF HAZARDOUS ICING CONDITIONS
MARCIA K. POLITOVICH (NOAA, Boulder, CO) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 159-163. refs
Copyright

Airborne measurements of hazardous icing conditions are used to study the effects of the icing environment on aircraft. The measurements include temperature, cloud droplets, cloud hydrometeors, and liquid water content. The characteristics of the icing regions are discussed. It is found that hazardous icing environments have a higher concentration of particles with diameters between 30 and 400 microns, compared with nearby nonhazardous regions. These hydrometeors are usually supercooled water droplets. It is concluded that these supercooled droplets pose the greatest hazard to flight in icing conditions. R.B.

A89-54805
REMOTE DETECTION OF AIRCRAFT ICING HAZARDS BY DOPPLER RADAR
LEON F. OSBORNE, JR. (North Dakota, University, Grand Forks) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 164-168. refs

(Contract DTFA01-87-C-00019)
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Results are presented from tests of an algorithm for the detection of icing hazards. The algorithm was developed from studies on the use of single-Doppler radar in icing detection (Osborne, 1986). The algorithm is directed toward the identification of regions of supercooled liquid water under stratiform or stratocumulus conditions during cool season months. The software is described and tests to identify the signatures discernable from the algorithm components and to determine the relative importance of the signatures are outlined. Preliminary results are given, showing a high variability in the success of the various components. R.B.

A89-54807
AIRCRAFT ICING CONDITIONS DETECTED BY COMBINED REMOTE SENSORS - A PRELIMINARY STUDY
INGRID A. POPA FOTINO, MARCIA K. POLITOVICH, and JOHN W. HINKLEMAN, JR. (NOAA, Boulder, CO) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 173-177. Research supported by FAA. refs
Copyright
Consideration is given to the use of microwave radiometers and remote sensing data to obtain data on the horizontal and vertical liquid distribution for forecasts of aircraft icing conditions. Data from two microwave radiometers, IR satellite images of cloud tops, and ceilometer measurements of cloud base altitudes are examined. The horizontal variability of icing conditions and the capability of complementary remote sensors to delimit a vertical range for radiometer-detected liquid water are studied. Average liquid-water concentrations are estimated in order to determine icing probability. It is found that the method of combining remote sensing data extends the icing detection capability of microwave radiometers. R.B.

A89-54821
AIRCRAFT ICING HAZARDS FORECASTING AND SYNOPTIC CLASSIFICATION
DAVID W. BERNHARDT (North Dakota, University, Grand Forks) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 249-251. refs
(Contract DTFA01-87-C-00019)
Copyright
A program to improve forecasts of aircraft icing potential and the synoptic classification of icing events is discussed. Daily forecasts were made for the winters seasons from 1985-86 to 1988-89. The performance of these forecasts was evaluated for the development of an algorithm to detect icing hazards using Doppler radar. The skill in forecasting icing, timing, type, intensity, and levels is examined. The process of classifying the events according to large-scale synoptic conditions is outlined. R.B.

A89-54823
THE ROLE OF THE SMITH-FEDDES MODEL IN IMPROVING THE FORECASTING OF AIRCRAFT ICING
P. A. HAINES (Purdue University, West Lafayette, IN), J. K. LUERS, and C. A. CERBUS (Dayton Research Institute, OH) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 258-263. refs
Copyright
Icing parameters from the updated Smith-Feddes model (Rogers et al., 1985) are compared with observational data to study the use of the model in forecasts of aircraft icing conditions. The model is reviewed and the process of validating the model using the FAA/NRL data base. The values of liquid water content, temperature, and mean volume drop observed by particle spectrometers and the Johnson-Williams meter are compared with values calculated by the model. It is found that, when accurate cloud information is available, the Smith-Feddes model exhibits skill in diagnosing vertical profiles of cloud liquid water. R.B.

A89-54838
SEVERE AIRCRAFT ICING EVENTS - A COLORADO CASE STUDY
DAVID BERNHARDT and LEON F. OSBORNE, JR. (North Dakota, University, Grand Forks) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 327-330.
(Contract DTFA01-87-C-00019)
Copyright
A large-scale icing event that took place on January 31 and February 1, 1988 over eastern Colorado is described together with the results of the analysis of Doppler radar data collected during the event. The analysis of atmospheric conditions showed that the pattern of westerly flow across the Rocky Mountains at midlevels with a cold dome of surface air over the Central Plains provided an upslope scenario conducive to continual conditions of supercooled liquid water in a low stratus deck, the presence of which was maintained for extended periods without significant reduction by glaciation. It is emphasized that, when an aircraft must remain within the confines of this layer of supercooled liquid water, the aircraft hazards are magnified; the use of radar detection during these times becomes extremely difficult due to the lack of significant backscatters. I.S.

N89-28507# National Transportation Safety Board, Washington, DC. Bureau of Field Operations.
AIRCRAFT ACCIDENT/INCIDENT SUMMARY REPORTS: BELLEVILLE, ILLINOIS, AUGUST 22, 1987; PENSACOLA, FLORIDA, DECEMBER 27, 1987
30 Jun. 1989 25 p
(PB89-910405; NTSB/AAR-89/02/SUM) Avail: NTIS HC A03/MF A01 CSCL 01/3
Two separate aircraft accidents investigated by the National Transportation Safety Board are compiled. The accident locations and their dates are as follows: Belleville, Illinois, August 22, 1987; and Pensacola, Florida, December 27, 1987. Author

N89-28508# Technische Univ., Berlin (Germany, F.R.). Wirtschaftswissenschaftliche Dokumentation.
COMPETITION AND SAFETY IN AIR TRAFFIC Thesis [WETTBEWERB UND SICHERHEIT IM LUFTVERKEHR]
MATTHIAS-WOLFGANG STOETZER 1988 50 p In GERMAN; ENGLISH summary
(TUB-DISS-PAPER-128; ETN-89-94421) Avail: NTIS HC A04/MF A01
The relations between competition and safety in the air transportion market are investigated. The allegation that competition in the air transportion market necessarily results in a deterioration of flight safety is examined on theoretical grounds. Existing studies of the relationship of safety and competition in flight transportation are summarized. The development of flight safety in the USA before and after the Airline Deregulation Act of 1978 is analyzed. Theoretical reasoning and the empirical confirmation lead to the conclusion that economic regulation is not inevitable in order to secure a high level of safety in air transportion. The maintaining or the regulation of technical standards is advised. ESA

N89-29332# RJO Enterprises, Inc., Lanham, MD.
ACCIDENT/INCIDENT DATA ANALYSIS DATABASE SUMMARIES, VOLUME 1 Final Report
T. P. MURPHY and R. J. LEVENDOSKI Mar. 1989 193 p
(DOT/FAA/DS-89/17-1) Avail: NTIS HC A01/MF A01
This two volume report provides a compendium of the existence, availability, limitations, and applicability of aviation accident and incident databases for use in human factors research. An aviation and data processing oriented form was used to survey 41 U.S. Government, military, aircraft manufacturers, airlines, special interest groups, and international aviation safety database sources. The compendium in Volume 1 presents information about 34 aviation safety databases. Recommendations include a feasibility study of a combined master aviation safety database, the convening

of a task force to standardize human factors terminology and data collection, the establishment of a limited immunity program to facilitate the flow of air carrier incident data, and a more vigorous effort to present available aviation safety information to pilots. Appendices are contained in Volume 2 to provide detailed information about database collection forms, data structures, and human factors information within the database. Author

N89-29333# RJO Enterprises, Inc., Lanham, MD.
ACCIDENT/INCIDENT DATA ANALYSIS DATABASE SUMMARIES, VOLUME 2 Final Report
T. P. MURPHY and R. J. LEVENDOSKI Mar. 1989 281 p
(DOT/FAA/DS-89/17-2) Avail: NTIS HC A13/MF A01

This two volume report provides a compendium of the existence, availability, limitations, and applicability of aviation accident and incident databases for use in human factors research. An aviation and data processing oriented form was used to survey 41 U.S. Government, military, aircraft manufacturers, airlines, special interest groups, and international aviation safety database sources. The compendium in Volume 1 presents information about 34 aviation safety databases. Recommendations include a feasibility study of a combined master aviation safety database, the convening of a task force to standardize human factors terminology and data collection, the establishment of a limited immunity program to facilitate the flow of air carrier incident data, and a more vigorous effort to present available aviation safety information to pilots. Appendices are contained in Volume 2 to provide detailed information about database colletion forms, data structures, and human factors information within the database. Author

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

A89-51716#
IMPROVED GUIDANCE LAW DESIGN BASED ON THE MIXED-STRATEGY CONCEPT
J. SHINAR (Technion - Israel Institute of Technology, Haifa) and I. FORTE Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 12, Oct. 1989, p. 739-745. Previously cited in issue 22, p. 3533, Accession no. A87-50469. refs
(Contract AF-AFOSR-86-0355)
Copyright

A89-52590#
DEVELOPMENT AND FLIGHT EVALUATION OF AN INTEGRATED GPS/INS NAVIGATION SYSTEM
WILMER A. MICKELSON and MATTHEW J. CARRICO (Rockwell International Corp., Collins Government Avionics Div., Cedar Rapids, IA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 618-627. refs
(AIAA PAPER 89-3498) Copyright

A low-cost strapdown IMU and a single channel P-code GPS receiver are integrated to provide an accurate navigation solution with in-flight IMU calibration and alignment capability. The tightly coupled integration uses INS velocity to aid GPS acquisition and tracking while the GPS measurements are used to estimate IMU errors. A data decoupling technique is described which allows separate GPS and INS Kalman filters to operate independently on the satellite line-of-sight pseudorange and delta-range measurements. The system provides modularity and reversionary modes to GPS-alone of IMU-alone navigation by using separate hardware for the GPS receiver and INS computer. The GPS receiver also uses baro altimeter data to extend its operation during periods of fewer than four SV coverage. Flight test data from the Yuma Proving Ground laser test range is presented. The test results demonstrate the expected navigation accuracy and transfer alignment capabilities. Author

A89-52591#
GLOBAL POSITIONING SYSTEM ACCURACY IMPROVEMENT USING RIDGE REGRESSION
R. J. KELLY (Allied-Signal Aerospace Co., Bendix Communications Div., Baltimore, MD) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 628-638. refs
(AIAA PAPER 89-3499) Copyright

A method for reducing the effects of the geometric dilution of position in GPS navigation system is proposed which is based on the incorporation of the Ridge regression into the GPS receiver signal processor. A computer simulation confirms the theoretical prediction that bias and variance inflation caused by the geometric dilution of position can be measurably reduced through the use of the Ridge regression algorithm. The technique proposed here can be applied to any position-fix navigation. V.L.

A89-52592*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PASSIVE NAVIGATION USING IMAGE IRRADIANCE TRACKING
P. K. A. MENON and B. SRIDHAR (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 639-646. refs
(Contract NAG2-463)
(AIAA PAPER 89-3500) Copyright

Rotorcraft operating at low altitudes require navigational schemes for locating the terrain and obstacles. Due to the covert nature of missions to be accomplished, a passive navigation scheme is desirable. This paper describes the development of a passive navigation scheme combining image sequences from a vehicle mounted camera with vehicle motion variables. Geometric properties of perspective projection together with an image irradiance tracking scheme at each pixel are used to determine the range to various objects within the field-of-view. Derivation of the numerical algorithm and simulation results are given. Other applications of the proposed approach include navigation for autonomous planetary rovers and telerobots. Author

A89-52594*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
FLIGHT-TEST EVALUATION OF CIVIL HELICOPTER TERMINAL APPROACH OPERATIONS USING DIFFERENTIAL GPS
F. G. EDWARDS and D. M. HEGARTY (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 657-666. refs
(AIAA PAPER 89-3635) Copyright

A civil code differential Global Positioning System (DGPS) has been developed and flight-tested by the NASA Ames Research Center. The system was used to evaluate the performance of the DGPS for support of helicopter terminal approach operations. The airborne component of the DGPS was installed in a NASA helicopter. The ground-reference component was installed in a mobile van and equipped with a real-time VHF telemetry data link to transmit correction information to the aircraft system. An extensive series of tests was conducted to evaluate the performance of the system for several different configurations of the airborne navigation filter. This paper will describe the systems, the results of the flight tests, and the results of the posttest analysis. Author

A89-52663*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
OBSERVABILITY STUDIES OF INERTIAL NAVIGATION SYSTEMS
I. Y. BAR-ITZHACK (NASA, Goddard Space Flight Center, Greenbelt, MD; Technion - Israel Institute of Technology, Haifa) and D. GOSHEN-MESKIN IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1283-1289. refs
(AIAA PAPER 89-3580) Copyright
The present work deals with an undamped three-channel inertial-navigation-system error model. It is shown that it is possible to fully observe, and thus estimate, all the states of the system. This is in contrast to a previous two-channel system, in which it was impossible to fully observe and estimate all the states of the system. The conclusions of the analysis are verified through covariance simulation, which yields identical results. Author

A89-52699*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CONTROLLER EVALUATIONS OF THE DESCENT ADVISOR AUTOMATION AID
LEONARD TOBIAS, UWE VOLCKERS, and HEINZ ERZBERGER (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1609-1618. Previously announced in STAR as N89-25981. refs
(AIAA PAPER 89-3624) Copyright
An automation aid to assist air traffic controllers in efficiently spacing traffic and meeting arrival times at a fix has been developed at NASA Ames Research Center. The automation aid, referred to as the descent advisor (DA), is based on accurate models of aircraft performance and weather conditions. The DA generates suggested clearances, including both top-of-descent point and speed profile data, for one or more aircraft in order to achieve specific time or distance separation objectives. The DA algorithm is interfaced with a mouse-based, menu-driven controller display that allows the air traffic controller to interactively use its accurate predictive capability to resolve conflicts and issue advisories to arrival aircraft. This paper focuses on operational issues concerning the utilization of the DA, specifically, how the DA can be used for prediction, intrail spacing, and metering. In order to evaluate the DA, a real time simulation was conducted using both current and retired controller subjects. Controllers operated in teams of two, as they do in the present environment; issues of training and team interaction will be discussed. Evaluations by controllers indicated considerable enthusiasm for the DA aid, and provided specific recommendations for using the tool effectively. Author

A89-52700*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PILOTED SIMULATION OF A GROUND-BASED TIME-CONTROL CONCEPT FOR AIR TRAFFIC CONTROL
THOMAS J. DAVIS and STEVEN M. GREEN (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1619-1625.
(AIAA PAPER 89-3625) Copyright
A joint simulation was carried out using a piloted simulator and an advanced-concept air traffic control simulation to study the acceptability and accuracy of the ground-based four-dimensional descent advisor (DA), an automation aid based on accurate models of aircraft performance and weather conditions. In the piloted simulation, airline crews executed controller-issued descent advisories along standard curved-path arrival routes and were able to achieve an arrival-time precision of plus or minus 20 s at the metering fix. An analysis of errors generated in turns resulted in a further enhancement of the DA algorithm. V.L.

A89-52701#
A MODEL OF THE NATIONAL AIRSPACE SYSTEM
MICHAEL J. WHITE (Mitre Corp., Bedford, MA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1626-1634.
(AIAA PAPER 89-3626) Copyright
A project is described in which the tools of operations research are applied to the analysis of the performance of the National Airspace System (NAS) in the face of changes in airport and airspace capacity and demand. Computer models created and used by the project team in predicting NAS performance under various conditions of capacity and demand are described, and examples of their performance metrics and outputs are shown. Author

A89-52702#
GROUND-HOLDING STRATEGIES FOR ATC FLOW CONTROL
MOSTAFA TERRAB, AMEDEO R. ODONI (MIT, Cambridge, MA), and OWEN L. DEUTSCH (Charles Stark Draper Laboratory, Inc., Cambridge, MA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1635-1646. refs
(AIAA PAPER 89-3628) Copyright
One of the most important functions of any air traffic management system is the assignment of 'ground-holding' times to flights, i.e., the determination of whether and by how much the take-off of a particular aircraft headed for a congested part of the ATC system should be postponed in order to reduce the likelihood and extent of airborne delays. An analysis is presented of the fundamental case in which flights from many destinations must be scheduled for arrival at a single congested airport. A set of approaches for addressing a deterministic and stochastic version of this problem is described. Optimal solution approaches include minimum cost flow algorithms and dynamic programming. Under a particular natural assumption regarding the functional form of delay, a very efficient algorithm can be used. This algorithm is also useful in addressing heuristically the stochastic version of the problem. Author

A89-52703#
AIRCRAFT TRAJECTORY PREDICTION FOR TERMINAL AUTOMATION
JAMES L. STURDY, JOHN W. ANDREWS, and JERRY D. WELCH (MIT, Lexington, MA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1647-1652. Research sponsored by FAA. refs
(AIAA PAPER 89-3634) Copyright
As part of the Terminal Air Traffic Control Automation (TATCA) program, equations and aircraft performance models have been integrated into a unified framework to support automation assistance over all phases of aircraft flight. The integrated set of mode-based aircraft trajectory-prediction algorithms is shown to deliver the accuracy required to support automated terminal planning while simultaneously achieving computational efficiency required to allow implementation on workstation or mini computers. V.L.

A89-52721#
OPERATIONAL EXPERIENCE WITH THE COMPUTER ORIENTED METERING PLANNING AND ADVISORY SYSTEM (COMPAS) AT FRANKFURT, GERMANY
UWE VOELCKERS and HANS-DIETER SCHENK (DLR, Institut fuer Flugfuehrung, Brunswick, Federal Republic of Germany) AIAA, Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989. 8 p. refs
(AIAA PAPER 89-3627) Copyright
The current status of a project to develop an operational COMPAS (Computer-Oriented Metering, Planning, and Advisory System) is reviewed. COMPAS is a computer-controlled planning system which helps the ATC controller to plan and control more

efficiently the inbound flow of air traffic in the airport terminal control area. The experimental and operational COMPAS are briefly compared, and the technical concept of the operational COMPAS is described. The technical realization of COMPAS is addressed, including the interface computer, main computer, display station computer, and network communication. The software development, mechanical construction, and system tests are briefly considered. C.D.

A89-52779
PRECISION CHARACTERISTICS OF A COORDINATE DEVICE FOR ESTIMATING THE VELOCITY OF AN OBJECT [TOCHNOSTNYE KHARAKTERISTIKI KOORDINATNOGO USTROISTVA OTSENKI SKOROSTI OB'EKTA]
A. A. ELISEEV, A. V. POKROVSKII, V. G. FARAFONOV, and G. G. GETMANENKO (Leningradskii Institut Aviatsionnogo Priborostroeniia, Leningrad, USSR) Priborostroenie (ISSN 0021-3454), vol. 32, July 1989, p. 10-14. In Russian. refs
Copyright
An analysis is made of numerical differentiation errors associated with calculations of the distance to an object based on the coordinate method of velocity estimation. The calculations are carried out under the assumption that the current distance function can be represented as a sum of regular and random components. An analysis is carried out for four approximations of the envelope of the spectral density of random component fluctuations of the distance parameter of interest. V.L.

A89-53484
OUT-OF-BAND RESPONSE OF VHF/UHF AIRBORNE ANTENNAE
ELYA B. JOFFE (K. T. M. Project Engineering, Ltd., Kfar-Sava, Israel) IN: IEEE 1989 National Symposium on Electromagnetic Compatibility, Denver, CO, May 23-25, 1989, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1989, p. 196-201. refs
Copyright
A method for measuring the response of antennas below band is presented that is reliable, repeatable, and simulates to a high level of confidence plane-wave conditions-the actual propagation mode that all airborne communication/navigation (COMM/NAV) antennas sense from most ground emitters and broadcast stations. The method has shown that the gain of most airborne COMM/NAV antennas is approximately -60 dBi, in the higher frequency range, to -120 dBi, in the lower frequency range, depending on the antenna. The VHF Whip antenna presents higher gain, due to its mechanical dimensions. I.E.

A89-53660#
THE LOCSTAR RADIODETERMINATION SATELLITE SYSTEM
RENAUD REGIS (Locstar, S.A., France) Ortung und Navigation (ISSN 0474-7550), vol. 30, no. 2, 1989, p. 259-267.
The design and current status of the Locstar commercial RDSS system are reviewed. Locstar is intended to provide radio location service with accuracy 100 m, radio navigation service, and limited-length (100 characters) alphanumeric message service to users in Europe, Africa, and the Middle East. The planned Locstar network comprises two or three GEO satellites with transceivers; a central ground segment with ground connection stations, satellite control station, position-computation and message-processing facilities, and a data-distribution network; and mobile user terminals. The development schedule calls for service to Western Europe (using one satellite) beginning in 1991. The many potential applications of the Locstar RDSS are discussed and illustrated with diagrams. T.K.

A89-53663#
MLS 1989 - STATUS REPORT FROM THE PERSPECTIVE OF THE AIRLINE COMPANIES [MLS 1989 - STANDORTBESTIMMUNG AUS DER SICHT DER LUFTVERKEHRSGESELLSCHAFTEN]
JENS-UWE KOCH (Deutsche Lufthansa AG, Frankfurt am Main, Federal Republic of Germany) Ortung und Navigation (ISSN 0474-7550), vol. 30, no. 2, 1989, p. 326-332. In German.
The current implementation status of the precision microwave approach and landing system MLS is assessed, with a focus on European developments. Consideration is given to European ILS-MLS transition planning, the installation of new onboard equipment (including some numerical data for Lufthansa), the claimed advantages of MLS, and critical opinions voiced by industry spokesmen. It is concluded that MLS does offer significant advantages and that the current European requirements (as formulated in IMTEG/7) allow enough freedom with regard to hardware purchases for the companies to react to the final ICAO decision (to be taken in 1992) and/or the results of ongoing FAA studies on the MLS use categories. T.K.

A89-53969
AIR TRAFFIC CONTROL SYSTEM - CAN WE CLOSE THE CONTROL LOOP?
ANDREW J. KORNECKI (Embry Riddle Aeronautical University, Daytona Beach, FL) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 1. New York, Institute of Electrical and Electronics Engineers, 1989, p. 310, 311. Research supported by the Florida High Technology/Industrial Council.
Copyright
The air traffic control (ATC) system is analyzed from the control engineering viewpoint. Despite the human operator in the loop, ATC represents a conventional, multidimensional control system. The system observability and controllability can be analyzed. A control performance index representing safety, accuracy, and fuel consumption is introduced. The author presents the concept of using an expert system as an automatic controller and outlines the ATC knowledge-domain representation. The implementation of such an expert controller is discussed. I.E.

A89-54082* National Aeronautics and Space Administration. *Ames Research Center, Moffett Field, CA.*
ROTORCRAFT DECELERATION TO HOVER USING IMAGE-BASED GUIDANCE
BANAVAR SRIDHAR (NASA, Ames Research Center, Moffett Field, CA) and ANIL V. PHATAK (Analytical Mechanics Associates, Mountain View, CA) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 3. New York, Institute of Electrical and Electronics Engineers, 1989, p. 2459, 2460. refs
Copyright
Rotorcraft operating in hostile environment fly at low altitudes to minimize exposure to the defensive weapons arrayed against them. The development of intelligent guidance commands at low altitudes requires the integration of conventional guidance with the information provided by the sensor on relative position between the vehicle and local terrain or obstacles. Deceleration to hover (DTH) is one of the common maneuvers executed by a rotorcraft. The authors describe the integration of DTH guidance logic with an image-based scheme to estimate the hover point. The performance of such a system is affected by parameters of the guidance and by navigation and image processing algorithms. Results are presented on the effect of the parameters on system performance. I.E.

A89-54083* National Aeronautics and Space Administration. *Ames Research Center, Moffett Field, CA.*
INTEGRATION OF ACTIVE AND PASSIVE SENSORS FOR OBSTACLE AVOIDANCE
VICTOR H. L. CHENG and BANAVAR SRIDHAR (NASA, Ames Research Center, Moffett Field, CA) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 3. New York, Institute of Electrical and Electronics Engineers, 1989, p. 2461-2468. refs
Copyright
The automatic obstacle-avoidance guidance problem is studied under the operational constraints imposed by the rotorcraft nap-of-the-earth (NOE) environment. The problem is discussed for

two different circumstances. The first assumes that a full range map is available, irrespective of the type of sensor being used. Two approaches are proposed to extend a two-dimensional obstacle-avoidance concept presented by Cheng (1988). The situation where only a sparse range map is available from a passive sensor is also treated. An integrated approach that augments the passive sensor with an active one is discussed, along with the problem of data fusion and how it is affected by the characteristics of NOE flight. I.E.

A89-54366
INTERFACING HYPERSONIC AIRCRAFT IN THE NATIONAL AIRSPACE SYSTEM
TIMOTHY J. LAEL (North Dakota, University, Grand Forks) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 409-417.
Copyright

The relationships between hypersonic aircraft and the National Airspace System and air traffic control are discussed. The National Airspace System is described, including airport and air traffic control facilities. Consideration is given to the possible expansion of air traffic control zones to incorporate microwave landing system approach areas, the creation of specific hypersonic arrival and departure corridors, and the implementation of a hypersonic transition area for arriving and departing LEO-tracking airspace jurisdiction. It is suggested that the current National Airspace System could accommodate hypersonic aircraft with few alterations. Recommendations are made for facilitating the introduction of hypersonic aircraft. R.B.

A89-54859
DATA LINK PROCESSOR (DLP), PILOT ACCESS TO WEATHER DATA
PAVEL KLEIN (Stanford Telecommunications, Inc., Reston, VA) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 430-432.
Copyright

The development of the Data Link Processor (DLP) to provide pilots with direct access to current weather products is discussed. The requirements, functions, and performance of the DLP systems are outlined. The operation of the system is described, including interfaces, product handling, and system hardware. The schedule for implementing the system and for proposed expansions to the system is presented. R.B.

N89-28509# Mitre Corp., McLean, VA.
COLLISION AVOIDANCE OPERATIONAL CONCEPT Final Report
MEERA SHARMA Jun. 1989 33 p
(Contract DTFA01-89-C-00001)
(WP-88W00418; NAS-SR-1325; DOT/FAA/DS-89/27) Avail: NTIS HC A03/MF A01

An operational concept is presented for collision avoidance services which will be in place upon implementation of the Federal Aviation Administration (FAA) National Airspace System (NAS) Plan. This operational concept only discusses the ground-base portion of how the Air Traffic Control System (ATCS) provides flight safety by maintaining adequate aircraft separation. This concept discusses the aircraft separation assurance per the National Airspace System Requirement Specification (NASSRS). The objective is to describe the relationship among subsystems, facilities, information, and operators/users involved in the collision avoidance service. In addition, the elements and operations of the NAS Plan are mapped into the collision avoidance requirements stated in the NASSRS, NAS-SR-1000. Several types of block diagrams are used to illusrate systems connectively and operational flow. Scenarios are also derived to describe the collision avoidance process from a user's perspective. Author

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A89-51701*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
PARAMETER ESTIMATION FOR FLIGHT VEHICLES
KENNETH W. ILIFF (NASA, Flight Research Center, Edwards, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 12, Sept.-Oct. 1989, p. 609-622. Previously cited in issue 08, p. 1049, Accession no. A87-22745. refs
Copyright

A89-51703*# Georgia Inst. of Tech., Atlanta.
STUDY OF AIRCRAFT CRUISE
P. K. A. MENON (Georgia Institute of Technology, Atlanta) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 12, Sept.-Oct. 1989, p. 631-639. Previously cited in issue 23, p. 3399, Accession no. A86-47704. refs
(Contract NAS2-11978)
Copyright

A89-51898
ULTRA HIGH BYPASS AIRCRAFT SONIC FATIGUE
DANIEL R. LORCH (Douglas Aircraft Co., Long Beach, CA) (Institute of Environmental Sciences, Annual Meeting, Anaheim, CA, May 3-5, 1989) Journal of Environmental Sciences (ISSN 0022-0906), vol. 32, July-Aug. 1989, p. 26-34. refs
Copyright

The development of a sonic fatigue treatment design of the ultra high bypass (UHB) engine for the MD-80 aircraft using high intensity noise testing and analysis is examined. Aircraft components are evaluated using progressive wave tube and shaker table tests to determine dammping, structural response, and sonic fatigue life. The testing of various sonic fatigue treatment designs on the UHB demonstrator aircraft is discussed. It is noted that lightweight and inexpensive treatments that protect against sonic fatigue can be developed. I.F.

A89-52041
A COUPLED ROTOR AEROELASTIC ANALYSIS UTILIZING NONLINEAR AERODYNAMICS AND REFINED WAKE MODELING
MICHAEL S. TOROK and INDERJIT CHOPRA (Maryland, University, College Park) (European Rotorcraft Forum, 14th, Milan, Italy, Sept. 20-23, 1988) Vertica (ISSN 0360-5450), vol. 13, no. 2, 1989, p. 87-106. refs
(Contract DAAL03-88-C-0002)
Copyright

The effects of improved aerodynamic modeling on rotor blade section and root loads, and blade response, are investigated. A nonlinear aerodynamic model based on an indicial method, is incorporated into a coupled rotor aeroelastic analysis. The aerodynamic analysis consists of three phases: a linear attached flow solution, a separated flow solution, and a dynamic stall solution. A prescribed and a free wake model are also included into the analysis. Blade responses and loadings are calculated using a finite element formulation in space and time. A modified Newton iterative method is used to calculate blade response and trim controls as one coupled solution. Results show that at high speed flight conditions, nonlinear effects dominate blade section forces, and significantly affect peak-to-peak values and the harmonic content of blade root loads. These effects are amplified at higher thrust conditions. Compressibility effects and blade twist considerably influence the extent of separated flow on the rotor disk. Free and prescribed wakes give similar results at a high speed flight condition. Author

A89-52042 Florida Atlantic Univ., Boca Raton.
PREDICTION OF INPLANE DAMPING FROM DETERMINISTIC AND STOCHASTIC MODELS
GOPAL H. GAONKAR, C. S. NAGARAJ (Florida Atlantic University, Boca Raton), and J. NAGABHUSHANAM (Indian Institute of Science, Bangalore, India) Vertica (ISSN 0360-5450), vol. 13, no. 2, 1989, p. 143-158. Research supported by the U.S. Army and NASA. refs
Copyright
This paper reviews computational reliability, computer algebra, stochastic stability and rotating frame turbulence (RFT) in the context of predicting the blade inplane mode stability, a mode which is at best weakly damped. Computational reliability can be built into routine Floquet analysis involving trim analysis and eigenanalysis, and a highly portable special purpose processor restricted to rotorcraft dynamics analysis is found to be more economical than a multipurpose processor. While the RFT effects are dominant in turbulence modeling, the finding that turbulence stabilizes the inplane mode is based on the assumption that turbulence is white noise. The relaxation of this assumption to include RFT effects merits further research. Author

A89-52044
FINITE ELEMENT BASED MODAL ANALYSIS OF HELICOPTER ROTOR BLADES
O. A. BAUCHAU and S. P. LIU (Rensselaer Polytechnic Institute, Troy, NY) Vertica (ISSN 0360-5450), vol. 13, no. 2, 1989, p. 197-206. refs
(Contract DAAG29-82-K-0093)
Copyright
A finite element formulation for arbitrarily large displacements and rotations of a naturally curved and twisted composite rotor blade including transverse shearing and torsion related warping deformations is presented. The formulation is based on Reissner's principle, and Euler parameters are used to represent the finite rotations. The resulting governing equations are shown to contain simple algebraic nonlinearities only, of the cubic order. Such a formulation is ideally suited for a modal approximation of the problem since no additional assumption is required to accommodate the modal representation. The concept of perturbation is introduced and shown to yield an extremely efficient and accurate solution procedure. Numerical examples show an excellent agreement between modal representation and full finite element solutions for both static and dynamic problems. C.E.

A89-52201
AT3 DEMONSTRATES FEASIBILITY OF CARGO STOL WITH LONG RANGE
WILLIAM B. SCOTT Aviation Week and Space Technology (ISSN 0005-2175), vol. 131, Sept. 4, 1989, p. 38-40, 45, 48, 49.
Copyright
An account is given of the design features and performance capabilities of the 62-percent scale proof-of-concept/flight test model of DARPA's Advanced Technology Tactical Transport (AT3) aircraft. The twin engine boom/tandem wing configuration of the AT3 has been shown to furnish the intended combination of STOL performance with extremely long range capability and high payload capacity. DARPA intends to continue the program by defining military requirements for a stealthy special-operations full-scale version of the AT3. The 'trimaran' configuration of the longitudinal structures linking the lifting surfaces of the AT3 is derived from the circumnavigation-range Rutan Voyager aircraft. O.C.

A89-52514
MI-28 HAVOC IS STILL TOMORROW'S TANK-BUSTER
MARK LAMBERT Interavia (ISSN 0020-5168), vol. 44, Aug. 1989, p. 802-805.
Copyright
A design-features exploration and performance capability evaluation is presented for the Mi-28 antiarmor helicopter designated 'Havoc' by NATO. Crew survival is noted to have been given high design-priority as a result of experience with the Mi-24 in Afghanistan; composite armor accordingly surrounds the crew below the window line. Armament consists of a 30-mm turret-mounted Gatling-action cannon, 20-tube pods of unguided rockets, and 'eight-packs' of AT-6 'Spiral' radio-guided antitank missiles. An export version of the Havoc is expected to be marketed. O.C.

A89-52525
GLAZING INTO THE FUTURE
Flight International (ISSN 0015-3710), vol. 136, Aug. 19, 1989, p. 33, 34.
Copyright
An account is given of the development status of novel aircraft cockpit transparency technologies. A transparency coating with 'memory' characteristics has been devised which is able to recover its original smooth surface after minor impact damage; another canopy material is undergoing development which darkens or lightens in response to a small voltage (which can be indefinitely sustained) in order to control radiant heat and glare. Also undergoing refinement are exotic films of Ag and Au for the reflection of EM interference used by enemy forces to affect the operation of military avionics, and ultrafine Cu grids furnishing protection from nuclear blast-generated EMP. O.C.

A89-52693*# Cincinnati Univ., OH.
PARALLEL DYNAMIC PROGRAMMING FOR ON-LINE FLIGHT PATH OPTIMIZATION
G. L. SLATER and K. HU (Cincinnati, University, OH) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1553-1559. refs
(Contract NAG2-175)
(AIAA PAPER 89-3615) Copyright
Parallel systolic algorithms for dynamic programming(DP) and their respective hardware implementations are presented for a problem in on-line trajectory optimization. The method is applied to a model for helicopter flight path optimization through a complex constraint region. This problem has application to an air traffic control problem and also to a terrain following/threat avoidance problem. Author

A89-52712*# Massachusetts Inst. of Tech., Cambridge.
HIGH PERFORMANCE LINEAR-QUADRATIC AND H-INFINITY DESIGNS FOR A 'SUPERMANEUVERABLE' AIRCRAFT
PETROS VOULGARIS and LENA VALAVANI (MIT, Cambridge, MA) AIAA, Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989. 10 p. refs
(Contract F08635-87-K-0031; NAG2-297)
(AIAA PAPER 89-3456) Copyright
Recent efforts by the National Aeronautics and Space Administration Langley Research Center have focused on expanding the flight envelope of the F/A-18 aircraft. Of particular concern has been the low speed, high angle-of-attack regime over which the conventional aerodynamic controls of the F/A-18 lose their effectiveness. In order to address this problem the F18 high alpha research vehicle was developed. This aircraft is essentially a modified F/A-18 which possesses thrust vectoring capabilities and hence increased maneuverability in this flight regime. The linear-quadratic-Gaussian with loop-transfer-recovery and H(infinity) design methodologies are used to design high performance controllers for the F18 at an operating point within the expanded envelope. In addition, how the control redundancy of the F18 can be used to maintain nominal performance, as well as nominal stability, in situations where failures occur, is shown. Author

A89-52959
SOME ASPECTS OF AIRCRAFT DYNAMIC LOADS DUE TO FLOW SEPARATION
D. G. MABEY (Royal Aerospace Establishment, Aerodynamics Dept., Bedford, England) Progress in Aerospace Sciences (ISSN 0376-0421), vol. 26, no. 2, 1989, p. 115-151. refs
Copyright
Topics discussed in this paper include the need for consistent

definitions of buffet and buffeting, the advantages of a consistent notation, buffeting due to wings and other components, the alleviation of buffeting, the special difficulties of flight tests and the special advantages of buffeting measurements in cryogenic wind-tunnels. Single degree of freedom flutter due to flow separation is not discussed, but may contribute significant dynamic loads. Author

A89-53255#

HEAT TRANSFER CHARACTERISTICS OF AN AERO-ENGINE INTAKE FITTED WITH A HOT AIR JET IMPINGEMENT ANTI-ICING SYSTEM

S. J. DOWNS (Rolls-Royce, PLC, Derby, England) and E. H. JAMES (Loughborough University of Technology, England) IN: ASME 1988 National Heat Transfer Conference, Houston, TX, July 24-27, 1988, Proceedings. Volume 1. New York, American Society of Mechanical Engineers, 1988, p. 163-170. refs

Copyright

Aircraft leading edges are commonly protected from potentially hazardous ice build-up by means of thermal anti-icing systems. Investigations have been carried out into the heat transfer characteristics of a typical aero-engine intake fitted with a jet impingement hot air anti-icing system to improve modeling techniques and thus facilitate optimization of this type of system. The results of experimental investigations into the internal lipskin heat transfer characteristics, a re-assessment of external heat transfer, conduction effects and a simple freezing option for areas of lipskin falling below zero degrees centigrade have been used to refine a computer thermal model. Proposed changes to modeling techniques are validated by reference to temperatures recorded during flight testing in dry air and in natural and simulated icing conditions. The resultant prediction capability in terms of skin temperature levels and residual ice quantities is satisfactory. Author

A89-53308#

EUROFAR - PROJECT FOR A PERPENDICULARLY LAUNCHED CRUISING AIRCRAFT [EUROFAR - PROJEKT FUER EIN SENKRECHT STARTENDES REISEFLUGZEUG]

R. D. VON RETH, U. HAGMANN, and H. HUBER (Messerschmitt-Boelkow-Blohm GmbH, Ottobrunn, Federal Republic of Germany) DGLR and ASI, Symposium ueber Luftfahrt-Staedtebau-Umwelt, Essen, Federal Republic of Germany, Jan. 17, 18, 1989, Paper. 38 p. In German.

(MBB-UD-538-88-PUB)

The operational characteristics and possible applications of the EUROFAR (European Future Advanced Rotorcraft) project are discussed. The flight profile, noise level, and safety of the aircraft are briefly examined, and the launch area and infrastructure required by it are addressed. The civil uses of the aircraft are discussed, and its cost aspects and future outlook are considered. C.D.

A89-53630

MDX - A HELICOPTER DESIGNED BY ITS USERS

JAMES H. BRAHNEY Aerospace Engineering (ISSN 0736-2536), vol. 9, Sept. 1989, p. 23-25.

Copyright

The MDX helicopter, which will incorporate the latest technologies and a wide range of user inputs to become the first new light helicopter of the 1990s, is discussed. The role of the users in the design of the aircraft is described. The main design features of the helicopter and its components are presented, giving data. C.D.

A89-53631

HISTORY OF THE AIRFRAME. III

TOM RHODES Aerospace Engineering (ISSN 0736-2536), vol. 9, Sept. 1989, p. 27-32.

Copyright

The history of the all-wood Mosquito aircraft is described. The development of wood aircraft in the 1930s is reviewed, including the Comet, Albatross, and Vega aircraft. The advances in airframe construction that these aircraft represented are pointed out. The fuselage and wing construction of the Mosquito are then described, and the characteristics of its performance that gave it a significant role in the Second World War are discussed. C.D.

A89-53641

A NEW HYBRID AIRSHIP ('HELISHIP') FOR COMMUTER TRANSPORT

SHIGENORI ANDO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 37, no. 426, 1989, p. 344-351. In Japanese, with abstract in English. refs

Copyright

As commuter air-transport vehicles to be used over both land- and water-surfaces, hybrid-airship has been noticed recently. The best one seems to be a hybrid between airship and helicopter. It relieves the serious defects before hybridization, significantly. The development of 'Helistat' is now substantially stopped, mainly because of catastrophic vibration problem. Presented here is named 'Heliship' which is a combination of a tandem-roter helicopter (at center) and two airship (both sides). Failure of one engine is less severe than the Helistat. Insufficient roll-control power at hover would be overcome through appropriate operating procedure. Author

A89-54006

AN INTEGRATED CONFIGURATION AND CONTROL ANALYSIS TECHNIQUE FOR HYPERSONIC VEHICLES

NEIL J. ADAMS and PHILLIP D. HATTIS (Charles Stark Draper Laboratory, Inc., Cambridge, MA) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 2. New York, Institute of Electrical and Electronics Engineers, 1989, p. 1105-1110. refs

Copyright

A design analysis methodology for hypersonic vehicles that treats the vehicle configuration and trajectory simultaneously is described. Vehicle geometry, dynamic discontinuities, and time-dependent control variables are all treated as optimization parameters with respect to a single performance measure. A generalized first-order gradient method is used to affect changes in the optimization variables to minimize a performance or cost measure. This is done while maintaining prescribed two-point boundary conditions and any path constraints imposed on the problem. The current research status and projected benefits of these activities are discussed. I.E.

A89-54066

AN UNCERTAINTY MODEL FOR SATURATED ACTUATORS

MARK R. ANDERSON (Systems Control Technology, Inc., Palo Alto, CA) and DAVID K. SCHMIDT (Arizona State University, Tempe) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 3. New York, Institute of Electrical and Electronics Engineers, 1989, p. 2257-2262. refs

Copyright

An uncertainty model for saturated actuators is reported. The model includes linear as well as quasi-linear elements, the latter being used to model the effects of rate and deflection limiting within the actuator. Since the actuator uncertainty model is quasi-linear, the magnitudes of the signals within the actuator model must be known. Linear and nonlinear simulations are considered for determining the actuator signal magnitudes. An actuator uncertainty model is then obtained for a forward-swept-wing fighter aircraft model. The example demonstrates how actuator saturation uncertainty can affect stability and performance robustness of a flight control system. I.E.

A89-54200#

HIGH ALTITUDE RECONNAISSANCE AIRCRAFT DESIGN

D. POLADIAN and D. J. REINHARD AIAA, AHS, and ASEE, Aircraft Design, Systems and Operations Conference, Seattle, WA, July 31-Aug. 2, 1989. 13 p. refs

(AIAA PAPER 89-2109) Copyright

A Universities Space Research Association (USRA) sponsored (undergraduate) study is presented on the feasibility and design of a high altitude reconnaissance/research aircraft. The aircraft mission was to carry 1,000 - 3,000 ponds of atmospheric pollutant monitoring equipment for 1-5 hours at an altitude of 100,000 - 130,000 feet. Three configurations subject to the same mission requirements were studied in detail. The three designs analyzed were the tandem-wing-twin-boom, joined wing and conventional twin-boom configurations. The performance of the three proposed configurations is presented and shows that high altitude flight is possible with current technology. Different possible propulsion systems were investigated and suggestions are made for further investigation and better optimization of the designs. Author

A89-54338
CONCEPTUAL DESIGN TOOLS FOR INTERNAL TANKAGE OF THE HYPERSONIC TRANSPORT
TIMOTHY K. HIGHT (Santa Clara, University, CA) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 166-169.
Copyright
An account is given of investigations conducted at NASA-Ames into the conceptual design of LH2 fuel storage systems for single-stage-to-orbit airbreathing launch vehicles and hypersonic transport aircraft. These efforts were directed, first, to vehicles of elliptic cross-section, aiming to optimize the 'pillow' configuration for maximum inscribed area with minimum structural weight. Then, work was undertaken on a more complex cross-section defined by a power-law function with a broader scope of components; a truly three-dimensional solution was sought. O.C.

A89-54344
HYPERSONIC AIR VEHICLE STABILITY AND CONTROL
JAMES W. KELLY (Kelly Engineering, Los Angeles, CA) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 219-225.
Copyright
In the present method for determining the stability and control of any aircraft, including those which are hypersonic cruise-capable, the DOFs are aircraft aerodynamics, guidance, control systems, structure, and propulsion; the airframe is represented by the classical, six-DOF Laplace-transformed equations-of-motion. Guidance is added in the form of additional equations whose feedback is proportional to each of the terms in the aerodynamic equations; the structure and control-system equations are added as required in order to represent those DOFs. The stability of the system is judged by the position of the roots on the complex plane and the root locus closures. O.C.

A89-54370
THE ADVANCED AERONAUTIC DESIGN PROGRAM - DESIGNING FOR THE FUTURE
SUSAN K. DURLAK (California, University, Los Angeles) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 445-454. refs
Copyright
Work carried out as part of the NASA/USRA (University Space Research Association) Advanced Design Program for Aeronautics at UCLA during 1987-1988 is presented. The program was divided into the following three groups: (1) propulsion, (2) thermal management, and (3) flight systems. Each group focused on one portion of the design of a hypersonic (Mach 10) drone aircraft. It was found that, after being involved in the design program, the students had greater experience with design teams and familiarity with NASA projects. K.K.

A89-54372
RESULTS OF A PRELIMINARY STUDY OF TWO HIGH-SPEED CIVIL TRANSPORT DESIGN CONCEPTS
LOUIS J. HENDRICH (Kansas, University, Lawrence) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 469-475. Research supported by the Universities Space Research Association. refs
Copyright
Two high speed civil transport (HSCT) design concepts are presented. Both transports are designed for 5500 n.m. range with 300 passengers. The first design concept is a Mach 2.5 joined-wing single fuselage transport. The second design concept is a Mach 4.0, twin fuselage, variable sweep wing transport. The use of conventional hydrocarbon fuels is emphasized to reduce the amount of change required in current airport facilities. Advanced aluminums are used in the designs when possible to reduce material and production costs over more 'exotic' materials. Methods to reduce the airport noise, community noise, and fly-over noise are incorporated into the designs. In addition, requirements set forth by the Federal Aviation Regulations (FAR's) have been addressed. Author

A89-54462#
OVERVIEW OF BUCKLING IN AIRCRAFT DESIGN
D. Y. KATTI (Aeronautical Development Agency, Bangalore, India) (NASAS - 89: National Seminar on Aero Structures, Bangalore, India, Mar. 1989) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 41, Mar.-May 1989, p. 97-109. refs
An overview is given of buckling from the designer's point of view. Providing a historical background, consideration is given to design philosophies, design office practices, and structural optimization. Future trends and the design approach adopted for light combat aircraft are discussed. K.K.

A89-54471#
APPLICATION OF MODERN OPTIMIZATION TOOLS FOR THE DESIGN OF AIRCRAFT STRUCTURES
A. LOTZE and J. SCHWEIGER (Messerschmitt-Boelkow-Blohm GmbH, Munich, Federal Republic of Germany) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 41, Mar.-May 1989, p. 225-235. refs
The structural optimization for aircraft structures is discussed. Attention given to early investigations with FASTOP (Flutter and Strength Optimization Program), the preliminary design of lifting surfaces with TSO (aeroelastic tailoring and structural optimization), and modern aircraft design with MBB-LAGRANGE. An example is presented of the structural design of vertical tails for high elastic directional stability and rudder effectiveness in the presence of strength flutter constraints. K.K.

A89-54901
DESIGN, FABRICATION, AND TESTING OF A COMPOSITE MAIN LANDING GEAR RETRACTING BEAM
KEVIN A. MCAFEE (Advance Ratio Design Co., Inc., Chester, PA) Society of Manufacturing Engineers, Fabricating Composites '88 Conference, Philadelphia, PA, Sept. 12-15, 1988. 15 p.
(SME PAPER EM88-551) Copyright
A more reliable, economical, and lighter composite retracting beam has been developed to replace the previously designed welded steel beam for an advanced technology tandem rotor helicopter. The helicopter incorporates a tricycle gear arrangement which requires the main gear to extend out from the side of the aircraft to provide acceptable tip over angles. The beam then must retract by folding forward and upward into the side of the aircraft while rotating the oleo and wheels to a horizontal position and folding the door behind it. Flight beam tests were conducted and a short beam specimen was tested to evaluate manufacturing techniques. The design, fabrication, and testing of an unprecedented thick walled composite main landing gear retracting beam are discussed. C.E.

N89-28511# Aerospace Medical Research Labs., Wright-Patterson AFB, OH.
SPECIFICATIONS AND MEASUREMENT PROCEDURES AND AIRCRAFT TRANSPARENCIES Final Report, Dec. 1987 - Jun. 1988
PETER T. LAPUMA and JOHN C. BRIDENBAUGH Sep. 1988

56 p
(AD-A209396; AAMRL-TR-88-058) Avail: NTIS HC A04/MF A01 CSCL 01/3

This report is a summary of the specification requirements for optical quality for several military aircraft transparencies. It is intended to provide the design engineer with an easy reference to a majority of the accumulated historical information concerning optical quality. GRA

N89-28513# Office of the Secretary of Defense, Washington, DC.

OPERATIONAL TEST PLAN CONCEPT FOR EVALUATION OF CLOSE AIR SUPPORT ALTERNATIVE AIRCRAFT Summary Report

31 Mar. 1989 130 p
(AD-A208185) Avail: NTIS HC A07/MF A01 CSCL 15/6

The FY 1989 Defense Authorization Amendments and Base Closure and Realignment Act, Public Law 100-526, required the Director, Operational Test and Evaluation (DOT&E) to prepare an operational test plan to conduct a competitive fly-off of alternative aircraft for the Close Air Support (CAS) mission and to complete the test plan. The Act also directed the Secretary of Defense to conduct an independent assessment of ongoing studies and analyses related to selection of an aircraft for the CAS mission and to examine the feasibility of transferring the CAS mission from the Air Force to the Army. The Army and Air Force have jointly developed a list of requirements for a CAS aircraft. In addition, a Mission Need Statement (MNS) for a fixed wing aircraft has been developed and approved by the Joint Requirements Oversight Council, Office of the Chairman, Joint Chiefs of Staff. These requirements can be grouped into three principal categories: effectiveness in killing assigned targets, survivability and responsiveness. The USAF has proposed to replace the A-10 Thunderbolt, which is currently its primary CAS aircraft. Air Force assessments have concluded that the A-10, even with an engine modification, cannot survive on current and future battlefields while faster aircraft have significantly greater survivability. The Air Force has recommended that the A-10 be replaced by a modified version of the F-16, which has been designated the A-16. GRA

N89-28514# National Aerospace Lab., Tokyo (Japan).

AN EXPERIMENTAL OPTICAL COUPLING DEVICE FOR AN AIRBORNE DIGITAL REDUNDANT SYSTEM

AKIRA WATANABE and KAORU WAKAIRO 1988 41 p In JAPANESE; ENGLISH summary
(NAL-TR-1003; ISSN-0389-4010) Avail: NTIS HC A03/MF A01

A new optical coupling device for an airborne digital redundant system is described. For an onboard system, it is very important to increase reliability and safety, so a redundant system is applied. In a redundant system, in order to verify whether each operation is correct, it is necessary to compare it with the same time data from other systems. A new characteristic coupling device was developed and its features verified experimentally. This system has the following characteristics: (1) It has a simple hardware architecture in order to increase reliability and safety; (2) Synchronization and data exchange are separated in time, so this system utilizes the same hardware for these tasks; (3) To increase transfer speed, a broadcast method is used and the number of receivers is (redundancy-1); thus each system can transmit and receive simultaneously; and (4) An optical signal is used in order to increase transfer speed and this is effective for electric separation among systems. Finally, a discussion is presented of how to recognize the end of transfer without an interrupt signal in a digital computer. Author

N89-29335# Aeronautical Research Labs., Melbourne (Australia).

AIRCRAFT TRAJECTORY GENERATION: A LITERATURE REVIEW

M. C. WALLER, D. R. BLACKMAN, and T. F. BERREEN (Monash Univ., Clayton, Australia) Jun. 1989 27 p
(AR-005-609; ARL-SYS-TM-121) Avail: NTIS HC A03/MF A01

There is a need in the current economic environment to minimize costs and maximize efficiency in aircraft operations. Optimal flight trajectory generation can reduce operating costs, increase passenger and aircrew comfort and in the case of military operations reduce the loss of aircrew and aircraft. A review is presented of the field of optimal flight path generation for both civil and military operations and gives some recommendations for future research. Author

N89-29336# Office of Naval Research, London (England).

WORKSHOP PROCEEDINGS ON COMPOSITE AIRCRAFT CERTIFICATION AND AIRWORTHINESS

DENNIS R. SADOWSKI 6 Oct. 1988 74 p Workshop held in London, United Kingdom, 16 Jul. 1987
(AD-A209321; ONRL-8-017-R) Avail: NTIS HC A04/MF A01 CSCL 01/3

This report contains a summary of the workshop, a list of attendees, a prepaper entitled, Some Areas for Discussion Suggested by RAE, and the presentations on Composite Aircraft Structures, Civil Aviation Concerns, Impact Damage, RAE Composite Certification, and the Effect of Observed Climatic Conditions on the Moisture Equilibrium Level of Fiber-Reinforced Plastics. GRA

N89-29337# Naval Postgraduate School, Monterey, CA.

FLIGHT TEST METHOD DEVELOPMENT FOR A QUARTER-SCALE AIRCRAFT WITH MINIMUM INSTRUMENTATION M.S. Thesis

NICOLAOS D. BAMICHAS Mar. 1989 80 p
(AD-A207896) Avail: NTIS HC A05/MF A01 CSCL 01/4

A flight test method was developed for a quarter-scale model aircraft with minimum onboard instrumentation for the determination of the drag polar, the thrust required curve and the power required curve. The test included a wind tunnel test for propeller efficiencies and thrust coefficients, a torque test for engine shaft horsepower, and a flight test for flight speeds at measured operating conditions. The only additional onboard instrumentation besides that for radio control was a small cassette recorder. Two methods are described for data manipulation and an error analysis is provided for each method. GRA

N89-29338# Aeronautical Research Labs., Melbourne (Australia).

INCORPORATION OF VORTEX LINE AND VORTEX RING HOVER WAKE MODELS INTO A COMPREHENSIVE ROTORCRAFT ANALYSIS CODE

R. TOFFOLETTO, N. E. GILBERT, S. HILL, and K. R. REDDY Jan. 1989 67 p
(AD-A208036; ARL-FLIGHT-MECH-TM-408; DODA-AR-005-586) Avail: NTIS HC A04/MF A01 CSCL 01/1

The incorporation of simplified hover wake models into the comprehensive rotorcraft analysis code CAMRAD is described and examples are given on their use. The axisymmetric models, in which vortices are represented by either straight lines or rings, are a more generalized form of the free wake models of R. T. Miller at MIT, with the wake geometry also able to be prescribed. Incorporation has allowed access to the tabular representation in CAMRAD of airfoil section characteristics as functions of angle attack and Mach number, and has broadened the range of rotor wake models in the code to include a free wake hover model that does not have the convergence problems of the existing free wake model when used for hover. GRA

N89-29339# Aeronautical Research Labs., Melbourne (Australia).

A USER'S MANUAL FOR THE ARL MATHEMATICAL MODEL OF THE SEA KING MK-50 HELICOPTER. PART 1: BASIC USE

A. M. ARNEY and N. E. GILBERT Oct. 1988 38 p
(AD-A208058; ARL-AERO-TM-406-PT-1) Avail: NTIS HC A03/MF A01 CSCL 12/4

A mathematical model of the Sea King Mk 50 helicopter, as used in the Anti-Submarine Warfare (ASW) role, was developed at the Aeronautical Research Labs (ARL). This document describes the basic use of the computer program representing this model on the ELXSI 6400. Details are given on setting up the model and running it, first in ASW mode as a means of trimming the aircraft, and then in either ASW, ASE (Auto Stabilizing Equipment), or pilot modes to simulate a desired maneuver. GRA

N89-29340# Aeronautical Research Labs., Melbourne (Australia).

A USER'S MANUAL FOR THE ARL MATHEMATICAL MODEL OF THE SEA KING MK-50 HELICOPTER. PART 2: USE WITH ARL FLIGHT DATA

A. M. ARNEY and N. E. GILBERT Oct. 1988 61 p
(AD-A208059; ARL-AERO-TM-407-PT-2) Avail: NTIS HC A04/MF A01 CSCL 12/4

A mathematical model of the Sea King Mk 50 helicopter, as used in the Anti-Submarine Warfare (ASW) role, was developed at the Aeronautical Research Labs (ARL) to run on the ELXSI 6400 computer. To validate this model, extensive flight trials were conducted by the Royal Australian Navy (RAN). This document provides a catalog of the many flight trials data files, shows how to access and process the flight data, and then how to run the mathematical model with inputs obtained from the flight data. GRA

N89-29341# Aeronautical Research Labs., Melbourne (Australia).

IDENTIFICATION OF AN ADEQUATE MODEL FOR COLLECTIVE RESPONSE DYNAMICS OF A SEA KING HELICOPTER IN HOVER

R. A. FEIK and R. H. PERRIN Jul. 1988 30 p
(AD-A208060; ARL-AERO-TM-399) Avail: NTIS HC A03/MF A01 CSCL 01/3

A mathematical representation of vertical acceleration response characteristics of a helicopter in hover is developed, including blade flapping, inflow, and rotor speed dynamics. A maximum likelihood parameter estimation technique is applied to assess the adequacy of the model, and to identify the relevant parameters, using flight data from a Sea King Mk 50 helicopter. A number of conclusions related to the validity of the modelling approach have resulted from comparisons between predicted and identified parameters, and further investigation of some aspects is indicated. GRA

N89-29343# Sandia National Labs., Albuquerque, NM.

FULL-SCALE AIRCRAFT IMPACT TEST FOR EVALUATION OF IMPACT FORCES. PART 1: TEST PLAN, TEST METHOD, AND TEST RESULTS

W. A. VONRIESEMANN, R. L. PARRISH, D. C. BICKEL, S. R. HEFFELFINGER, K. MUTO, T. SUGANO, H. TSUBOTA, N. KOSHIKA, M. SUZUKI, and S. OHRUI Mar. 1989 9 p Presented at the 10th International Conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim. CA, 14-18 Aug. 1989 Prepared in cooperation with Muto Inst. of Structural Mechanics, Tokyo (Japan)
(Contract DE-AC04-76DP-00789)
(DE89-009329; SAND-89-0345C; CONF-890855-6) Avail: NTIS HC A02/MF A01

One of the factors considered in the design of critical concrete structures is the estimation of the global elasto-plastic structural response caused by the accidental impact of an aircraft. To estimate the response of the structure, the impact force (the force versus time relationship) must be known. Previous analytical studies have derived the forcing function using the impact velocity of the aircraft and the calculated mass and strength distribution of the aircraft. This paper describes a test conducted on April 19, 1988, at an existing rocket sled facility at Sandia National Laboratories in Albuquerque, New Mexico, USA, in which an actual F-4 Phantom aircraft was impacted at a nominal velocity of 215 m/s into an essentially rigid block of concrete. This was accomplished by supporting the F-4 on four struts that were attached to the sled track by carriage shoes to direct the path of the aircraft. Propulsion was accomplished by two stages of rockets. The concrete target was floated on a set of air bearings. Data acquisition consisted of measurements of the acceleration of the fuselage and engines of the F-4, and measurements of the displacement, velocity and acceleration of the concrete target. High-speed photography recorded the impact process and also permitted the determination of the impact velocity. This paper describes the test plan, method and results, while a companion paper discusses the analyses of the results. DOE

N89-29344# Sandia National Labs., Albuquerque, NM.

FULL-SCALE AIRCRAFT IMPACT TEST FOR EVALUATION OF IMPACT FORCE. PART 2: ANALYSIS OF RESULTS

K. MUTO, T. SUGANO, H. TSUBOTA, N. KOSHIKA, M. SUZUKI, S. OHRUI, W. A. VONRIESEMANN, D. C. BICKEL, R. L. PARRISH, and R. D. M. TACHAU 1989 6 p Presented at the 10th International Conference on Structural Mechanics in Reactor Technology (SMIRT), Anaheim, CA, 14-18 Aug. 1989 Prepared in cooperation with Muto Inst. of Structural Mechanics, Tokyo (Japan)
(Contract DE-AC04-76DP-00789)
(DE89-009335; SAND-89-0619C; CONF-890855-13) Avail: NTIS HC A02/MF A01

For estimating the global elasto-plastic structural response of critical concrete structures subjected to an aircraft crash, the time dependent impact force of a flat rigid barrier against a normally impacting aircraft was evaluated and then the response to the impact force was calculated. In this approach, a significant problem was to determine the impact force for the aircraft against a rigid target. A review of the method proposed to determine the impact forces showed that all were based on analytical methods. However, in these analytical methods, there were many assumptions and many questions remaining to be answered. Because of the uncertainty involved in the analytical prediction of the impact force, a full-scale aircraft impact test was performed and an extensive suite of response measurements was obtained. In this paper, these measurements are analyzed to evaluate the impact force accurately. Also, the results were used to evaluate existing analytical methods for prediction of the impact force. DOE

N89-29345 Wisconsin Univ., Madison.

DESIGN BY FUNCTIONAL FEATURE FOR AIRCRAFT STRUCTURE Ph.D. Thesis

SPENCER P. MAGLEBY 1988 155 p
Avail: Univ. Microfilms Order No. DA8903300

The term Functional Features refers to discrete functional aspects of a product model. Design by Functional Feature is a concept wherein product models are both designed and digitally represented in a database, in terms of functional features. This dissertation presents new concepts in the following areas: (1) a canonical functional feature definition and representation scheme that accommodates design needs and captures design intent; (2) feature-based user interfaces that guide and constrain the user while enforcing a predefined structure on the database being created; (3) use of geometry as constraints for a product model; and (4) a means to map functional features to another set of features in order to accommodate diverse features views of a product model. A software architecture for a design by functional feature system (DFFS) is presented. A review of related literature shows the growing popularity of this field but also its immaturity. The objectives and requirements of a DFFS are presented and detailed explanations of proposed representation methods and philosophies are discussed. Methods to supply intelligent feature-related data to application programs are presented. User interface issues are discussed and a sample design session is illustrated. Previous work leading to this system design is outlined. Finally, the benefits of the DFFS approach are enumerated and outstanding research issues are presented. An appendix contains a detailed example of an aircraft structural part designed by using functional features. Author

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A89-51704*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EVALUATION OF A TAKEOFF PERFORMANCE MONITORING SYSTEM DISPLAY
DAVID B. MIDDLETON (NASA, Langley Research Center, Hampton, VA) and RAGHAVACHARI SRIVATSAN (University of Kansas Center for Research, Inc., Lawrence) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 12, Sept.-Oct. 1989, p. 640-646. Previously cited in issue 22, p. 3535, Accession no. A87-50419. refs
Copyright

A89-52540#
WIDEBAND LINEAR QUADRATIC GAUSSIAN CONTROL OF STRAPDOWN DRY TUNED GYRO/ACCELEROMETERS
PIERRE CONSTANCIS (Societe d'Applications Generales d'Electricite et de Mecanique, Cergy-Pontoise, France) and MICHEL SORINE (Institut National de Recherche en Informatique et en Automatique, Le Chesnay, France) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 141-145. refs
(AIAA PAPER 89-3441) Copyright

The sophisticated LQG control strategy developed by Craig (1972) is applied to regulate the miniature gyro/accelerometers employed in the SIGAL family of strapdown inertial navigation systems. A stochastic model of the angular rate and linear acceleration of the system is derived and used in the construction of the Kalman filter algorithm, keeping the closed-loop bandwidth and the potentially much higher estimation bandwidth separate. Results obtained in laboratory frequency-response tests with the LQG controller implemented using a TMS 320C25 digital signal microprocessor are presented in graphs and briefly characterized. Data reported include unity steady-state gain, bandwidth 140 Hz, gain margin 6 dB, phase margin 40 deg, and closed-loop resonance 3 dB. T.K.

A89-52559#
INTEGRATED CONTROL AND AVIONICS FOR AIR SUPERIORITY - COMPUTATIONAL ASPECTS OF REAL-TIME FLIGHT MANAGEMENT
STEVEN M. WAGNER and STEVEN W. ROTHSTEIN (USAF, Wright Research Development Center, Wright-Patterson AFB, OH) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 321-326. refs
(AIAA PAPER 89-3463)

The current status of the air-combat flight-management system (ACFMS) being developed in the USAF Integrated Control and Avionics for Air Superiority (ICAAS) program is surveyed, with an emphasis on computational aspects. Consideration is given to the ICAAS multiprocessor architecture, the ICAAS Integration Computer (for the ACFMS tactics algorithm, the attack-guidance algorithm, the defense-assets manager, the aircraft performance monitor, and the flight-control coupler) and the ICAAS Support Computer (for integrated flight and fire control, air-to-air combat management, and the air-combat engagement system). Flow charts, diagrams, and tables listing the computer resource requirements are provided. T.K.

A89-52716#
UPDATE 89 - ADDITIONAL RESULTS WITH THE MULTIFUNCTION RLG SYSTEM
MICHAEL J. HADFIELD and R. E. WHEELER (Honeywell, Inc., Military Avionics Div., Clearwater, FL) AIAA, Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989. 23 p. refs
(AIAA PAPER 89-3583) Copyright

The expanded roles being assumed by ring laser gyro (RLG) technologies in military and commercial navigation systems are discussed, using two systems as examples and emphasizing the capability of current RLG system technology to meet more dynamic output requirements. Linear velocity, angular velocity and angular/linear acceleration requirements are taken into account along with accuracy, jitter, and other noise characteristics of RLG systems. Data on frequency-domain characterization for linear velocities and accelerations and on attitude, angular rates, and accelerations are presented. C.D.

A89-52717#
PERFORMANCE TEST RESULTS OF A MULTI-FUNCTION FAULT-TOLERANT RLG SYSTEM
MAHESH K. JEERAGE (Honeywell Systems and Research Center, Minneapolis, MN) AIAA, Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989. 11 p.
(AIAA PAPER 89-3584) Copyright

This paper presents the performance test results of a fault-tolerant RLG system featuring skewed axis inertial sensors, sensor redundancy management scheme, and fault-tolerant electronics. This system, built by Honeywell's Commercial Flight Systems Group, was calibrated and tested in the laboratory by Honeywell's Systems and Research Center. This system is currently being flight tested by Boeing Commercial Airplane Company. A brief description of the system is presented in the paper with emphasis on the fault-tolerant aspects. The performance test results presented include nominal navigation performance and navigation performance under sensor failures. Performance of the failure detection and isolation scheme is also presented. Author

A89-52974
SENSITIVE SKINS
NORMAN LYNN Flight International (ISSN 0015-3710), vol. 136, Aug. 26, 1989, p. 34-36.
Copyright

'Smart-skin' technology designates a potentially revolutionary family of aircraft structural surface-design and fabrication methods incorporating electronic and avionic sensors for real-time, continuous monitoring of both the vehicle's environment and the status of the structure itself. Communications and electronic warfare functions are also possible for smart-skinned/smart-structured vehicles; applicable sensors encompass phased radar arrays, IR focal plane arrays, and parallel processors, as well as sensors able to monitor the chemical and physical environment, the vehicle's navigational status, and the military or collisional threat environment, in all directions. Fiber-optics is the most important of the smart-skin technologies. O.C.

A89-53309#
VISUAL AND SENSORY AIDS FOR HELICOPTERS IN THE YEAR 2000 [VISIONIK/SENSORIK IM HUBSCHRAUBEREINSATZ DES JAHRES 2000]
H.-D. V. BOEHM (Messerschmitt-Boelkow-Blohm GmbH, Ottobrunn, Federal Republic of Germany) Internationales Hubschrauber-Forum, 17th, Bueckeburg, Federal Republic of Germany, May 9, 10, 1988, Paper. 29 p. In German. refs
(MBB-UD-541-89-PUB)

The use of visual and sensory aids for maintaining high performance in helicopters in the year 2000 is discussed. Aids used for night flight are addressed, including image-strengthening goggles, infrared devices, and low light level TV cameras. Technical data are presented for sensory platforms for helicopter night flight. Aids for pilot self-defense and for night fighting are examined. C.D.

A89-53313* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
AIRBORNE RAIN MAPPING RADAR
W. J. WILSON, G. S. PARKS, F. K. LI, K. E. IM, and R. J. HOWARD

(California Institute of Technology, Jet Propulsion Laboratory, Pasadena) IN: Tropical rainfall measurements. Hampton, VA, A. Deepak Publishing, 1988, p. 229-233.
Copyright

An airborne scanning radar system for remote rain mapping is described. The airborne rain mapping radar is composed of two radar frequency channels at 13.8 and 24.1 GHz. The radar is proposed to scan its antenna beam over + or - 20 deg from the antenna boresight; have a swath width of 7 km; a horizontal spatial resolution at nadir of about 500 m; and a range resolution of 120 m. The radar is designed to be applicable for retrieving rainfall rates from 0.1-60 mm/hr at the earth's surface, and for measuring linear polarization signatures and raindrop's fall velocity. I.F.

A89-54345
INTELLIGENT AVIONICS
WARREN MOSELEY (Alabama, University, Huntsville) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 226-234.
Copyright

Such next-generation aerospace systems as the Space Station, the Advanced Tactical Fighter, autonomous vehicles, and hypersonic cruise aircraft, will require real-time expert system collaboration with crews and ground controllers. In avionics applications, such AI systems would be intimately involved in mission planning on the basis of real-time-accessible guidance and sensor data; these data can be processed by highly parallel computer architectures. The activities of the ground personnel responsible for the inspection and maintenance of these aircraft will also be greatly aided by the application of AI avionics that can be interrogated to ascertain subsystems' status. O.C.

A89-54482
CAMOUFLAGE CAP ALLOWS AIRCRAFT TO DISAPPEAR [TARNKAPPE LAESST FLUGZEUGE VERSCHWINDEN]
Luft- und Raumfahrt (ISSN 0173-6264), vol. 10, 3rd Quarter, 1989, p. 18, 19. In German.
Copyright

A method for providing complete radar camouflage to military aircraft is briefly discussed. A step-by-step description of the method is given. Applications of the method are addressed. C.D.

A89-54848
AIRCRAFT LOW LEVEL WIND SHEAR DETECTION AND WARNING SYSTEM
PETER C. SINCLAIR (Colorado State University, Fort Collins, CO) and PETER M. KUHN (Aris, Inc., Boulder, CO) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 381-384. Research supported by NOAA. refs
(Contract NSF ATM-84-20980)
Copyright

This paper describes techniques involved in a test for assessing the ability of a prototype airborne IR system to detect, in advance, thunderstorm downbursts and low-level wind shear in the presence of light-to-moderate rain. In this test, the IR sensing system, which is a modified Barnes precision radiation thermometer with special filters for sensing in the 13 to 15 micron portion of the atmospheric molecular spectrum CO2, was mounted, forward pointing, on the wing of a research aircraft. To test the detection capability of the system, the aircraft penetrated several downbursts. The results of two of these penetrations are presented. New microburst features are pointed out. I.S.

N89-28515# School of Aerospace Medicine, Brooks AFB, TX.
TOWARDS A PHYSIOLOGICALLY BASED HUD (HEAD-UP DISPLAY) SYMBOLOGY Final Report, Jul. 1987 - Jun. 1988
FRED H. PREVIC Jan. 1989 22 p
(AD-A207748; USAFSAM-TR-88-25) Avail: NTIS HC A03/MF A01 CSCL 01/4

New concepts in HUD symbology, based on an understanding of the physiological mechanisms and ecological origins of the human visual system are described which may enable future HUD displays to serve as primary flight directors in addition to their current roles. The four key elements of this new symbology are: (1) prioritization of space according to the three-dimensional structure of visual attention, (2) an attitude display in the form of a global percept; (3) effective preattentive attitude cueing based on an ecologically valid simulation of the visual terrain during flight ; and (4) visual reference framing which depicts the roll of the aircraft relative to a stable horizon. Prototypes which illustrate the physiological HUD concept are presented. The specific advantage of the proposed symbology may be to allow the pilot to maintain effective attitude control while directing his attention towards the out-the-window environment. GRA

07

AIRCRAFT PROPULSION AND POWER

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

A89-52025*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FUEL PROPERTIES EFFECT ON THE PERFORMANCE OF A SMALL HIGH TEMPERATURE RISE COMBUSTOR
WALDO A. ACOSTA (NASA, Lewis Research Center; U.S. Army, Propulsion Directorate, Cleveland, OH) and STEPHEN A. BECKEL (United Technologies Corp., Pratt and Whitney Group, West Palm Beach, FL) AIAA, ASME, SAE, and ASEE, Joint Propulsion Conference, 25th, Monterey, CA, July 10-12, 1989. 11 p. Previously announced in STAR as N89-25238. refs
(Contract N00140-83-C-8899)
(AIAA PAPER 89-2901) Copyright

The performance of an advanced small high temperature rise combustor was experimentally determined at NASA-Lewis. The combustor was designed to meet the requirements of advanced high temperature, high pressure ratio turboshaft engines. The combustor featured an advanced fuel injector and an advanced segmented liner design. The full size combustor was evaluated at power conditions ranging from idle to maximum power. The effect of broad fuel properties was studied by evaluating the combustor with three different fuels. The fuels used were JP-5, a blend of Diesel Fuel Marine/Home Heating Oil, and a blend of Suntec C/Home Heating Oil. The fuel properties effect on the performance of the combustion in terms of pattern factor, liner temperatures, and exhaust emissions are documented. Author

A89-52306#
A MULTI-OBJECTIVE OPTIMUM DESIGN METHOD FOR A RADIAL-AXIAL FLOW TURBINE WITH THE OPTIMUM CRITERIA OF BLADE TWIST AT OUTLET OF BLADES
LINGEN CHEN (Naval Academy of Engineering, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, July 1989, p. 218-222, 290. In Chinese, with abstract in English. refs

This paper provides a multiobjective optimum design method for a radial-axial flow turbine stage. The method takes the parameters in mean radius and the criteria of blade twist at the outlet of the blades as design variables and selects the internal efficiency in the design conditions and the total weight of the turbine stage as objective functions. The model presented is a nonlinear multiobjective programming problem of two objective functions with 29 constrained functions and 6 variables. The mathematical model for optimization and some analytical results of single- and multiobjective optimizations for a variety of twisted blades are also presented. Author

A89-52315#

AN INVESTIGATION ON STAGNATION PRESSURE ERRORS DUE TO ROTATION STATE BEHIND A ROTOR

GUOCAI TANG (Nanjing Aeronautical Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, July 1989, p. 259-261, 293. In Chinese, with abstract in English.

This paper proposes that the errors in stagnation pressure measurement due to rotation state behind a rotor should include perception errors in addition to the weighting error and dynamic response errors. The analysis and experimental data show that the stagnation pressure in the wake may be higher than that in the main flow, so the weighting error may be positive. Author

A89-52317#

FLIGHT TESTS FOR AIR INTAKE FLOWFIELD AND ENGINE OPERATING STABILITY

YIYUN LUN (Shenyang Aeroengine Research Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, July 1989, p. 265-268, 294. In Chinese, with abstract in English.

The operating compatibility between air intake and engine during the flight tests of a supersonic fighter is considered. The flight tests were completed under conditions of horizontal accelerating flight, uprated and retarded throttles of the engine during horizontal flight, and constant-Mach climbing with maximum and augmented thrust rating. The flow conditions at the intake and the tendency of flowfield variation at the inlet of the engine were evaluated by means of six pressure tappings at the variable intake cone and a cross rake pressure probe at the exit of the intake. Author

A89-52319#

OPTIMUM DESIGN FOR GEOMETRIC PARAMETERS OF AXISYMMETRIC CONVERGING-DIVERGING NOZZLE

JUN ZEN and JINGYUN ZHAO (Gas Turbine Establishment, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, July 1989, p. 271, 272, 294. In Chinese, with abstract in English.

A mathematical model of an axisymmetric converging-diverging nozzle in design conditions is set up by quadratic-regression equation. The thrust force coefficient is taken as an objective function. The three geometric parameters (half-convergent angle, half-divergent angle, radius ratio of throat curvature to throat) are chosen as design variables. The optimum design is completed by the random-walk method. The relationships of the optimum geometric parameters to the designed pressure ratio of the nozzle are obtained. The results provide the basis for designing the axisymmetric convergent-divergent nozzle of an axhaust system. Author

A89-52320#

EFFECT OF GEOMETRIC PARAMETERS ON INTERNAL PERFORMANCE OF CONVERGENT-DIVERGENT NOZZLE

JINGYUN ZHAO (Gas Turbine Establishment, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, July 1989, p. 273, 274, 295. In Chinese, with abstract in English.

The effect of geometric parameters on internal performance of convergent-divergent nozzle has been investigated experimentally. The relationships of thrust coefficient and wall static pressure distribution to area ratio, divergent angle, convergent angle, and throat radius of curvature are presented in this paper. Author

A89-52323#

FLOW SIMILARITY IN IGNITION PROCESS OF JET ENGINE

HONGMING WANG (Beijing University of Aeronautics and Astronautics, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 4, July 1989, p. 283-285, 296. In Chinese, with abstract in English. refs

An analytical study on the flow similarity in ignition process is completed in respect to the effects of the airflow on the local fuel and oxygen distribution near the plug. For lean light-off limitation, a momentum criteria is derived from the motion equation of a fuel droplet. The criteria state that the ignition velocity rises with the increase of altitude. It is in quite good agreement with the experimental data. The results suggest that the ignition process changes gradually with the decrease of p(a) into optimum range when the fuel flow is kept constant. Author

A89-52482

THE DEVELOPMENT OF ADVANCED COMPUTATIONAL METHODS FOR TURBOMACHINERY BLADE DESIGN

P. STOW (Rolls-Royce, PLC, Derby, England) International Journal for Numerical Methods in Fluids (ISSN 0271-2091), vol. 9, Aug. 1989, p. 921-941. refs

Copyright

The paper describes the basic components of a turbomachinery blade design system. A number of modeling aspects of the advanced computational methods in use and under development are reviewed, together with areas for future research and development. Various features of blade-to-blade analysis are discussed, including the use of compatible design and analysis modes and coupled boundary-layer analysis capable of handling attached and separated flow; examples are included to show capabilities. Advances being made in the development and application of Reynolds-averaged Navier-Stokes models are covered showing capabilities with regard to loss and heat-transfer prediction. Author

A89-52660#

DESIGN OF TUNABLE DIGITAL SET-POINT TRACKING PID CONTROLLERS FOR GAS TURBINES WITH UNMEASURABLE OUTPUTS

B. PORTER and H. YAMANE (Salford, University, England) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1258-1266. refs

(AIAA PAPER 89-3577) Copyright

The tunable digital set-point tracking PID controllers of Porter and Jones are enriched by the inclusion of pre-filters so as to embrace linear multivariable plants with unmeasurable outputs. It is shown that the pre-filter matrices, together with the proportional, integral, and derivative controller matrices embodied in the resulting tunable digital PID controllers, can be determined from open-loop step-response tests. The effectiveness of the resulting design methodology is illustrated by designing a tunable digital set-point tracking PID controller for a modern gas-turbine engine with five measurable outputs and five unmeasurable outputs. Author

A89-52832

PROBABILISTIC METHODS FOR ESTIMATING THE REMAINING LIFE OF STRUCTURAL ELEMENTS OF OPERATING AIRCRAFT GAS TURBINE ENGINES [VEROIATNOSTNYE METODY OTSENKI OSTATOCHNOGO RESURSA KONSTRUKTIVNYKH ELEMENTOV AVIATSIONNYKH GTD V EKSPLUATATSII]

A. N. VETROV and A. G. KUCHER (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukrainian SSR) Problemy Prochnosti (ISSN 0556-171X), Aug. 1989, p. 70-76. In Russian. refs

Copyright

Based on the linear damage summation hypothesis, two probabilistic approaches are proposed for estimating the remaining life of aircraft engines using a criterion related to the strength loss of engine components. One approach is based on the correlation theory of random values and the central limiting theorem; the other is based on the analysis of the distribution of the random damage of structural components per flight loading cycle and on the property of infinite divisibility of the lognormal distribution law. Examples of turbine life calculations are presented. V.L.

A89-52960

DIAGNOSTIC TECHNIQUES FOR PROPULSION SYSTEMS

Y. M. TIMNAT (Technion - Israel Institute of Technology, Haifa) Progress in Aerospace Sciences (ISSN 0376-0421), vol. 26, no. 2, 1989, p. 153-168. Research supported by the Technion - Israel

Institute of Technology. refs
Copyright
The paper discusses diagnostic techniques for propulsion systems dealing with temperature measurements by thermocouples and non-intrusive optical methods, velocity determination with lasers, concentration measurements using probes and optical techniques and regression rates in solid propellants, employing microwaves and ultrasonics. Different types of measurements of the same parameter are compared, stressing the suitability of each technique for particular experimental conditions. Particular attention will be given to application in supersonic flow, specially for propulsive systems, and to the author's original contributions.
Author

A89-52991#
COMPUTERISED DESIGN OF BLADE ELEMENTS IN TURBOMACHINES
K. A. DAMODARAN (Indian Institute of Technology, Madras, India) and T. VENKATA KRISHNAIAH Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 41, Feb. 1989, p. 25-31. refs
This paper deals with a method of computerized design of blade elements for compressible or incompressible, inviscid flow in high-solidity stators and rotors of axial, radial or mixed flow compressors, turbines or two-dimensioal cascades. The method is based on Stanitz inverse methods of profile design in which the blade element profile is generated for a given distribution of surface velocities. In order to take into account the real-flow viscous effects, a blade boundary-layer estimation code is incorporated, and the new blade profile is generated deducting the boundary-layer displacement thickness.
Author

A89-53304*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AERONAUTICAL APPLICATIONS OF HIGH-TEMPERATURE SUPERCONDUCTORS
GEORGE E. TURNEY, ROGER W. LUIDENS (NASA, Lewis Research Center, Cleveland, OH), KENNETH UHERKA, and JOHN HULL (Argonne National Laboratory, IL) AIAA, AHS, and ASEE, Aircraft Design, Systems and Operations Conference, Seattle, WA, July 31-Aug. 2, 1989. 14 p. Previously announced in STAR as N89-26008. refs
(AIAA PAPER 89-2142) Copyright
The successful development of high-temperature superconductors (HTS) could have a major impact on future aeronautical propulsion and aeronautical flight vehicle systems. A preliminary examination of the potential application of HTS for aeronautics indicates that significant benefits may be realized through the development and implementation of these newly discovered materials. Applications of high-temperature superconductors (currently substantiated at 95 k) were envisioned for several classes of aeronautical systems, including subsonic and supersonic transports, hypersonic aircraft, V/STOL aircraft, rotorcraft, and solar, microwave and laser powered aircraft. Introduced and described are the particular applications and potential benefits of high-temperature superconductors as related to aeronautics and/or aeronautical systems.
Author

A89-53351*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MIXING AUGMENTATION TECHNIQUE FOR HYPERVELOCITY SCRAMJETS
A. KUMAR, D. M. BUSHNELL, and M. Y. HUSSAINI (NASA, Langley Research Center, Hampton, VA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 5, Sept.-Oct. 1989, p. 514-522. Previously cited in issue 20, p. 3156, Accession no. A87-45275. refs
Copyright

A89-53366#
FLIGHT TEST OF THE F100-PW-220 ENGINE IN THE F-16
MARK T. CHILDRE and KEVIN D. MCCOY (General Dynamics Corp., Fort Worth, TX) Journal of Propulsion and Power (ISSN 0748-4658), vol. 5, Sept.-Oct. 1989, p. 620-625. Previously cited in issue 20, p. 3155, Accession no. A87-45245.
Copyright

A89-53956* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
TURBOFAN ENGINE CONTROL SYSTEM DESIGN USING THE LQG/LTR METHODOLOGY
SANJAY GARG (NASA, Lewis Research Center; Sverdrup Technology, Inc., Cleveland, OH) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 1. New York, Institute of Electrical and Electronics Engineers, 1989, p. 134-141. Previously announced in STAR as N89-26004. refs
Copyright
Application of the linear-quadratic-Gaussian with loop-transfer-recovery methodology to design of a control system for a simplified turbofan engine model is considered. The importance of properly scaling the plant to achieve the desired target feedback loop is emphasized. The steps involved in the application of the methodology are discussed via an example, and evaluation results are presented for a reduced-order compensator. The effect of scaling the plant on the stability robustness evaluation of the closed-loop system is studied in detail.
Author

A89-54131#
RESEARCH ON SURGE MONITORING SYSTEM OF TURBOJET ENGINE ON ACTIVE SERVICE
WANXUE LIU (Air Force PR China, Engineering Institute, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), Aug. 1989, p. 34-38, 81. In Chinese, with abstract in English. refs
In this paper, the severe surge failures of turbojet engines serving in the Chinese Air Force are analyzed and a proposal on a surge-prevention monitoring system (SPMS) is presented, based on which, FCJ-124 SPMS has been developed. The FCJ-124 system have been used in many surge monitor tests with engines on ground and on active fighters. The results are satisfactory.
Author

A89-54132#
A METHOD FOR CALCULATION OF MATCHING POINT OF INLET AND ENGINE
XUELIANG ZHANG (Chengdu Aircraft Corp., People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), Aug. 1989, p. 43-45, 82. In Chinese, with abstract in English.
A method for the calculation of matching point of inlet and engine according to testing data of inlet and flow performance is presented. Inlet performance data can be precisely calculated for any flight condition and engine throttle. The method in this paper can be used to set a mathematical model based on inlet performance data from wind tunnel tests and given engine performance.
Author

A89-54328
PROPULSION CYCLES FOR TRANSATMOSPHERIC ACCELERATORS
FREDERICK S. BILLIG (Johns Hopkins University, Laurel, MD) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 45-67.
Copyright
A comprehensive assessment is made of the design features and comparative performance and economic advantages of the composite airbreathing propulsion system configurations conceived to date for transatmospheric vehicles, which require that efficient operation be achieved from Mach 0 at takeoff/launch at sea level to Mach 16 at extreme altitude before final acceleration on nonairbreathing power to orbital velocity. LH2 is in all cases the requisite fuel. Attention is given to liquid air cycle engine (LACE), rocket ejector-compressor engine, and scramjet engine

configurations, as well as such combinations of these features as the ejector ramjet, scram-LACE, etc. O.C.

A89-54473#

GAS TURBINE RESEARCH AND DEVELOPMENT IN INDIA

ARUN PRASAD (Gas Turbine Research and Development Establishment, Bangalore, India) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 41, Mar.-May 1989, p. 243-252.

A survey is presented of the R & D activities in aircraft gas turbines in India. Particular attention given to the technological challenges of the GTX engine development program for the light combat aircraft. The development of a high-speed small engine for the pilotless target aircraft is discussed as well. K.K.

A89-54483

HISTORY OF LOW-POWER JET ENGINES [GESCHICHTE DER TRIEBWERKE KLEINER LEISTUNG]

KARL-HEINZ COLLIN and HANS FRICKE (Kloeckner-Humboldt-Deutz AG, Oberursel, Federal Republic of Germany) Luft- und Raumfahrt (ISSN 0173-6264), vol. 10, 3rd Quarter, 1989, p. 34, 36, 38, 39. In German.

Copyright

The development of low-power jet aircraft engines since World War II is described. The early history is traced, including the first auxiliary gas turbines, turboprops, and small turbojet engines, and the major developments in France, the U.S., and the Soviet Union are described in detail, with an emphasis on German participation. Numerical data on engines developed between 1950 and 1989 are presented in tables, and it is shown that current computer technology and advanced materials make possible the development of more efficient jet engines, taking into account air flow rates, compression ratios, turbine inlet temperatures, and component performance. C.E.

A89-54881

DIAGNOSTICS AND CONTROL OF THE FUEL SYSTEMS OF AIRCRAFT ENGINES [DIAGNOSTIROVANIE I REGULIROVANIE TOPLIVNOI APPARATURY AVIADVIGATELEI]

ALEKSANDR A. ZARIN, VASILII E. LOGINOV, and ZAKHARII S. OTMAN Moscow, Izdatel'stvo Transport, 1989, 80 p. In Russian. refs

Copyright

Various problems related to the technical diagnostics and control of the fuel systems of aircraft engines during operation and maintenance are examined. The factors affecting the output characteristics and functioning of fuel system components are discussed. Mathematical models of the principal functional components of fuel systems are presented, and the possibilities afforded by these models in optimizing the output parameters of fuel system components are demonstrated. V.L.

A89-54884

JET ENGINES FOR HIGH SUPERSONIC FLIGHT VELOCITIES (2ND REVISED AND ENLARGED EDITION) [REAKTIVNYE DVIGATELI DLIA BOL'SHIKH SVERKHZVUKOVYKH SKOROSTEI POLETA /2ND REVISED AND ENLARGED EDITION/]

RUVIM I. KURZINER Moscow, Izdatel'stvo Mashinostroenie, 1989, 264 p. In Russian. refs

Copyright

Theoretical principles are presented for jet engines designed for use in aircraft flying at high supersonic velocities in the atmosphere. In particular, attention is given to the thermodynamic principles of ramjet and combination turbojet-ramjet engines; methods for calculating the cycle parameters of ramjet and turbojet-ramjet engines; ramjet engines for supersonic and hypersonic flight; and turboramjet engines. The discussion also covers integral rocket ramjets; cryogenic-fuel combination turbojet-ramjet engines; and methods for the analysis of the efficiency and applications of combination turbojet-ramjet and high-velocity jet engines. V.L.

N89-28516# Naval Air Propulsion Test Center, Trenton, NJ.

STATISTICS ON AIRCRAFT GAS TURBINE ENGINE ROTOR FAILURES THAT OCCURRED IN US COMMERCIAL AVIATION DURING 1984 Final Report

R. A. DELUCIA, J. T. SALVINO, and B. C. FENTON (Federal Aviation Administration, Atlantic City, NJ.) Jun. 1989 26 p (Contract DOT/FA71NA-AP98)

(NAPC-PE-185; DOT/FAA/CT-89/6) Avail: NTIS HC A03/MF A01

Presented here is statistical information relating to gas turbine engine rotor failures which occurred during 1984 in commercial aviation service use. Two hundred and six failures occurred in 1984. Rotor fragments were generated in 114 of the failures and, of these, 18 were uncontained. The predominant failure involved blade fragments, 90.3 percent of which were contained. Seven disk failures occurred and all were uncontained. Seventy percent of the 206 failures occurred during the takeoff and climb stages of flight. This service data analysis is prepared on a calendar year basis and published yearly. The data are useful in support of flight safety analyses, proposed regulatory actions, certification standards, and cost benefit analyses. Author

N89-28517# Naval Air Propulsion Test Center, Trenton, NJ.

STATISTICS ON AIRCRAFT GAS TURBINE ENGINE ROTOR FAILURES THAT OCCURRED IN US COMMERCIAL AVIATION DURING 1985 Final Report

R. A. DELUCIA, J. T. SALVINO, and B. C. FENTON (Federal Aviation Administration, Atlantic City, NJ.) Jul. 1989 28 p (Contract DOT/FA71NA-AP98)

(NAPC-PE-188; DOT/FAA/CT-89/7) Avail: NTIS HC A03/MF A01

Statistics relating to gas turbine engine rotor failures which occurred during 1985 in U.S. commercial aviation service use are given. Two hundred and seventy-three failures occurred in 1985. Rotor fragments were generated in 150 of the failures, and of these 14 were uncontained. The predominant failure involved blade fragments, 94.4 percent of which were contained. Six disk failures occurred and all were uncontained. Fifty-seven percent of the 273 failures occurred during the takeoff and climb stages of flight. This service data analysis is prepared on a calendar year basis and published yearly. The data support flight safety analyses, proposed regulatory actions, certification standards, and cost benefit analyses. Author

N89-28518# Aeronautical Research Labs., Melbourne (Australia).

AERODYNAMIC MODEL TESTS OF EXHAUST AUGMENTORS FOR F/A-18 ENGINE RUN-UP FACILITY AT RAAF WILLIAMTOWN Summary Report

S. A. FISHER and A. M. ABDEL-FATTAH Dec. 1988 29 p (AD-A208110; ARL-AERO-PROP-TM-458; AR-005-583) Avail: NTIS HC A03/MF A01 CSCL 21/5

Model tests of the air cooled exhaust augmentors proposed for the F/A-18 engine ground run-up facilities at RAAF Williamtown were undertaken, to confirm satisfactory aerodynamic behavior of the augmentor designs and to provide data for optimizing certain aspects of the designs. The tests were carried out on 1/45 scale models, using an unheated air jet to represent the engine exhaust. Geometric features were identified which had important influence on augmentor duct flow symmetry and the cooling flow augmentation ratio. GRA

N89-28519# Institut Franco-Allemand de Recherches, Saint-Louis (France).

MEASUREMENTS OF MEAN-FLOW AND TURBULENCE CHARACTERISTICS IN A TURBOJET EXHAUST USING A LASER VELOCIMETER

H. J. SCHAEFER 13 Sep. 1988 16 p Presented at the 11th Symposium on Turbulence, Rolla, MO, 17-19 Oct. 1988

(ISL-CO-226/88; ETN-89-95033) Avail: NTIS HC A03/MF A01

Mean-flow and turbulence characteristics are measured in a high-temperature axisymmetric jet exhausting from an aero engine. The effects of exit Mach number and temperature on the jet flow field are studied. A laser Doppler velocimeter is used to map the flow characteristics over a range of Mach numbers from 0.46 to 0.84. Radial distributions of the mean axial velocity and the root mean square of the corresponding fluctuations are obtained at different axial stations in the flow. The various distributions are found to collapse when plotted in appropriate coordinates. The collapsed data can be approximated by a universal profile. The radial mean-velocity scans at various axial stations exhibit a strong similarity when compared in reduced lateral coordinates. The spread of the mixing layer decreases with increasing exit Mach number and temperature. ESA

N89-29347# DieselDyne Corp., Morrow, OH.
A STUDY OF AN ADVANCED VARIABLE CYCLE DIESEL AS APPLIED TO AN RPV: EVALUATION OF AN RPV VARIABLE CYCLE DIESEL ENGINE Final Report, 11 Aug. 1988 - 28 Feb. 1989
RICHARD P. JOHNSTON 1 May 1989 85 p
(Contract DAAH01-88-C-0660; DARPA ORDER 5916)
(AD-A207754; DDC-89-01) Avail: NTIS HC A05/MF A01 CSCL 21/7

A variable cycle diesel is examined for use in an unmanned long endurance remotely piloted vehicle (RPV). Engine configuration studies are made and a possible installation arrangement developed. Installed performance projections are made and a long endurance RPV mission fuel, installed engine weight and propeller performance estimates made along with several aircraft installation drawings. It was found that the final engine configuration performed the specified mission with a total fuel and installed engine weight fraction of only 24 percent of the vehicle Take Off Gross Weight. The mission was evaluated at a cruise altitude of 65000 feet and an engine configuration suitable for use at 85000 feet was also investigated. GRA

N89-29348# Aeronautical Research Labs., Melbourne (Australia).
A MODIFIED LEAST SQUARES ESTIMATOR FOR GAS TURBINE IDENTIFICATION
G. L. MERRIGNTON Dec. 1988 34 p
(AD-A207911; ARL-AERO-PROP-TM-445; DODA-AR-004-577)
Avail: NTIS HC A03/MF A01 CSCL 21/5

A simple estimator is proposed for use in extracting the spool dynamic characteristics of a gas turbine engine. It provides realistic estimates even when the input/output signals are contaminated by high levels of measurement noise. As a result, it has the potential to form the basis of a useful engine health monitoring tool. GRA

N89-29351*# General Electric Co., Cincinnati, OH. Aircraft Engines Dept.
REVOLUTIONARY OPPORTUNITIES FOR MATERIALS AND STRUCTURES STUDY, ADDENDUM
P. D. FEIG 1987 39 p
(Contract NAS3-24622)
(NASA-CR-179642-ADD; NAS 1.26:179642-ADD) Avail: NTIS HC A03/MF A01 CSCL 21/5

This report is an addendum to the Revolutionary Opportunities for Materials and Structures Study (ROMS), modifying the original by the addition of two tasks. The primary purpose of these tasks was to conduct additional aircraft/engine sizing and mission analysis to obtain contributory aircraft performance data such as fuel burns and direct operating costs for both the subsonic and supersonic engines. Author

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AIRCRAFT STABILITY AND CONTROL

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

A89-51702*# Systems Technology, Inc., Hawthorne, CA.
FLIGHT INVESTIGATION OF HELICOPTER LOW-SPEED RESPONSE REQUIREMENTS
DAVID G. MITCHELL, ROGER H. HOH (Systems Technology, Inc., Hawthorne, CA), and J. MURRAY MORGAN (National Aeronautical Establishment, Ottawa, Canada) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 12, Sept.-Oct. 1989, p. 623-630. Research supported by the U.S. Army. Previously cited in issue 22, p. 3537, Accession no. A87-49578. refs
(Contract NAS2-11304)
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A89-51723#
DESIGN OF A MODALIZED OBSERVER WITH EIGENVALUE SENSITIVITY REDUCTION
KENNETH M. SOBEL (City College, New York) and SIVA S. BANDA (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) *Journal of Guidance, Control, and Dynamics* (ISSN 0731-5090), vol. 12, Oct. 1989, p. 762-764.
(Contract F49620-87-R-0004)

A novel approach is proposed for the design of modalized observers which yields an observer possing both good error attenuation to an initial condition mismatch of known direction and small eigenvalue sensitivity. The basis of the method is the minimization of a cost function that is dependent on the norm of the observer modal matrix, as well as the condition number of this modal matrix and directional information concerning the initial condition mismatch. An illustrative example is presented for the lateral dynamics of the L-1011 aircraft which demonstrates the superiority of the new approach. O.C.

A89-52168
PERFORMANCE ANALYSIS OF VOTING STRATEGIES FOR A FLY-BY-WIRE SYSTEM OF A FIGHTER AIRCRAFT
C. SUBRAMANIAN and D. K. SUBRAMANIAN (Indian Institute of Science, Bangalore, India) IEEE Transactions on Automatic Control (ISSN 0018-9286), vol. 34, Sept. 1989, p. 1018-1021. refs
Copyright

Findings of studies on processing data from a digital fly-by-wire system of a fighter aircraft are presented. The objectives are to select a suitable software structure complying with reliability and fault-tolerance requirements and to assess its computational load. Ramp and constant input signals with noise are studied using on Monte Carlo methods. Voting strategies studied and compared include lower median, upper median, and weighted average. Execution times and memory requirements of each strategy are also assessed. I.E.

A89-52526
AIAA GUIDANCE, NAVIGATION AND CONTROL CONFERENCE, BOSTON, MA, AUG. 14-16, 1989, TECHNICAL PAPERS. PARTS 1 & 2
Conference sponsored by AIAA. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. Pt. 1, 864 p.; pt. 2, 856 p. For individual items see A89-52527 to A89-52710.
Copyright

Recent advances in aircraft and spacecraft navigation, guidance, and control are discussed in reviews and reports. Topics addressed include multidisciplinary flight controls, control methods for spacecraft, component development, launch-vehicle guidance, aircraft control systems, design techniques, intelligent systems to aid pilot decisions, aerostructural controls, momentum management, missile guidance, and nonlinear techniques. Consideration is given to aided inertial navigation; robustness analysis; fault accommodation; dynamics and control methods for spacecraft; mission planning; robotics for aerospace applications; large-space-structure control; filters and observers; spacecraft guidance; missile autopilot design; experiments on active control of flexible structures; output feedback; strapdown alignment and navigation; differential games; spacecraft attitude control; eigenstructure design; optimization; navigation, sensors, and simulations for spacecraft; and ATC. T.K.

A89-52527#
A NEW TECHNIQUE FOR AIRCRAFT FLIGHT CONTROL RECONFIGURATION
MARCELLO R. NAPOLITANO and ROBERT L. SWAIM (Oklahoma State University, Stillwater) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1-9. refs
(AIAA PAPER 89-3425) Copyright

An original algorithm is applied to the aircraft flight control reconfiguration problem. The determination of the desired control law, which can adapt in a very short period of time to a major damage to a control surface, is obtained by making use of the recent control and response time histories. In addition, a method is proposed to efficiently distribute the reconfiguration task among all the remaining healthy control surfaces. The estimated model of the damaged aircraft used in this technique is obtained by using a multiple model Kalman filtering approach. The model estimation and the control algorithm have been codified in a computer simulation program for a 6 degrees of freedom aircraft model. The simulation results of the reconfiguration are presented. Author

A89-52528*# Integrated Systems, Inc., Santa Clara, CA.
A REAL-TIME EXPERT SYSTEM FOR SELF-REPAIRING FLIGHT CONTROL
S. A. GAITHER, A. K. AGARWAL, S. C. SHAH (Integrated Systems, Inc., Santa Clara, CA), and E. L. DUKE (NASA, Flight Research Center, Edwards, CA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 10-16. refs
(AIAA PAPER 89-3427) Copyright

An integrated environment for specifying, prototyping, and implementing a self-repairing flight-control (SRFC) strategy is described. At an interactive workstation, the user can select paradigms such as rule-based expert systems, state-transition diagrams, and signal-flow graphs and hierarchically nest them, assign timing and priority attributes, establish blackboard-type communication, and specify concurrent execution on single or multiple processors. High-fidelity nonlinear simulations of aircraft and SRFC systems can be performed off-line, with the possibility of changing SRFC rules, inference strategies, and other heuristics to correct for control deficiencies. Finally, the off-line-generated SRFC can be transformed into highly optimized application-specific real-time C-language code. An application of this environment to the design of aircraft fault detection, isolation, and accommodation algorithms is presented in detail. T.K.

A89-52529*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
A DESIGN PROCEDURE FOR THE HANDLING QUALITIES OPTIMIZATION OF THE X-29A AIRCRAFT
JOHN T. BOSWORTH and TIMOTHY H. COX (NASA, Flight Research Center, Edwards, CA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 17-34. refs
(AIAA PAPER 89-3428) Copyright

The techniques used to improve the pitch-axis handling qualities of the X-29A wing-canard-planform fighter aircraft are reviewed. The aircraft and its FCS are briefly described, and the design method, which works within the existing FCS architecture, is characterized in detail. Consideration is given to the selection of design goals and design variables, the definition and calculation of the cost function, the validation of the mathematical model on the basis of flight-test data, and the validation of the improved design by means of nonlinear simulations. Flight tests of the improved design are shown to verify the simulation results. T.K.

A89-52547#
SYNTHESIS OF A HELICOPTER FULL AUTHORITY CONTROLLER
M. W. HEIGES, P. K. MENON, and D. P. SCHRAGE (Georgia Institute of Technology, Atlanta) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 207-213. refs
(AIAA PAPER 89-3448) Copyright

A full-authority controller for an autonomous helicopter is developed analytically on the basis of nonlinear transformation theory. A 6-DOF model is employed, and the twelfth-order nonlinear system of equations is reduced using a singular-perturbation technique, separating the position and attitude dynamics under the assumption that the former is slower than the latter. Details of the inverse transformation and the solution of the inverse kinematics problem are given; the transformed linear feedback controller is described; and results from controller evaluations using the NASA Ames TMAN program (Lewis and Aiken, 1985) to simulate one-on-one nap-of-the-earth air combat are presented graphically. The controller is found to function adequately with errors of up to 20 percent in the force and moment terms used in the transformation. T.K.

A89-52548#
TIME PERIODIC CONTROL OF A MULTI-BLADE HELICOPTER
STEVEN G. WEBB (U.S. Air Force Academy, Colorado Springs, CO), ROBERT A. CALICO, and WILLIAM E. WIESEL (USAF, Institute of Technology, Wright-Patterson AFB, OH) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 214-220. refs
(AIAA PAPER 89-3449)

The equations of motion for a rigid helicopter containing four blades free to flap and lag are determined. Control techniques are developed which stabilize the entire system for a variety of flight conditions. A modal control technique, based on Floquet theory, is used to eliminate multiple blade instabilities by controlling pairs of unstable roots at a specific design point. Another modal controller is designed for the resulting new system which shifts a second pair of unstable roots to desired locations. This process is repeated until all instabilities are eliminated. Numerical inaccuracies, however, limit the number of possible repetitions of this procedure. Author

A89-52549*# California Univ., Davis.
SELF-TUNING GENERALIZED PREDICTIVE CONTROL APPLIED TO TERRAIN FOLLOWING FLIGHT
R. A. HESS (California, University, Davis) and Y. C. JUNG IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 221-235. refs
(Contract NAG2-221)
(AIAA PAPER 89-3450) Copyright

Generalized Predictive Control (GPC) describes an algorithm for the control of dynamic systems in which a control input is generated which minimizes a quadratic cost function consisting of a weighted sum of errors between desired and predicted future system output and future predicted control increments. The output predictions are obtained from an internal model of the plant dynamics. Self-tuning GPC refers to an implementation of the GPC algorithm in which the parameters of the internal model(s) are estimated on-line and the predictive control law tuned to the parameters so identified. The self-tuning GPC algorithm is applied to a problem of rotorcraft longitudinal/vertical terrain-following flight. The ability of the algorithm to tune to the initial vehicle parameters

and to successfully adapt to a stability augmentation failure is demonstrated. Flight path performance is compared to a conventional, classically designed flight path control system.
Author

A89-52550#
COMPARISON OF EIGENSTRUCTURE ASSIGNMENT AND THE SALFORD SINGULAR PERTURBATION METHODS IN VSTOL AIRCRAFT CONTROL LAW DESIGN
P. R. SMITH (Royal Aerospace Establishment, Bedford, England), D. HOPPER (Salford, University, England), and A. BRADSHAW (Lancaster, University, England) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 236-246. refs
(AIAA PAPER 89-3451) Copyright

The fundamental principles of the eigenstructure assignment and singular-perturbation techniques, as applied to the design of control laws for VSTOL aircraft, are examined in an analytical review, with a focus on developments at the University of Salford. The mathematical bases of the methods are outlined, and a control law for a hypothetical thrust-vectoring VSTOL aircraft in steady level flight at 120 knots is developed using each of the methods. Details of the procedures and numerical results are presented in extensive tables and graphs, and both of the controllers developed are found to have satisfactory performance. It is pointed out that the singular-perturbation method, with its graphical approach, is easier to use, but that eigenstructure assignment offers superior treatment of system zeros and is applicable to studies of handling qualities.
T.K.

A89-52551#
FLIGHT CONTROL SYNTHESIS FOR AN UNSTABLE FIGHTER AIRCRAFT USING THE LOG/LTR METHODOLOGY
THOMAS R. WENDEL (McDonnell Aircraft Co., Saint Louis, MO) and DAVID K. SCHMIDT (Arizona State University, Tempe) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 247-254. refs
(AIAA PAPER 89-3452) Copyright

The Linear-Quadratic-Gaussian with Loop-Transfer-Recovery design methodology is used to develop the flight control laws for a representative advanced fighter aircraft. The ability of the technique to meet both flying qualities and robustness requirements is examined. Initial application of the LOG/LTR methodology reveals that, because of an unstable pole in the open-loop plant, a relatively high bandwidth (30 radians/second) is required to achieve the desired loop shape. The ability to closely match a desired loop shape is important when flying qualities requirements must be satisfied. With this high bandwidth system, the flying qualities requirements are satisfied, however, insufficient high frequency attenuation exists to account for an unmodeled structural mode. The implications of this development are examined and potential solutions are identified and investigated.
Author

A89-52552#
APPLICATION OF PERFECT MODEL FOLLOWING TO A CONTROL CONFIGURED VEHICLE
WAYNE C. DURHAM IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 255-262.
(AIAA PAPER 89-3453) Copyright

Perfect explicit model following control is applied to a flight path angle command design problem for an aerodynamically unstable F-104 airplane. The problem features a model of lower order than the plant, performance specifications on the response to step commands and to external disturbances, and a requirement for satisfactory performance in the presence of changes in the plant parameters due to center of gravity shifts. The method presented features perfect model trajectory following, unambiguous understanding of the roles of the gains, and simple expressions for error dynamics. The expressions for the error dynamics permit analysis of system performance in the presence of variations in plant parameters using conventional methods.
Author

A89-52555#
LINEAR QUADRATIC GAUSSIAN DESIGN FOR ROBUST PERFORMANCE OF A HIGHLY MANEUVERABLE AIRCRAFT
DOUGLAS P. LOOZE (Massachusetts, University, Amherst) and JAMES S. FREUDENBERG (Michigan, University, Ann Arbor) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 282-288. refs
(Contract F33615-88-C-3601)
(AIAA PAPER 89-3457) Copyright

The robust command following problem with input uncertainty is investigated analytically. The derivation of the governing equations is outlined; design criteria are defined in terms of the desired characteristics of the compensated loop transfer function; a procedure for selecting the LQG/LTR weights is developed; and particular attention is given to the case of longitudinal dynamic control of a highly maneuverable aircraft (Hartmann et al., 1979). Numerical results are presented in extensive graphs and discussed in detail.
T.K.

A89-52558#
ON-BOARD AUTOMATIC AID AND ADVISORY FOR PILOTS OF CONTROL-IMPAIRED AIRCRAFT
ELAINE A. WAGNER (General Dynamics Corp., Fort Worth, TX) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 306-320. refs
(AIAA PAPER 89-3460) Copyright

The design and performance of an automatic aid and advisory system to permit pilots to maneuver an aircraft after partial failure of the flight-control systems are discussed, summarizing the results of the author's dissertation (Wagner, 1987). The need to change the automatic-control law after failure is stressed. Topics addressed include operating constraints, airspeed-type limitations on controllability, changes in stall and control-reversal airspeed, performance constraints, equilibria and other retrim information, and the structure of an expert system to find the appropriate postfailure emergency response. The response of a C-130 aircraft to -9-deg off-nominal elevator jam and expert-system-directed compensation is shown in graphs, and a preliminary description of an integrated recovery aid and advisory system is given. T.K.

A89-52561*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
MODELING OF AERODYNAMIC FORCES IN THE LAPLACE DOMAIN WITH MINIMUM NUMBER OF AUGMENTED STATES FOR THE DESIGN OF ACTIVE FLUTTER SUPPRESSION SYSTEMS
E. NISSIM (NASA, Flight Research Center, Edwards, CA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 332-352. refs
(AIAA PAPER 89-3466) Copyright

A method is proposed by which an aeroservoelastic problem is brought to a state-space form with a minimum number of augmented aerodynamic terms. The examples treated in this work relate to NASA's Drone for Aerodynamic and Structural Testing-Aerodynamic Research Wing 1 (DAST-ARW1) and to the YF-17 fighter model. It is shown that in all cases considered, the method yields a very good accuracy regarding the flutter parameters and the dynamic behavior of the systems, using only two augmented aerodynamic states. The method should prove useful in the design of lower order control laws based on optimal control theory.
Author

A89-52562#
SENSITIVITY DERIVATIVES OF FLUTTER CHARACTERISTICS AND STABILITY MARGINS FOR AEROSERVOELASTIC DESIGN
M. KARPEL (Technion - Israel Institute of Technology, Haifa) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 354-364. refs
(AIAA PAPER 89-3467) Copyright
The interaction between aeroelastic response, flutter, and control systems in a highly maneuverable flight vehicle is characterized analytically. A state-space approach is used to obtain exact derivatives of the flutter dynamic pressure, flutter frequency, and gain and phase margins with respect to the structural and control design variables. These expressions are then applied to the control-gain design problem for an active flexible wing model to be tested in the NASA Langley Transonic Dynamics Tunnel. Numerical results are presented in tables and graphs, demonstrating the accuracy and efficiency of the derivatives and their ease of implementation in control algorithms. T.K.

A89-52563#
AN EFFECTIVE FLUTTER CONTROL METHOD USING FAST, TIME-ACCURATE CFD CODES
D. OMINSKY and H. IDE (Rockwell International Corp., Los Angeles, CA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 365-375.
(AIAA PAPER 89-3468) Copyright
The application of state-of-the-art CFD codes to the construction of aircraft flutter-control laws is described and demonstrated. The advantages of the CFD time-integration approach over classical frequency-domain control-design methods are reviewed; the derivation of the equations of motion and the steps in a time-dependent aeroelastic computation are outlined; the information provided by the generic flexible-wing model is summarized; and the experimental verification of a full potential CFD code on this model is explained. For the flutter analysis, consideration is given to the harmonic control inputs and the effects of phase angle, amplitude, and frequency. The feedback-control formulation is presented, and numerical results are shown in extensive graphs. It is found that a control law capable of damping out a specified flutter mode can be developed at minimal cost in computation time and effort. T.K.

A89-52565#
STABILITY ANALYSIS OF FLEXIBLE BODY DYNAMICS FOR A HIGHLY MANEUVERABLE FIGHTER AIRCRAFT
H. M. YOUSSEF, S. P. LEE, and D. DINGEMAN (Lockheed Aeronautical Systems Co., Burbank, CA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 386-390. refs
(AIAA PAPER 89-3471) Copyright
Dynamics equations for an advanced fighter aircraft with flexible body structure have been developed. The linear and angular deformations are assumed to be small in the body reference frame. This allows the equations to be linearized in the deformation variables. The resulting integrated equations, the total body dynamics, and the flexible body dynamics are formulated in a state-space-like format for convenient implementation of computer programs. The equations simplify considerably in the case of constant angular rate of the body reference frame. A generic fighter aircraft structure model was developed and the stability effects due to high roll rate were studied. The results show that at high roll rates the rigid body modes become unstable and the frequency of the first bending mode is slightly lower with higher damping. The dynamics effects of the high roll rate is equivalent to adding a negative stiffness constant to the structure model. Author

A89-52579*# Minnesota Univ., Minneapolis.
NONLINEAR CONTROL OF A SUPERMANEUVERABLE AIRCRAFT
S. ANTONY SNELL, WILLIAM L. GARRARD (Minnesota, University, Minneapolis), and DALE F. ENNS (Honeywell Systems and Research Center; Minnesota, University, Minneapolis) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 519-531. refs
(Contract NAG1-821)
(AIAA PAPER 89-3486) Copyright
This paper describes a technique which may be used to design the flight control system for a highly maneuverable aircraft. The control system was provided to stabilize the dynamics of the aircraft model and allow it to fly simulated, poststall 'supermaneuvers'. Although the aircraft dynamics are highly nonlinear under these conditions, the gain-scheduled, flight control system was designed using basically linear techniques. A manuever generator was implemented to pilot the mathematical model through prescribed optimal trajectories. The control system design performed well while executing maneuvers involving small angular rates where the governing dynamics could be considered linear. However, the performance deteriorated once the model was subjected to high angular rates at high angle of attack. Author

A89-52580#
NONLINEAR STABILIZING CONTROL OF HIGH ANGLE OF ATTACK FLIGHT DYNAMICS
EYAD H. ABED (Maryland, University, College Park) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 532-536. refs
(Contract NSF CDR-88-03012; NSF ECS-86-57561; AF-AFOSR-87-0073)
(AIAA PAPER 89-3487) Copyright
A new approach to the feedback control of aircraft at high angles of attack is presented which is based on recent results of control of nonlinear systems at bifurcation points. The bifurcation control technique used here provides an analytically-based algorithmic approach to the stabilization of vehicles at the onset of flow separation. Wing rock stabilization for the HP 115 research aircraft is considered as an example. V.L.

A89-52581#
HIGH GAIN FLIGHT CONTROLLERS FOR NONLINEAR SYSTEMS
MARIO INNOCENTI (Auburn University, AL) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 537-545. refs
(AIAA PAPER 89-3488) Copyright
An approach to flight vehicle control is presented which is based on a combination of variable structure control (VSC) and hyperstability. VSC is used to derive the error dynamics and the convergence of the sliding hyperplanes. Hyperstability theory is used to derive the passive switching control laws by ensuring global stability of the sliding motion. Results of a prelimiary simulation involving glide slope and flare trajectories are examined. V.L.

A89-52582*# California Univ., Berkeley.
ON THE DESIGN OF NONLINEAR CONTROLLERS FOR FLIGHT CONTROL SYSTEMS
JOHN HAUSER, SHANKAR SASTRY (California, University, Berkeley), and GEORGE MEYER (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 546-555. Research supported by the Schlumberger Foundation and Berkeley Engineering Fund. refs
(Contract NAG2-243)
(AIAA PAPER 89-3489) Copyright
A method of approximate input-output linearization by dynamic

state feedback is presented, with the flight control of VTOL aircraft used as an example. It is shown that the closed loop system has a graceful degradation of performance as the moment-to-force coupling is increased. It is also demonstrated that the approach proposed here leads to an asymptotically stable closed loop system with guaranteed bounds on the tracking error caused by the nonminumum phase character of the system. V.L.

A89-52583#
OPTIMAL CONTROL FOR MAXIMUM ENERGY EXTRACTION FROM WIND SHEAR
GOTTFRIED SACHS, KLAUS LESCH, and ALEXANDER KNOLL (Muenchen, Technische Universitaet, Munich, Federal Republic of Germany) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 556-564. refs
(AIAA PAPER 89-3490) Copyright

Maximum energy extraction from wind shear by appropriate flight maneuvers is treated as an optimal control problem. This problem is solved by applying a numerical optimization procedure based on the method of multiple shooting. Necessaray optimality conditions are formulated with the use of the minimum principle. Additional optimization considerations are concerned with limiting bounds in regard to the optimal flight path, thus resulting in an optimization problem with a state variable constraint. The basic characteristics of optimal control for maximizing energy transfer from wind shear to the aircraft and the properties of the resulting trajectory are shown. Furthermore, an evaluation of the wind shear conditions necessary for maintaining a continuous flight is presented, covering a wide range of parameters generally important for the performance of aircraft. It is shown which of these parameters are significant for the energy extraction problem considered. Author

A89-52584#
COMPARISON OF CHARACTERISTIC LOCUS AND H-INFINITY METHODS IN VSTOL FLIGHT CONTROL SYSTEM DESIGN
S. J. WILLIAMS (Cambridge Control, England) and P. R. SMITH (Royal Aerospace Establishment, Bedford, England) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 565-575. Research supported by the Ministry of Defence Procurement Executive. refs
(AIAA PAPER 89-3491) Copyright

The objective of the work described in this paper has been to investigate the application of a variety of frequency-domain multivariable design techniques to the design of a VSTOL aircraft pitch plane dynamics control system. Multivariable 'Nyquist-like' methods have been used, including the Characteristic Locus and Direct Nyquist Array methods. In addition, more modern, optimization-based H(infinity) methods have also been used. The paper describes the background to the methods and then their use in design. The H(infinity) methods show great promise but there is still some work to be done before they will be established in common use - particularly for nonsquare systems. Author

A89-52587#
DESIGN OF ADAPTIVE DIGITAL MODEL-FOLLOWING FLIGHT-MODE CONTROL SYSTEMS FOR HIGH-PERFORMANCE AIRCRAFT
B. PORTER and M. Z. OTHMAN (Salford, University, England) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 593-601.
(AIAA PAPER 89-3495) Copyright

It is shown that by incorporating on-line recursive identifiers to provide updated step-response matrices for inclusion in digital PID control laws, highly effective adaptive digital model-following control systems can be readily designed for multivariable plants. The effectiveness of such a 'certainty equivalent' adaptive digital model-following control system is illustrated by the design of an adaptive digital flight-mode control system for the F-16 aircraft. Author

A89-52595#
EVALUATION METHODS FOR COMPLEX FLIGHT CONTROL SYSTEMS
MARK R. ANDERSON, URI H. RABIN, and JAMES H. VINCENT (Systems Control Technology, Inc., Palo Alto, CA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 667-675. refs
(Contract N00421-85-D-0155)
(AIAA PAPER 89-3502) Copyright

Fight control system verification requires an analytical comparison of system characteristics to the control system specification MIL-F-9490 and the appropriate flying quality specifications MIL-F-8785, MIL-F-8330, or MIL-STD-1797. These evaluations become increasingly difficult, however, as the design trend towards increased control system integration, sophistication, and coupling continues. This paper documents several extensions to existing methods for evaluating system stability margins and producing low-order equivalent models (for flying qualities evaluations) of complex aircraft flight control systems which may include over one-hundred states. Author

A89-52598*# Princeton Univ., NJ.
APPLICATION OF STOCHASTIC ROBUSTNESS TO AIRCRAFT CONTROL SYSTEMS
ROBERT F. STENGEL (Princeton University, NJ) and LAURA E. RYAN IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 698-708. Research sponsored by FAA. refs
(Contract NGL-31-001-252)
(AIAA PAPER 89-3505) Copyright

Stochastic robustness, a simple numerical procedure for estimating the stability robustness of linear, time-invariant systems, is applied to a forward-swept-wing aircraft control system. Based on Monte Carlo evaluation of the system's closed-loop eignevalues, this analysis approach introduces the probability of instability as a scalar stability robustness measure. The related stochastic root locus provides insight into robustness characteristics of the closed-loop system. Three Linear Quadratic controllers of decreasing robustness are chosen to demonstrate the use of stochastic robustness to analyze and compare control designs. Examples are presented illustrating the use of stochastic robustness analysis to address the effects of actuator dynamics and unmodeled dynamics on the stability robustness of the forward-swept-wing aircraft. Author

A89-52600#
MODIFICATION OF TRIM POINT AND FEEDBACK GAINS FOR FAILED AIRCRAFT
YOSHIMASA OCHI and KIMIO KANAI (Defense Academy, Yokosuka, Japan) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 717-727. refs
(AIAA PAPER 89-3507) Copyright

In this paper, two approaches are proposed for a restructurable flight control system which stabilizes and settles a failed aircraft at a desirable trim point. The first approach is based on the optimal regulator with identification both of the linearized mathematical model of the aircraft and of disturbances caused by failures. The trim point is modified to a desirable one using the estimates, and feedback gains are also updated with the Kleinman method at regular intervals. Simulation results are presented for the longitudinal motion of the F-8 with failures at the horizontal tails. The second one is based on the feedback linearization method with parameter identification of the nonlinear model of the aircraft. Since the state variables used are not their perturbations around the trim point. It is possible to settle them at a desirable point directly. Incorporating control distributor into the controller, simulation was conducted for the six degrees of freedom nonlinear aircraft model with many effectors. Author

A89-52602#
SURFACE FAILURE DETECTION AND EVALUATION OF CONTROL LAW FOR RECONFIGURATION OF FLIGHT CONTROL SYSTEM
PETROS IOANNOU (Southern California, University, Los Angeles, CA) and R. ROONEY (Lockheed Aeronautical Systems Co., Burbank, CA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 733-740. refs
(AIAA PAPER 89-3509) Copyright

The problem of detecting actuator surface failures and evaluating the control law for reconfiguration of flight control systems is considered. The method used for detecting failures is based on tracking error criteria which are developed by considering linear combinations of measured residual tracking errors. The tracking errors are generated using a model of the aircraft multivariable dynamics. Measurement disturbances/noise are also included and avoidance of false alarms is discussed. The detection and control law, which consists of a control mixer and a compensating signal, evaluation method is demonstrated using a six degree of freedom A-7D Digitac II aircraft model at 0.6 Mach and 15,000 ft. altitude. The simulation results indicate that failure detection can be fast and successful, and false alarms can be avoided by properly modifying the tracking error criteria. The method developed is independent of the feedback control input and therefore the controller of the system can be updated at different failure situations with absolutely no effect on the detection decision making. Author

A89-52609*# California Univ., Davis.
EVALUATION OF A TECHNIQUE FOR PREDICTING LONGITUDINAL PILOT-INDUCED-OSCILLATIONS
R. A. HESS (California, University, Davis) and R. M. KALTEIS IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 802-815. refs
(Contract NAG2-490)
(AIAA PAPER 89-3517) Copyright

A technique for predicting the susceptibility of an aircraft to longitudinal pilot-induced-oscillations (PIO's) is evaluated using 62 configurations from a pair of flight tests involving the NT-33 variable stability aircraft. The technique is based upon the characteristics of the open-loop pilot/vehicle system for attitude control as predicted by the Optimal Control Model (OCM) of the human pilot. The OCM is simplified so that only the index of performance weighting coefficients need to be considered as problem variables and a simple technique for generating these coefficients is reviewed. Author

A89-52611*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INTEGRATED FLIGHT/PROPULSION CONTROL SYSTEM DESIGN BASED ON A CENTRALIZED APPROACH
SANJAY GARG, DUANE L. MATTERN (NASA, Lewis Research Center; Sverdrup Technology, Inc., Cleveland, OH), and RANDY E. BULLARD (NASA, Lewis Research Center, Cleveland, OH) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 827-839. Previously announced in STAR as N89-26009. refs
(AIAA PAPER 89-3520)

An integrated flight/propulsion control system design is presented for the piloted longitudinal landing task with a modern, statically unstable, fighter aircraft. A centralized compensator based on the Linear Quadratic Gaussian/Loop Transfer Recovery methodology is first obtained to satisfy the feedback loop performance and robustness specificiations. This high-order centralized compensator is then partitioned into airframe and engine sub-controllers based on modal controllability/observability for the compensator modes. The order of the sub-controllers is then reduced using internally-balanced realization techniques and the sub-controllers are simplified by neglecting the insignificant feedbacks. These sub-controllers have the advantage that they can be implemented as separate controllers on the airframe and the engine while still retaining the important performance and stability characteristics of the full-order centralized compensator. Command prefilters are then designed for the closed-loop system with the simplified sub-controllers to obtain the desired system response to airframe and engine command inputs, and the overall system performance evaluation results are presented. Author

A89-52612*# Georgia Inst. of Tech., Atlanta.
THRUST VECTORING EFFECT ON TIME-OPTIMAL 90 DEGREES ANGLE OF ATTACK PITCH UP MANEUVERS OF A HIGH ALPHA FIGHTER AIRCRAFT
HAROLD STALFORD and ERIC HOFFMAN (Georgia Institute of Technology, Atlanta) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 840-846. refs
(Contract NAG1-959)
(AIAA PAPER 89-3521) Copyright

Using thrust vectoring, the problem of pitching up a high alpha fighter aircraft to 90 degrees angle of attack in minimum time is considered. Pontryagin's maximum principle is used together with a two-point boundary value numerical algorithm to derive open-loop controls for various parameterized limits on thrust vectoring angles. Without thrust vectoring, a high alpha fighter with initial conditions 0.6 Mach number and 15,000 feet requires 7.0 seconds to pitch-up to 90 degrees. However, with 20-degree angle thrust vectoring, the pitch-up takes only 1.5 seconds with a final Mach number of 0.47. Also, the gain in altitude is less than 100 feet. More important, additional thrust vectoring yields litle benefit beyond the 20-degree angles. This paper describes control solutions in detail for thrust vectoring angles between 0 and 90 degrees. Author

A89-52615#
INTELLIGENT FLIGHT MANAGEMENT PERFORMANCE USING DISCRETE-EVENT SIMULATION
JOHN L. VIAN (Boeing Military Airplanes, Wichita, KS) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 859-864.
(AIAA PAPER 89-3526) Copyright

Performance of an intelligent flight management system is evaluated using discrete-event simulation. An intelligence paradigm is formulated for military missions within high threat environments with logic based on mission state, information state, and processing state. The paradigm determines reactive, heuristic, suboptimal, or optimal four-dimensional operating modes for the trajectory generation process of the system. Overall performance is evaluated by determining operating mode as percentage of total mission time. Various aircraft and system processing configurations are evaluated for stochastically simulated threat beddowns. Author

A89-52628*# Mississippi State Univ., Mississippi State.
AN OBSERVER-BASED COMPENSATOR FOR DISTRIBUTED DELAYS IN INTEGRATED CONTROL SYSTEMS
ROGELIO LUCK (Mississippi State University, Mississippi State) and ASOK RAY (Pennsylvania State University, University Park) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 988-996. refs
(Contract NAG3-823)
(AIAA PAPER 89-3541) Copyright

This paper presents an algorithm for compensation of delays that are distributed within a control loop. The observer-based algorithm is especially suitable for compensating network-induced delays that are likely to occur in integrated control systems of the future generation aircraft. The robustness of the algorithm relative to uncertainties in the plant model have been examined. Author

A89-52642*# Planning Research Corp., Hampton, VA.
A MULTILOOP, DIGITAL FLUTTER SUPPRESSION CONTROL LAW SYNTHESIS CASE STUDY
VIVEK MUKHOPADHYAY (Planning Research Corp., Hampton, VA), BOYD PERRY, III, and THOMAS E. NOLL (NASA, Langley Research Center, Hampton, VA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1105-1113. refs
(AIAA PAPER 89-3556) Copyright

A methodology for obtaining a digital low-order, multiloop, robust control law for aeroelastic application from a full-state Linear Quadratic Gaussian design is presented. As part of the design methodology, the multivariable system robustness at the plant input and output is evaluated using singular value properties and improved using constrained optimization procedures. To validate the methodology, a digital flutter suppression system has been designed for the full-span Active Flexible Wing (AFW) wind-tunnel model as part of a collaborative effort between the NASA Langley Research Center and Rockwell International. Preliminary results for a low-order discrete, symmetric flutter suppression system design that significantly improved the AFW model stability are provided and the experiences gained during the design process are discussed. Author

A89-52643#
DYNAMIC STABILITY AND ACTIVE CONTROL OF ELASTIC VEHICLES ACTING WITH UNSTEADY AERODYNAMIC FORCES
SHILU CHEN, SHUO TANG, HENGYUAN YAN, and XIUFANG HUO (Northwestern Polytechnical University, Xian, People's Republic of China) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1114-1117. refs
(AIAA PAPER 89-3557) Copyright

The present study of the problems posed by elastic vehicle structures' control in unsteady aerodynamic structures derives longitudinal equations of disturbance motions, and a method for the analysis of aeroelastic effects on the stability of these vehicles is proposed which employs a simplified model of unsteady aerodynamic forces. The synthesis of an active control system's optimal design is studied from the viewpoint of the coordination of the design of active feedback controls, and the choice of vehicle control surface positions and gyroscopic sensors, for the most effective vibration suppression. O.C.

A89-52644#
APPLICATION OF TOTAL ENERGY CONTROL FOR HIGH PERFORMANCE AIRCRAFT VERTICAL TRANSITIONS
ANTHONY WARREN (Boeing Advanced Systems, Seattle, WA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1118-1126. refs
(AIAA PAPER 89-3559) Copyright

Energy management guidance algorithms for automated, fast transitions between cruise states are presented. These algorithms use total energy control principles to regulate throttle and flight control inputs. Two principal algorithms are used to perform cruise state transitions: Energy Hold/Altitude Hold - This algorithm consists of two guidance laws which regulate thrust and vertical lift to acquire and maintain a desired height/energy cruise point. Energy Capture - This algorithm regulates flight path angle at fixed throttle to coordinate height/speed transitions to a desired cruise point. It is primarily used for large energy transitions at max or min throttle setting, and requires switching to energy hold/altitude hold as the cruise state is approached. Author

A89-52645#
THRUST LAWS FOR MICROBURST WIND SHEAR PENETRATION
MARK L. PSIAKI (Cornell University, Ithaca, NY) and KIHONG PARK IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1127-1138. refs
(AIAA PAPER 89-3560) Copyright

Two thrust guidance strategies have been developed and analyzed for the ability that they give aircraft to safely penetrate microburst wind shear during landing approach. These are used in conjuction with a pitch steering strategy that has already been shown to give improved performance by maintaining nominal glide path in the presence of microburst winds. The strategies provide valuable understanding of good thrust policy in a microburst. One of the two strategies is to control the airspeed to its nominal value, and the other strategy is to control the airspeed or the inertial speed, which ever is smaller, to the nominal value. To evaluate these strategies, a simplified 1st-order aircraft model has been used. Headwind/tailwind and downdraft microburst models have been considered separately. The safe-performance limits with respect to ability to track glide path have been plotted and compared with those for optimal trajectories. The thrust laws' performance limits are not as good as those for optimal trajectories, as expected; the thrust guidance laws cannot use the global knowledge of the wind field that the optimal trajectories use. Nevertheless, the ability of the practical strategies to safely penetrate severe microburst wind shear has been demonstrated. The best performing guidance law was that which controlled the minimum of airspeed and inertial speed to a nominal value. This demonstrates the importance of using thrust to keep the inertial speed at or above the nominal value. Author

A89-52646*# Stanford Univ., CA.
OPTIMAL PATHS THROUGH DOWNBURSTS
YIYUAN ZHAO and A. E. BRYSON (Stanford University, CA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1139-1149. refs
(Contract NAG2-191)
(AIAA PAPER 89-3561) Copyright

The control of an aircraft's takeoff path through a downburst is presently formulated as a dynamic optimization problem with minimum-altitude constraint and two different performance measures; a landing path through a downburst is also discussed. Paths are determined which, in addition to maximizing an airspeed/altitude combination immediately after downburst penetration, minimize deviation from the intended flight path. For mild-to-moderate downbursts, the performance strategy maintains altitude at the expense of airspeed loss, while the survival strategy involves a descent of the aircraft to the minimum altitude in order to obtain greater airspeed. For a severe downburst, both optimal paths maintain minimum altitude. O.C.

A89-52659*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
APPLICATION OF VARIABLE-GAIN OUTPUT FEEDBACK FOR HIGH-ALPHA CONTROL
AARON J. OSTROFF (NASA, Langley Research Center, Hampton, VA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1249-1257. refs
(AIAA PAPER 89-3576) Copyright

This paper describes a variable-gain optimal discrete output-feedback design approach that is applied to a nonlinear flight regime covering a wide angle-of-attack range that includes stall and poststall. The paper includes brief descriptions of the variable-gain formulation, the discrete-control structure and flight equations used to apply the design approach, and the high performance airplane model used in the application. Both linear

and nonlinear analyses are shown for a longitudinal four-model design case with angles of attack of 5, 15, 35, and 60 deg.
Author

A89-52661#
ROBUST CONTROL SYSTEM DESIGN WITH MULTIPLE MODEL APPROACH AND ITS APPLICATION TO ACTIVE FLUTTER CONTROL
YOSHIKAZU MIYAZAWA (National Aerospace Laboratory, Chofu, Japan) and EARL H. DOWELL (Duke University, Durham, NC) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1267-1276. refs
(Contract NSF MSM-85-04105)
(AIAA PAPER 89-3578) Copyright

An approach to the design of a robust control system is proposed to apply to the active flutter control problem. The control system robustness is introduced by considering multiple plant models that represent the uncertain dynamics. Output feedback control with a fixed gain is assumed, and the gain is obtained by minimizing a quadratic performance index. An efficient and reliable computational algorithm based on the penalty function method is proposed. The algorithm is essential in the case when there is no obvious feedback gain that stabilizes all models. Active flutter control of a simple airfoil model in incompressible flow is considered as an example. The flow velocity, location of the center of gravity, and time delay inserted in the control loop are taken into account as uncertain parameters. The numerical results show that the multiple model approach can introduce a robust control system, where the performance is less sensitive to the parameter change considered than single model designs. Author

A89-52662#
ALGEBRAIC LOOP TRANSFER RECOVERY - AN APPLICATION TO THE DESIGN OF A HELICOPTER OUTPUT FEEDBACK CONTROL LAW
C. CHAMPETIER, J. F. MAGNI, and P. APKARIAN (ONERA, Centre d'Etudes et de Recherches de Toulouse, France) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1277-1282.
(AIAA PAPER 89-3579) Copyright

This paper is concerned with the problem of designing robust minimal order observer-based controllers. A simple and straightforward procedure achieving, in the observer case, the same level of robustness as a given state-feedback control law is derived. The proposed methodology is based on eigenspace techniques and is particularly suited to take into account design objectives expressed in terms of eigenvalues and eigenvectors. The stability robustness is considered at the plant input and thus is related to the corresponding return difference transfer matrix. The technique is applied to a realistic helicopter control problem. The performance and robustness properties of the derived controller are investigated in regard to wide changes in the flight condition. Author

A89-52671#
COMPARISON OF NONLINEAR CONTROLLERS FOR TWIN-LIFT CONFIGURATIONS
J. V. R. PRASAD, D. P. SCHRAGE, and MANOJ MITTAL (Georgia Institute of Technology, Atlanta) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1350-1357. refs
(AIAA PAPER 89-3591) Copyright

The stability and control problems associated with twin-lift helicopter configurations are analyzed. For the two twin-lift configurations viz. twin-lift with spreader bar and twin-lift without spreader bar, a nonlinear control scheme based on feedback linearization is presented. The performance of the resulting closed-loop systems in terms of trim attitudes and required control travel for carrying out a typical twin-filt mission is evaluated through nonlinear simulation. Also, the effect of controller and sensor degradations on the overall system performance is discussed.
Author

A89-52672#
DEVELOPMENT OF A FLIGHT CONTROL SYSTEM FOR VTOL AIRCRAFT SUPPORTED BY DUCTED FANS
S. NIWA, M. SUZUKI (Nagoya University, Japan), I. SUGIURA (Chubu University, Kasugai, Japan), J. KONDO (Hitachi Zosen Technical Research Institute, Japan), M. MURAKAMI (Hitachi Zosen Corp., Japan) et al. IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1358-1365. refs
(AIAA PAPER 89-3592) Copyright

This paper presents a design of automatic flight control system for VTOL research aircraft supported by four ducted fans. Two remotely piloted research models, an electric motor model and an engine model, are developed for the purpose of detailed investigation of ducted fan type VTOL aircrafts. Especially the development of the automatic flight control system is one of the main purposes of this research. Automatic flight control systems which aid remote piloting are designed to control the attitude and altitude of these models. Many kinds of control tests on the test stands were performed to examine the control systems. As the result of a lot of flight tests, fairly well automatic stabilization of attitude and altitude of the reseach models was achieved in hovering and low speed flight condition. Author

A89-52673#
THE FLIGHT CONTROL SYSTEM FOR THE DAEDALUS HUMAN POWERED AIRCRAFT
R. BRYAN SULLIVAN (Orbital Sciences Corp., Fairfax, VA) and STEPHEN L. FINBERG (Charles Stark Draper Laboratory, Inc., Cambridge, MA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1366-1372.
(AIAA PAPER 89-3593) Copyright

The design and testing of an autopilot system for the Daedalus human powered aircraft are reviewed. In particular, attention is given to the airspeed hold system, wing leveler and heading hold system, electrostatic sensors, and the effect of the structural flexibility of the tailboom on the longitudinal and lateral dynamics. Although performance degradation was observed when the flexibility effects were included, adequate performance was achieved by proper augmentation of the feedback compensation. It is noted that the experience gained from the work on the Daedalus autopilot system should prove useful in the design of autopilots for future human powered aircraft. V.L.

A89-52674*# Boeing Commercial Airplane Co., Seattle, WA.
DESIGN OF INTEGRATED AUTOPILOT/AUTOTHROTTLE FOR NASA TSRV AIRPLANE USING INTEGRAL LQG METHODOLOGY
ISAAC KAMINER and RUSSELL A. BENSON (Boeing Commercial Airplanes, Seattle, WA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1373-1391. refs
(Contract NAS1-18027)
(AIAA PAPER 89-3595) Copyright

An integrated autopilot/autothrottle control system has been developed for the NASA transport system research vehicle using a two-degree-of-freedom approach. Based on this approach, the feedback regulator was designed using an integral linear quadratic regulator design technique, which offers a systematic approach to satisfy desired feedback performance requirements and guarantees stability margins in both control and sensor loops. The resulting feedback controller was discretized and implemented using a delta coordinate concept, which allows for transient free controller switching by initializing all controller states to zero and provides a simple solution for dealing with throttle limiting cases. V.L.

A89-52675*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

INITIAL FLIGHT QUALIFICATION AND OPERATIONAL MAINTENANCE OF X-29A FLIGHT SOFTWARE

MICHAEL R. EARLS and JOEL R. SITZ (NASA, Flight Research Center, Edwards, CA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1392-1415.
(AIAA PAPER 89-3596) Copyright

This paper is predominantly a nontechnical discussion of some significant aspects of the initial flight qualification and operational maintenance of the flight control system software for the X-29A technology demonstrator. Flight qualification and maintenance of complex, embedded flight control system software poses unique problems. The X-29A technology demonstrator aircraft has a digital flight control system which incorporates functions generally considered too complex for analog systems. Organizational responsibilities, software assurance issues, tools, and facilities are discussed. Author

A89-52685#

ROBUST EIGENSTRUCTURE ASSIGNMENT FOR FLIGHT CONTROL USING THE CTRL-C DESIGN PACKAGE

S. P. BURROWS and R. J. PATTON (York, University, Heslington, England) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1489-1494. refs
(AIAA PAPER 89-3607) Copyright

Eigenstructure assignment for linear systems is basically an inverse eigenvalue problem. A robust eigenstructure assignment is one such that the eigenvalues of the closed-loop system are made insensitive to perturbations applied to the elements of the system matrices using a linear state feedback control law. Two possible solutions to this are presented here, the second of which is a refinement of an earlier version and performs more reliably when assigning a number of complex eigenvalues. Both have been implemented on the commercially available Ctrl-C Design Package for control system design and analysis. These algorithms use Singular Value Decomposition for the calculation of assignable eigenvector subspaces and are shown to produce robust solutions to the state-feedback pole assignment problem. An aircraft example is included in order to demonstrate the relative strengths of the two techniques. Author

A89-52687*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

MODAL TECHNIQUES FOR ANALYZING AIRPLANE DYNAMICS

P. DOUGLAS ARBUCKLE and STEVEN M. SLIWA (NASA, Langley Research Center, Hampton, VA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1502-1511. refs
(AIAA PAPER 89-3609) Copyright

A series of techniques are presented for analyzing airplane control and output characteristics. State-space matrix equations describing the linear perturbation dynamics are transformed from physical coordinates into scaled, modal coordinates. Techniques for analyzing the impacts of system inputs on the fundamental modes of motion and the appearance of these modes in the system outputs are explained. Scaled modal matrices are used to compute steady-state control inputs which optimize the steady-state response of selected system outputs. Graphics which promote quick understanding of the analysis are presented to display the resulting vectors and matrices. The defined analysis techniques are applied to an example airplane model, illustrating the insight which can be acquired using the described modal techniques. Author

A89-52688*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

ACTIVE FLUTTER SUPPRESSION USING INVARIANT ZEROS/EIGENSYSTEM ASSIGNMENT

S. SRINATHKUMAR and W. M. ADAMS, JR. (NASA, Langley Research Center, Hampton, VA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1512-1518. refs
(AIAA PAPER 89-3610) Copyright

An active control law is synthesized to raise the flutter dynamic pressure boundary of an active flexible wing wind tunnel model. The multi-input/multi-output controller has a two-degree-of-freedom structure consisting of: (1) an output dynamic compensator selected to assign system invariant zeros to shape the multivariable root loci, and (2) an output gain feedback controller, based on eigensystem assignment theory, using the compensator augmented system to stabilize the flutter mode and optimize a specified performance index. Evaluation of a digital implementation of a constant gain controller in a general batch simulation of the system reveals that the feedback system is stable over a dynamic pressure range of 50-400 psf, indicating robustness of design to dynamic pressure variations. Author

A89-52690#

A PERFECT EXPLICIT MODEL FOLLOWING CONTROL SOLUTION TO IMPERFECT MODEL FOLLOWING CONTROL PROBLEMS

FREDERICK H. LUTZE (Virginia Polytechnic Institute and State University, Blacksburg) and WAYNE C. DURHAM IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1525-1534. refs
(AIAA PAPER 89-3612) Copyright

For cases in which perfect model following is not possible for a particular desired model, a class of candidate models is defined that can be followed perfectly by the given plant. A candidate model that most closely matches the dynamics of the desired model is then determined through constrained parameter optimization. The result is perfect model following of a model that has an eigenstructure that closely resembles that of the desired model. A new variation on perfect model following control law development explicitly displays the feedforward and feedback gains that determine the system error dynamics, which may be arbitrarily selected by conventional pole placement methods if the plant is completely controllable. Author

A89-52692*# Georgia Inst. of Tech., Atlanta.

SINGULAR TRAJECTORIES FOR TIME-OPTIMAL HALF-LOOP MANEUVERS OF A HIGH ALPHA FIGHTER AIRCRAFT

ERIC HOFFMAN and HAROLD STALFORD (Georgia Institute of Technology, Atlanta) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1544-1552. refs
(Contract NAG1-59)
(AIAA PAPER 89-3614) Copyright

Consideration is given to the problem of deriving a time-optimal open-loop control for the half-loop maneuver of a high-alpha aircraft, with initial conditions Mach 0.6 and 15,000 feet. Pontriagin's maximum principle is used to derive candidate optimal solutions. Using the two-point boundary-value algorithm, the flight path angle is maximized for various increasing specified final times until a final time of 13.6 sec yields a 180-deg flight-path angle. As the final time increased from 0.0 to 13.6 sec, the optimization process revealed 13 distinct switching structures of the control law, of which 11 contained singular arcs, and two had double singular arcs. Author

A89-52694#

ON OPTIMAL RIGID BODY MOTIONS

EUGENE M. CLIFF, FREDERICK H. LUTZE (Virginia Polytechnic

Institute and State University, Blacksburg), and RAJIV S. CHOWDHRY IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1560-1569. Research supported by DARPA. refs
(Contract F49620-87-C-0116)
(AIAA PAPER 89-3616) Copyright

Optimal rigid body angular motions are studied for the case of the absence of direct control over one of the angular velocity components. Numerical results for the first-order necessary conditions for optimality indicate that over a large range of boundary conditions there are, in general, several distinct extremal solutions. Subfamilies of extremal solutions have been classified, and the domains of existence of the extremal subfamilies are identified. The global optimality of extremal solutions has been determined in relation to a locus of Darboux points. Second-order necessary conditions have also been obtained, verifying local optimality for the candidate minimizers. R.R.

A89-52718#
LATERAL ELECTRIC FLIGHT CONTROL LAWS OF A CIVIL AIRCRAFT BASED UPON EIGENSTRUCTURE ASSIGNMENT TECHNIQUE
J. FARINEAU (Aerospatiale, Toulouse, France) AIAA, Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989. 16 p.
(AIAA PAPER 89-3594) Copyright

This paper demonstrates an application of the eigenvector theory to the lateral electric flight control law of the A320 aircraft. Consideration is given to the lateral aircraft flight mechanics. The various modes relative to the roll and yaw movements are considered, and the fly-by-wire system structure is described. Some flight test results are presented. I.S.

A89-52989#
ADAPTIVE CONTROL OF HIGH PERFORMANCE UNSTABLE AIRCRAFT - A REVIEW
B. S. REDDY, KOTA HARINARAYANA (Aeronautical Development Agency, Bangalore, India), and J. CHANDRASEKHAR (Indian Institute of Technology, Bombay, India) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 41, Feb. 1989, p. 15-19. refs

Successful implementation of active control technology (ACT) requires a clear definition of critical issues and synthesis techniques for flight-control-system design. The emergence of ACT as a design feature raises several questions in respect of acceptable handling quality, power requirements, and control-law synthesis. This review covers various fundamental issues, design problems, and possible design solutions of adaptive flight-control systems for high-performance unstable aircraft. Author

A89-53301*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INTEGRATED FLIGHT/PROPULSION CONTROL SYSTEM DESIGN BASED ON A DECENTRALIZED, HIERARCHICAL APPROACH
DUANE MATTERN, SANJAY GARG (NASA, Lewis Research Center; Sverdrup Technology, Inc., Cleveland, OH), and RANDY BULLARD (NASA, Lewis Research Center, Cleveland, OH) AIAA, Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989. 13 p. refs
(AIAA PAPER 89-3519) Copyright

A sample integrated flight/propulsion control system design is presented for the piloted longitiudinal landing task with a modern, statistically unstable fighter aircraft. The design procedure is summarized, the vehicle model used in the sample study is described, and the procedure for partitioning the integrated system is presented along with a description of the subsystems. The high-level airframe performance specifications and control design are presented and the control performance is evaluated. The generation of the low-level (engine) subsystem specifications from the airframe requirements are discussed, and the engine performance specifications are presented along with the subsystem control design. A compensator to accommodate the influence of airframe outputs on the engine subsystem is also considered. Finally, the entire closed loop system performance and stability characteristics are examined. C.D.

A89-53640
STUDY ON A DESIGN METHOD FOR THE LATERAL STABILITY OF THE AIRPLANE BY THE CONDITIONS FOR THE STEADY HORIZONTAL TURN WITH CONTROL SURFACES FIXED
MASAYOSHI NAGASHIMA and KUNIHIKO YAMAUCHI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 37, no. 426, 1989, p. 337-343. In Japanese, with abstract in English.
Copyright

This report clarifies the relation between the lift coefficient and the dihedral angle of the main wing and the vertical tailplane for an airplane, given a shape of the fuselage and a plane form of the main wing, to be able to turn steadily at a small bank angle and with all control surfaces fixed. Here, the balancing of the moments of air forces about the vertical axis and longitudinal axis is considered. For simplicity, the air forces are assumed to be two-dimensional. From this relation, the suitable values of the dihedral angle and the vertical tail plane area and the position of the airplane to be designed will be evaluated by referring to these values of many excellent airplanes already in practical service. Author

A89-53955
AN IMPROVED PSEUDO STATE METHOD FOR AIRCRAFT CONTROLLER DESIGN
CHIN E. LIN and JIEH-SHIAN YOUNG (National Cheng Kung University, Tainan, Republic of China) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 1. New York, Institute of Electrical and Electronics Engineers, 1989, p. 128-133. refs
Copyright

An improved method for compensator design in aircraft control applications is presented. A design technique using a pseudo-state equation together with an enlarged system is discussed. This method improves the redesign procedure when the compensator characteristics cannot meet the required specifications. The theoretical basis of the proposed method is investigated, and an algorithm is developed. To prove the effectiveness of the pseudo-state method, an example of an aircraft controller for landing approach is discussed and tested. The simulation results show that the redesign efforts are reduced, and the characteristics of the designed compensators are improved. I.E.

A89-53957* Minnesota Univ., Minneapolis.
NONLINEAR LONGITUDINAL CONTROL OF A SUPERMANEUVERABLE AIRCRAFT
WILLIAM L. GARRARD, ANTHONY SNELL (Minnesota, University, Minneapolis), and DALE F. ENNS (Honeywell Systems and Research Center; Minnesota, University, Minneapolis) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 1. New York, Institute of Electrical and Electronics Engineers, 1989, p. 142-147. refs
(Contract NAG1-821)
Copyright

A technique is described which can be used for design of feedback controllers for high-performance aircraft operating in flight conditions in which nonlinearities significantly affect performance. Designs are performed on a mathematical model of the longitudinal dynamics of a hypothetical aircraft similar to proposed supermaneuverable flight test vehicles. Nonlinear controller designs are performed using truncated solutions of the Hamilton-Jacobi-Bellman equation. Preliminary results show that the method yields promising results. I.E.

A89-53959
FLIGHT CONTROL RECONFIGURATION USING MODEL REFERENCE ADAPTIVE CONTROL
WILLIAM MORSE and KATHLEEN OSSMAN (Ohio State University, Columbus) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 1. New York, Institute of Electrical and Electronics Engineers, 1989, p. 159-164. refs
(Contract F49620-88-C-0053)
Copyright

A simplified multivariable model reference adaptive control (MRAC) is shown to provide control reconfiguration for the AFTI/F16 during single, double, triple, and quadruple control surface failures. The simplified MRAC is unique in that it can use a reduced-order model and is applicable to unstable nonminimum-phase plants. The MRAC is capable of implicitly redistributing the control effort among the aircraft's effective surfaces without explicit knowledge of the failure. The resulting control reconfiguration forces the aircraft to approximate the reference model trajectories. The AFTI/F16 model used for simulations incorporated the nonlinear rate and saturation-limited servo dynamics. I.E.

A89-53976
LATERAL AXIS AUTOPILOT DESIGN FOR LARGE TRANSPORT AIRCRAFT - AN EXPLICIT MODEL-MATCHING APPROACH
K. DEAN MINTO (GE Control Systems Laboratory, Schenectady, NY), JOE H. CHOW, and JAN BESELER (Rensselaer Polytechnic Institute, Troy, NY) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 1. New York, Institute of Electrical and Electronics Engineers, 1989, p. 585-591. refs
Copyright

A description is given of the application of a technique for linear multivariable control law design to an autopilot design problem for large transport aircraft. The method is based on an explicit model-matching approach in the frequency domain, whereby compensator parameters are tuned via a least-squares approach to minimize the error between desired and actual closed-loop frequency responses. Recently, the design method has been overhauled to incorporate some of the latest theoretical advances, including controller parameterization and plant factorization. The resulting design technique has been considerably streamlined and is now implemented within the ISICLE package, a PRO-MATLAB based toolbox. One of the unique features of the ISICLE design package is the ability to deal with constraints on the compensator dynamic order and structure in a straightforward manner. Such constraints often arise in practical problems from the necessity for reduced complexity in the compensator, in order to deal effectively with issues such as gain scheduling and limit protection. I.E.

A89-53977
DESIGN OF LOCALIZER CAPTURE AND TRACK MODES FOR A LATERAL AUTOPILOT USING H(INFINITY) SYNTHESIS
ISAAC KAMINER, GREG ROBEL (Boeing Commercial Airplanes, Seattle, WA), and PRAMOD P. KHARGONEKAR (Minnesota, University, Minneapolis; Boeing Commercial Airplanes, Seattle, WA) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 1. New York, Institute of Electrical and Electronics Engineers, 1989, p. 592-601. refs
Copyright

Results are presented of a design exercise in which the most recent developments in H(infinity) synthesis theory were applied to the problem of designing a lateral autopilot for a typical transport airplane. The bulk of the engineering effort in applying these results was in the formulation of an appropriate synthesis model. Once this was done, H(infinity) synthesis led to a satisfactory design after only a few iterative adjustments of the weights on the criterion outputs. It is concluded that these developments have made H(infinity) synthesis an effective tool for multivariable control design. I.E.

A89-53978
DESIGN OF LOCALIZER CAPTURE AND TRACK USING CLASSICAL CONTROL TECHNIQUES
YAGHOOB S. EBRAHIMI and EDWARD E. COLEMAN (Boeing Commercial Airplanes, Seattle, WA) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 1. New York, Institute of Electrical and Electronics Engineers, 1989, p. 602-608.
Copyright

A typical localizer mode of the automatic landing system control laws provided in all new Boeing commercial airplanes is discussed. The linear control law diagram of this mode consists of three separate modules: yaw damper, roll inner loop, and localizer outer loop. The yaw damper and roll inner loop are used in conjunction with other modes of the roll axis control laws of the autopilot and are, therefore, predetermined for the localizer mode. I.E.

A89-53979
INTEGRAL LQG MODEL FOLLOWING CONTROLLER
EDWARD E. COLEMAN (Boeing Commercial Airplanes, Seattle, WA) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 1. New York, Institute of Electrical and Electronics Engineers, 1989, p. 609-614.
Copyright

The design of a single autopilot control system to provide both lateral axis stability augmentation and aircraft directional control across the flight envelope is discussed. The autopilot provides heading and ground track heading hold for cruise, and localizer beam capture and hold for landing approach. The approach taken was to use ailerons and rudder to control heading and sideslip independently. The feedback controller was designed to provide stability augmentation and sufficient command response bandwidth to meet the performance requirements. A separate feedforward controller was designed to filter pilot inputs to achieve desired transient responses. An additional outer-loop controller generates heading commands for localizer capture and hold. I.E.

A89-53980
A MULTIVARIABLE CONTROL DESIGN FOR THE LATERAL AXIS AUTOPILOT OF A TRANSPORT AIRCRAFT
S. H. JAVID, R. A. HAMMOND, B. R. UMMEL (Boeing Computer Services, Seattle, WA), J. H. CHOW, and M. A. KALE (Rensselaer Polytechnic Institute, Troy, NY) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 1. New York, Institute of Electrical and Electronics Engineers, 1989, p. 615-620. refs
Copyright

A lateral axis control problem for a transport aircraft is described. The application of a multivariable control design method to solve this problem is presented. A simulation of the performance of the resulting control design shows a smooth bank and turn without hitting mechanical actuator positions or rate limits. I.E.

A89-53988
ASYMPTOTICALLY DECOUPLED VARIABLE STRUCTURE CONTROL OF SYSTEMS AND LARGE MANEUVER OF AIRCRAFT
SAHJENDRA N. SINGH (Nevada, University, Las Vegas) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 1. New York, Institute of Electrical and Electronics Engineers, 1989, p. 717-722. refs
(Contract DAAL03-87-G-0004)
Copyright

The author treats the question of control of a class of nonlinear systems that can be decoupled by state variable feedback. Based on variable-structure-system theory, a discontinuous control law is derived which accomplishes asymptotic decoupled output trajectory following in the presence of uncertainty in the system. In the closed-loop system, the trajectories are attracted towards a chosen hypersurface in the state space and then slide along it. During the sliding phase the motion is insensitive to parameter variations. Based on this result, a control law for asymptotically decoupled control of roll angle, angle of attack, and sideslip in rapid, nonlinear maneuvers is derived. Simulation results are presented to show that large, simultaneous lateral and longitudinal maneuvers can be performed in spite of uncertainty in the stability derivatives. I.E.

A89-54080

QFT DIGITAL CONTROLLER FOR AN UNMANNED RESEARCH VEHICLE (URV)

S. HAMILTON, I. M. HOROWITZ, and C. H. HOUPIS (USAF, Institute of Technology, Wright-Patterson AFB, OH) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 3. New York, Institute of Electrical and Electronics Engineers, 1989, p. 2441-2452. refs

Copyright

Quantitative feedback theory (QFT) is used to design the digital flight control system for an unmanned research vehicle (URV). Digital controllers are designed for three outputs which are controlled by seven independent control surfaces. The system is transformed into the w'-domain, and a 3 x 7 plant matrix P of transfer functions relating surface deflections to system outputs incorporating servos is derived. A single set of fixed controllers and prefilters is obtained by QFT; they apply the appropriate feedback to maintain control over the entire range of uncertainty due to surface failures. Single, double, and triple failures are considered. Failed surfaces are considered locked in the trim condition. Fault detection/isolation and scheduling are not required. A modification is made to the controllers to compensate for the addition of more realistic servos and sensors. The resulting design is nearly as robust as the original system. The QFT design controls the A/C despite the uncertainty due to surface failures, and both the continuous and discrete domains satisfy the design objectives. I.E.

A89-54081* Georgia Inst. of Tech., Atlanta.

MAXIMUM PRINCIPLE SOLUTIONS FOR TIME-OPTIMAL HALF-LOOP MANEUVERS OF A HIGH ALPHA FIGHTER AIRCRAFT

HAROLD STALFORD and ERIC HOFFMAN (Georgia Institute of Technology, Atlanta) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 3. New York, Institute of Electrical and Electronics Engineers, 1989, p. 2453-2458. refs

(Contract NAG1-959)

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An investigation was conducted of maximum principle solutions for an initial 0.6 Mach number and 15,000-ft altitude. The authors generate these solutions for a family of prescribed final times tf, starting with tf = 0.5 s. Using a nonlinear wind-tunnel model they construct maximum principle solutions. Above tf = 1.2 s some small nonlinear variations in the aerodynamic pitching moment coefficient presented difficulty with respect to numerical convergence. This was circumvented by fitting analytical models to the aerodynamic coefficients of the wind-tunnel model at Mach 0.4. Maximum principle solutions of the analytical model are shown to compare well with those obtained for tf of less than 1.2 s. Using the analytical model the authors extended the prescribed final time to a value of 13.65 s at which time the aircraft completes the half-loop maneuver. This is 0.53 s longer than that obtained using the singular perturbation feedback control law. I.E.

A89-54084* Georgia Inst. of Tech., Atlanta.

STUDY OF A PURSUIT-EVASION GUIDANCE LAW FOR HIGH PERFORMANCE AIRCRAFT

PEGGY S. WILLIAMS, P. K. A. MENON (Georgia Institute of Technology, Atlanta), ROBERT F. ANTONIEWICZ, and EUGENE L. DUKE (NASA, Flight Research Center, Edwards, CA) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 3. New York, Institute of Electrical and Electronics Engineers, 1989, p. 2469-2474.

Copyright

The study of a one-on-one aircraft pursuit-evasion guidance scheme for high-performance aircraft is discussed. The research objective is to implement a guidance law derived earlier using differential game theory in conjunction with the theory of feedback linearization. Unlike earlier research in this area, the present formulation explicitly recognizes the two-sided nature of the pursuit-evasion scenario. The present research implements the guidance law in a realistic model of a modern high-performance fighter aircraft. Also discussed are the details of the guidance law, implementation in a highly detailed simulation of a high-performance fighter, and numerical results for two engagement geometries. Modifications of the guidance law for onboard implementation is also discussed. I.E.

A89-54347

CONCEPTS FOR CONTROL OF HYPERVELOCITY VEHICLES

JAMES E. SORRELLS (Dynetics, Inc., Huntsville, AL) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 242-246. Research supported by USAF. refs

Copyright

Disturbance-accommodating control (DAC) theory is highly suited to the management of uncertainties encountered in the control tasks of a hypervelocity vehicle. Both parametric and dynamical uncertainties are taken into account into the control law-development algorithms resulting from the application of DAC theory to this class of problems. DAC theory, due to its generality, allows the designer to anticipate vector disturbance processes; when the problem in question is stated within this framework, standard modern control state space control law design algorithms become candidate methods for designing the individual control actions. O.C.

A89-54371

FLIGHT SYSTEMS DESIGN ISSUES FOR A RESEARCH-ORIENTED HYPERSONIC VEHICLE

PHILIP J. HAMORY (Datamax Computer Systems, Inc., Edwards, CA) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 455-468. refs

Copyright

The impact of flight system design for a research-oriented hypersonic vehicle is examined. The design requirements of the vehicle are discussed, incuding strong onboard processing capability, integrated propulsion and flight controls, and analytic redundancy management. Consideration is given to tradeoffs between synchronization and asynchronization, distributed and centralized architectures, and digital and analog backup systems. A research-oriented hypersonic vehicle structure is proposed which uses nodal network architecture to maximize flight system effectiveness in controlling various tasks. R.B.

A89-54799

A CURSORY STUDY OF F-FACTOR APPLIED TO DOPPLER RADAR

KIMBERLY L. ELMORE and WAYNE R. SAND (National Center for Atmospheric Research, Boulder, CO) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 130-134. Research supported by the National Center for Atmospheric Research.

(Contract DTFA01-82-Y-10513)

Copyright

A method is presented in which single-Doppler radar data is used to calculate the F-factor, which may be used to quantitatively characterize the effect of wind shear on jet performance (Bowles and Targ, 1988). The method calculates the F-factor with a monochromatic sine-wave model fitted to the radar data. The results from this approach are compared to those from the least-sqares estimate. R.B.

N89-28522# Technische Univ., Berlin (Germany, F.R.). Inst. fuer Luft- und Raumfahrt.
STATUS AND DEVELOPMENT POTENTIAL OF THE FLY BY LIGHT TECHNOLOGY IN CIVIL AIRCRAFT [STAND UND ENTWICKLUNGSPOTENTIAL DER FLY-BY-LIGHT TECHNOLOGIE IN ZIVILEN LUFTFAHRZEUGEN]
HEINRICH MENSON and RALPH SCHUETTE Apr. 1988 142 p In GERMAN
(ILR-MITT-212; ETN-89-94562) Avail: NTIS HC A07/MF A01

Fiber optics communication techniques and their applicability in flight control are reviewed. The design of an optical digital system (communication principle, emitting sources, optical waveguides, receiver element, optical coupling) is outlined. The fundamentals of data communication systems aboard aircrafts, the technical requirements and operational behavior of optical components, and existing fly by light concepts are presented. Fly by light technology is compared with conventional technology. Further application of fiber optics elements in aircrafts are discussed. ESA

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.

A89-52613#
MAP, OPERATOR, MAINTENANCE STATIONS
RICK POPE (Horizons Technology, Inc., San Diego, CA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 847-849.
(AIAA PAPER 89-3523) Copyright

The complexity of mission planning has grown proportionally with the sophistication of the planes that fly the missions. Due to that complexity, mission planning has gravitated to the mainframe computer, creating a physical gap between the development of mission planning data and the application of that data. The Map, Operator, and Maintenance Stations (MOMS), has bridged that gap by allowing the development of mission planning to be carried to the operational area of the aircraft. The MOMS system is three coordinated stations that can generate map data, develop mission plans, and perform integrated maintenance support. Author

A89-53476#
EXCITATION OF AIRCRAFT FOR HARDNESS SURVEILLANCE USING THE AIRCRAFT'S OWN HF ANTENNA
L. O. HOEFT, J. S. HOFSTRA (BDM Corp., Albuquerque, NM), and W. D. PRATHER (USAF, Weapons Laboratory, Kirtland AFB, NM) IN: IEEE 1989 National Symposium on Electromagnetic Compatibility, Denver, CO, May 23-25, 1989, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1989, p. 87-89.

A technique is reported for testing the electromagnetic radiation hardening of aircraft. The electromagnetic excitation of the aircraft is accomplished by driving the aircraft's high-frequency (HF) antenna at the fundamental resonant frequency of the aircraft. Surface magnetic fields in the range of 1 to 10 mA/m were easily produced with 15 W of RF power. In addition to exciting the fundamental resonances, useful surfaces fields from 10 to 100 MHz were also obtained. The technique is called antenna SPEHS (single-point excitation for hardness surveillance). Measurements of the magnetic field at a prescribed distance from the outside and inside surfaces of hardened apertures, such as window screens and gasketed doors, were made using a multiturn loop sensor and a battery-operated field-strength meter. I.E.

A89-54349
AUSTRALIAN HYPERSONIC FACILITIES
VINCENT CAPIZZI (British Aerospace Australia, Ltd., Salisbury, Australia) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 263-266. refs
Copyright

Two Australian free piston-driven shock tunnels are shown to offer high-enthalpy hypervelocity flow to simulate gas effects during the ascent and reentry phases of aerospace vehicles. The primary simulation variables are stagnation enthalpy and the binary scaling parameter; real gas effects are noted, and prospects for the validation of CFD investigations of hypersonic flows are evaluated. Both shock tunnels are currently being used in tests of such hypervelocity vehicle designs as HOTOL, Hermes, and the NASA National Aerospace Plane; one has seen specialized use as a testbed for scramjet propulsion, and the other is developing a CARS optical-diagnostics facility. O.C.

A89-54368
FACILITIES AND SUPPORT REQUIREMENTS FOR ADVANCED FLIGHT VEHICLES
MICHAEL G. VENACCIO (USAF, Grand Forks AFB, ND) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 432-436.
Copyright

This paper is intended to stimulate discussion and thought on the facilities, support equipment, and spares required to support future aerospace vehicles. The scope of the data presented is based on the requirements needed to support the B-IB. Maintenance facility requirements and construction are discussed in depth along with spares requirements considerations and maintainability and reliability issues. Author

N89-28523# Naval Civil Engineering Lab., Port Hueneme, CA.
JOINT SEALANTS FOR AIRPORT PAVEMENTS. PHASE 1: LABORATORY AND FIELD INVESTIGATIONS Final Report, Jul. 1986 - Dec. 1988
C. M. INABA, M. C. HIRONAKA, and T. NOVINSON Dec. 1988 63 p
(Contract DTFA01-86-1-02015)
(DOT/FAA/DS-89/2-PHASE-1) Avail: NTIS HC A04/MF A01

The objectives were to determine the essential characteristics of sealants for joints in Portland cement concrete (PCC) airport pavements that should be incorporated in specifications and select best candidate sealants for field evaluation. Laboratory and field investigations of sealants were performed for data needed to meet these objectives. Major factors that sealants must be resistant to are: chemicals (jet fuel, hydraulic fluid, lubricating oil), physical (elongation, compression, intrusion), and environmental (thermal, sunlight, weathering). In laboratory specification conformance tests, only 3 of 18 (17 percent) of the sealants passed the tests. In field inspection of sealants and discussions with airport personnel, there was no one clearly outstanding performing seal that was identified; however, several airports favored the Dow Corning 888 silicone seal. There is a strong indication of material of specification (or both) deficiencies. Sealants selected for evaluation in Phase 2 have the following material compositions: silicone, polyurethane, coal tar/polyvinyl chloride, and chloroprene. Author

N89-28524# Mitre Corp., McLean, VA.
DIRECT USER ACCESS TERMINAL (DUAT) OPERATIONAL CONCEPT Final Report
A. L. SPRINGEN Jun. 1989 36 p
(Contract DTFA01-89-C-00001)
(WP-88W00075; NAS-SR-DUAT; DOT/FAA/DS-89/28) Avail: NTIS HC A03/MF A01

This concept of operations is one of a set that in total describes the operation of the National Airspace System (NAS) when the projected upgrades are completed. The Direct User Access Terminal (DUAT) is a Federal Aviation Administration (FAA) program

that enables pilots to obtain self-briefings and submit flight plans, much as they receive these services from Flight Service Stations (FSSs) and Automated FSSs (AFSSs) today; however, DUAT is provided by the private sector. DUAT Service capabilities and interactions between the user, the DUAT Service, and NAS subsystems are described. It is intended to provide a common perspective for personnel engaged in DUAT-related activities.
Author

N89-28526# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
AIRPORT NOISE MEASURING DATA COLLCTION SYSTEM
M. H. J. B. VERSTEEG 19 Jan. 1987 12 p Presented at the VMEbus Application Seminar, Antwerp, Belgium, 25 Feb. 1987
(NLR-MP-87006-U; ETN-89-95410) Avail: NTIS HC A03/MF A01
The technical aspects of the central unit of the permanent noise measuring system, are discussed. The measured noise data values are obtained from a set of noise monitoring terminals located near a military airbase on Dutch territory. These values are collected together with time tags, stored on magnetic tape and processed. The central unit of this system is built using versa module eurocard technology, and the controlling software is developed using micro concurrent PASCAL language, whose compiler performs extensive type checking and identifies development errors. The most time consuming part of the software development is the development of the links of the system hardware. The central unit of the noise measuring system is built in such a way as to be fault tolerant. Missing data samples, lost connections or erroneous collected data should not disrupt the operation of the system. ESA

N89-29352# Federal Aviation Administration, Washington, DC.
ACCOMPLISHMENTS UNDER THE AIRPORT IMPROVEMENT PROGRAM: FISCAL YEAR 1988 Annual Report No. 7, Fiscal Year ending 30 Sep. 1988
JEAN HETSKO 1988 123 p
(AD-A208200; DOT/FAA/RP-89/3) Avail: NTIS HC A06/MF A01 CSCL 14/2
Section 521 of the Airport and Airway Improvement Act of 1982 (Public Law 97-248) requires that the Secretary of Transportation submit an annual report to Congress describing the accomplishment of the Airport grant program. This report covers activities for the fiscal year ending September 30, 1988. GRA

10

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.

A89-52973
SAENGER AEROSPACEPLANE GAINS MOMENTUM
TIM FURNISS Flight International (ISSN 0015-3710), vol. 136, Aug. 12, 1989, p. 39-41.
Copyright
The turboramjet-powered first stage of the Saenger two-stage air-breathing launch vehicle system offers the maximum potential commonality with a prospective hypersonic airliner capable of Mach 5 cruise in civilian passenger-carrying operation, with a capacity of 250 seats and a range of 10,000 km. Flights of such a vehicle from Frankfurt to Tokyo would last only three hours. Attention is presently given to the international participation possibilities that arise in the development of critical technologies for both this first-stage vehicle and its alternative Horus four-crew-manned and Cargus unmanned upper stages. O.C.

A89-54009
OPTIMAL TRAJECTORY GENERATION AND DESIGN TRADES FOR HYPERSONIC VEHICLES
PHILIP D. HATTIS (Charles Stark Draper Laboratory, Inc., Cambridge, MA) and RICHARD K. SMOLSKIS (Rockwell International Corp., Space Transportation Systems Div., Downey, CA) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 2. New York, Institute of Electrical and Electronics Engineers, 1989, p. 1125-1130. refs
Copyright
A method for determing the optimum-trajectory flight path for an air-breathing single-stage-to-orbit vehicle is presented. A calculus-of-variations direct method of steepest descent is used to determine angle of attack, bank angle, and engine power setting time histories. Trajectory profiles resulting from using both nominal and off-nominal vehicle sytem parameters and environmental conditions are addressed. Design and/or control trades which will become apparent from trajectory study results are identified. Considerations affecting the application of analysis algorithm features to the onboard guidance strategy are also discussed.
I.E.

A89-54085* Georgia Inst. of Tech., Atlanta.
A REAL-TIME GUIDANCE ALGORITHM FOR AEROSPACE PLANE OPTIMAL ASCENT TO LOW EARTH ORBIT
A. J. CALISE, G. A. FLANDRO (Georgia Institute of Technology, Atlanta), and J. E. CORBAN IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 3. New York, Institute of Electrical and Electronics Engineers, 1989, p. 2475-2481. Research supported by General Dynamics Corp. refs
(Contract NAG1-784)
Copyright
Problems of onboard trajectory optimization and synthesis of suitable guidance laws for ascent to low Earth orbit of an air-breathing, single-stage-to-orbit vehicle are addressed. A multimode propulsion system is assumed which incorporates turbojet, ramjet, Scramjet, and rocket engines. An algorithm for generating fuel-optimal climb profiles is presented. This algorithm results from the application of the minimum principle to a low-order dynamic model that includes angle-of-attack effects and the normal component of thrust. Maximum dynamic pressure and maximum aerodynamic heating rate constraints are considered. Switching conditions are derived which, under appropriate assumptions, govern optimal transition from one propulsion mode to another. A nonlinear transformation technique is employed to derived a feedback controller for tracking the computed trajectory. Numerical results illustrate the nature of the resulting fuel-optimal climb paths. I.E.

A89-54326 North Dakota Univ., Grand Forks.
INTERNATIONAL CONFERENCE ON HYPERSONIC FLIGHT IN THE 21ST CENTURY, 1ST, UNIVERSITY OF NORTH DAKOTA, GRAND FORKS, SEPT. 20-23, 1988, PROCEEDINGS
MARY E. HIGBEA, ED. and JAMES A. VEDDA, ED. (North Dakota, University, Grand Forks) Conference sponsored by NASA, ESA, AIAA, et al. Grand Forks, ND, University of North Dakota, 1988, 545 p. For individual items see A89-54327 to A89-54374.
Copyright
The present conference on the development status of configurational concepts and component technologies for hypersonic-cruise and transatmospheric vehicles discusses topics relating to the U.S. National Aerospace Plane program, ESA-planned aerospace vehicles, Japanese spaceplane concepts, the integration of hypersonic aircraft into existing infrastructures, hypersonic airframe designs, hypersonic avionics and cockpit AI systems, hypersonic-regime CFD techniques, the economics of hypersonic vehicles, and possible legal implications of hypersonic flight. Also discussed are Soviet spaceplane concepts, propulsion systems involving laser power sources and hypervelocity launch technologies, and the management of support systems operations for hypersonic vehicles. O.C.

A89-54327
FORCES FOR CHANGE AND THE FUTURE OF HYPERSONIC FLIGHT IN THE 21ST CENTURY
ROBERT M. WILLIAMS (DARPA, Washington, DC) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 1-27. refs
Copyright

A comprehensive evaluation is made of the outstanding organizational, technological, and political problems to be solved *en route* to the creation of a successful hypersonic cruise/transatmospheric vehicle and its support infrastructure in the early 21st century. The technological problems range over advanced refractory materials, active structural cooling systems, CFD for hypersonic flows, and high power density onboard electrical systems. Attention is given to the prospects for hydrogen fuel derivation from lunar soils via fusion reactor power. The economics and demographics of 21st-century hypersonic vehicle and airbreathing spacecraft launch system operations are also discussed. O.C.

A89-54329
SAENGER: AN ADVANCED SPACE TRANSPORT SYSTEM FOR EUROPE - PROGRAM OVERVIEW AND KEY TECHNOLOGY NEEDS
HERIBERT KUCZERA (Messerschmitt-Boelkow-Blohm GmbH, Munich, Federal Republic of Germany) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 68-77. refs
Copyright

The West German Saenger two-stage (manned or unmanned cargo upper stage) launch vehicle employs an airbreathing lower stage that may be employed as a hypersonic-cruise passenger transport vehicle. A development status report for Saenger with a view to the technology-readiness issues of most pressing importance. Three turbomechanical configurations are under consideration for the lower stage's propulsion system: a turbojet-ramjet in parallel arrangement with common inlet and nozzle, a turbojet-ramjet in coaxial arrangement with plug nozzle, and a windmilling turbofan-ramjet. Upper stage design features are also presented. O.C.

A89-54330
HOTOL - A EUROPEAN AEROSPACEPLANE FOR THE 21ST CENTURY
B. R. A. BURNS (British Aerospace, PLC, London, England) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 78-109.
Copyright

Rockets are extremely inefficient in the early stages of a launch system's flight trajectory; the HOTOL single-stage-to-orbit launch vehicle eliminates the mass penalty of the heavy LOX tankage requirement in the early stages of flight through the incorporation of an airbreathing feature. The changeover from airbreathing to LOX is in the vicinity of Mach 5-6, at 26-30 km altitude. Due to its low planform loading, which is about 40 percent that of the Space Shuttle Orbiter, HOTOL begins its reentry deceleration at a relatively high altitude; as a result, peak reentry temperatures are of the order of 250 C lower than those of the Space Shuttle Orbiter, and replaceable thermal protection tiles are obviated. O.C.

A89-54331
NAL'S RESEARCH FOR HYPERSONIC FLIGHT
TATSUO YAMANAKA (National Aerospace Laboratory, Chofu, Japan) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 110-116.
Copyright

NAL's hypersonic flight-related research activities, which began in 1966 with the construction of a hypersonic wind tunnel and have encompassed CFD investigations into hypersonic flows, were in 1987 expanded to undertake the conceptual development of aerospaceplanes. Efforts are simultaneously being made toward the development of hypersonic airframes and airbreathing powerplants, with a view to their integration at a more advanced design stage. An unmanned hypersonic experimental aircraft will in due course be built and flight tested to verify the materials, structures, control system, etc., technologies chosen during the current development program. O.C.

A89-54332
PERSPECTIVE ON JAPANESE SPACE PLANE RESEARCH AND DEVELOPMENT
SHIGEO KOBAYASHI, MASATAKA MAITA, TATSUO YAMANAKA, and YOSHIAKI OHKAMI (National Aerospace Laboratory, Chofu, Japan) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 117-124. refs
Copyright

The organization of the long-range goal-oriented activities of the Japanese aerospaceplane R&D establishment, encompassing the NAL, NASDA, and ISAS, is presented. Both airbreathing launchers and hypersonic cruise aircraft and propulsion systems are under consideration; single-stage-to-orbit and two-stage-to-orbit configurations will be investigated for spacecraft launch services. An account is given of the development timetable for aerospacecraft spanning from the present to 2010 and beyond. O.C.

A89-54340
THERMAL STRESS ANALYSIS OF THE NASA DRYDEN HYPERSONIC WING TEST STRUCTURE
GLENN MORRIS (General Dynamics Corp., Fort Worth, TX) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 180-188.
Copyright

While there are numerous texts and papers on thermal stress analysis, practical examples and experience on light gage aircraft structures are limited. A research program has been undertaken to demonstrate the present state of the art, verify methods of analysis, gain experience in their use, and develop engineering judgement in thermal stress analysis. The approach for this project has been to conduct a series of analyses of this sample problem and compare analysis results with test data. Author

A89-54355
'SPACEPLANES' AND THE RISE OF 'ULTRA TECH'
JOHN GUTHRIE IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 311-315.
Copyright

A development history is presented for high speed aircraft capable of edge-of-space cruise performance, from World War II's (fortunately only conceptual) Saenger-Bredt 'Antipodal Bomber', capable of intercontinental hypersonic cruise in the interest of military superiority, to the NASA National Aerospace Plane (NASP), which has entered its technology-development and configurational-design phase. It is noted that NASP will engender the development of endoatmospheric hypersonic-cruise commercial aircraft, which can proceed with greater assurance of the technological and economic risks involved. O.C.

A89-54359
THE TRISONIC AEROSPACE MOTOR - PROPULSION VEHICLE FOR THE 21ST CENTURY
C. E. JANEKE (Janeke and Cumming, Pretoria, Republic of South Africa; Adaptive Resources, Inc., Claremont, CA) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND,

University of North Dakota, 1988, p. 335-352.
Copyright

This paper discusses the features of the Trisonic, a proposed transatmospheric aerospace propulsion engine, which encompasses all the elements of the subsonic, supersonic, and hypersonic propulsion and rocket-propulsion technology. Special attention is given to the Trisonic propulsion scheme, the algorithmic modeling of various Trisonic regimes, and the computational analysis of the propulsive power. Results of case studies, conducted to determine the parametric ranging and propulsive power of Trisonic-concept planforms are discussed. I.S.

11

CHEMISTRY AND MATERIALS

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

A89-51860
TURBULENT REACTIVE FLOWS
R. BORGHI, ED. (Rouen, Universite, Mont-Saint-Aignan, France) and S. N. B. MURTHY, ED. (Purdue University, West Lafayette, IN) New York, Springer-Verlag (Lecture Notes in Engineering. Volume 40), 1989, 958 p. For individual items see A89-51861 to A89-51886.
Copyright

Various papers on turbulent reactive flows are presented. Some of the individual topics discussed include: measurement of the topology of large-scale structures in turbulent reacting flows; structure of jet diffusion flames; comparison between two highly turbulent flames having very different laminar burning velocities; structure of turbulent premixed flames as revealed by spectral analysis; turbulent flow field and front position statistics in V-shaped premixed flame with and without confinement; structure of flamelets in turbulent reacting flows and influences of combustion on turbulence fields; flamelet library for turbulent wrinkled flames; length and time scales in turbulent combustion; model for reactions in turbulent jets, including the effects of Reynolds, Schmidt, and Damkoehler numbers; fractal description of flamelets; and interaction of a flame front with vortices. C.D.

A89-52022
AEROSPACE INVESTMENT CASTING IN THE U.S.A. 1988
THIERRY N. THYS (Precision Founders, Inc., San Leandros, CA) IN: High integrity castings; Proceedings of the Conference on Advances in High Integrity Castings, Chicago, IL, Sept. 24-30, 1988. Metals Park, OH, ASM International, 1988, p. 45-49.
Copyright

The history of the investment casting industry is reviewed, and attention is given to the beginning of aerospace quality castings. Aluminum castings, vacuum-cast superalloys, and titanium structural castings are also considered. It is expected that turbine engines will continue to increase their use of investment castings. B.J.

A89-52775
DENORMALIZED PRODUCT OF THE ADSORPTIVE ZEOLITE EXTRACTION OF PARAFFINS AS A JET FUEL COMPONENT [DENORMALIZAT ADSORBTSIONNOGO VYDELENIIA PARAFINOV NA TSEOLITAKH KAK KOMPONENT REAKTIVNYKH TOPLIV]
B. A. ENGLIN, M. V. KHOKHLACHEVA, E. M. BUSHUEVA, and M. V. PEREZHIGINA (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Neftianoi Promyshlennosti, Moscow, USSR) Khimiia i Tekhnologiia Topliv i Masel (ISSN 0023-1169), no. 7, 1989, p. 5-7. In Russian.
Copyright

The paper is concerned with the possibility of using the denormalized product of the adsorptive extraction of paraffins on zeolites as a component of highly thermally stable RT and T-8V jet fuels with a final boiling temperature of not higher than 280 and 300 C. The factors limiting the amount of the denormalized product that can be added to the fuel are examined, and maximum contents of the denormalized product are determined in relation to the properties of the latter. The properties of experimental samples of RT and T-8V jet fuels containing the denormalized product of paraffin extraction are presented. V.L.

A89-52827
RECOVERY OF THE FATIGUE STRENGTH OF STRUCTURAL ELEMENTS OF ALUMINUM ALLOYS BY SURFACE HARDENING [VOSSTANOVLENIE SOPROTIVLENIIA USTALOSTI ELEMENTOV KONSTRUKTSII IZ ALIUMINIEVYKH SPLAVOV POVERKHNOSTNYM NAKLEPOM]
M. N. STEPNOV, S. P. EVSTRATOVA, V. V. LOGVINENKO, and V. V. MOZALEV (Moskovskii Aviatsionnyi Tekhnologicheskii Institut, Moscow, USSR) Problemy Prochnosti (ISSN 0556-171X), Aug. 1989, p. 16-19. In Russian.
Copyright

An analysis is made of fatigue test data obtained for specimens of AK6 aluminum alloy which were subjected to repeat surface hardening after their useful life had been partially exhausted. It is shown that surface hardening through plastic surface working (e.g., roller burnishing, vibrational hardening, and shot peening) makes it possible to completely restore the safe service life of structural elements of AK6 alloy. The restoration of the service life of the structural elements can be conducted repeatedly. V.L.

A89-52830
FATIGUE LIFE OF ZHS6U ALLOY WITH PROTECTIVE COATINGS UNDER THERMAL CYCLING LOADING [DOLGOVECHNOST' SPLAVA ZHS6U S ZASHCHITNYMI POKRYTIIAMI PRI TERMOTSIKLICHESKOM NAGRUZHENII]
K. P. BUISKIKH and V. G. BARILO (AN USSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR) Problemy Prochnosti (ISSN 0556-171X), Aug. 1989, p. 42-47. In Russian. refs
Copyright

Empirical equations are obtained which relate the fatigue life of ZhS6U, a turbine blade alloy, to the parameters of the thermal and stress-strain states. The equations obtained here provide a way to predict the thermal cycling fatigue life of ZhS6U alloy with different coatings under conditions of inhomogeneous stressed state in the temperature range 1040-1100 C and thermal stress range 220-470 MPa. V.L.

A89-52994#
ENVIRONMENTAL EFFECTS ON COMPOSITE STRUCTURES
R. GOPALAN and RAMESH CHANDRA (National Aeronautical Laboratory, Bangalore, India) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 41, Feb. 1989, p. 55-59. refs

Environmental effects on the degradation of the strength and stiffness of both GFRP test coupons and an actual composite structure (Radome) of a wing mounted store of a military aircraft were experimentally determined. The experimental investigation revealed that the GFRP composite absorbs 1.2 percent moisture when exposed to water at 343 K for 20 days. The degradation on the ultimate tensile strength and Young's modulus was 19 percent and 14.7 percent, respectively. A GFRP radome fabricated at NAL was subjected to various environmental tests as per MIL and JSS specification. Static tests were carried out on the radome before and after exposure to various environmental tests. The radome withstood the design load without failure but with an increase in the tip deflection of 20 percent and 45 percent at limit load and at ultimate load, respectively. Author

A89-53310#
HIGH-PERFORMANCE FIBER COMPOSITE MATERIALS WITH THERMOPLASTIC MATRIX [HOCHLEISTUNGS-FASERVERBUNDWERKSTOFFE MIT THERMOPLASTMATRIX]
H. RICHTER (Messerschmitt-Boelkow-Blohm GmbH, Ottobrunn, Federal Republic of Germany) Fachtagung ueber polymere

Hochleistungswerkstoffe in der technischen Anwendung, Wuerzburg, Federal Republic of Germany, May 31, June 1, 1989, Paper. 15 p. In German.
(MBB-Z-0257-89-PUB)

The use of thermoplastics in fiber composite materials for aircraft technology is discussed. Thermoplastic semifinished materials are addressed, and processing aspects of thermoplastic fiber composite materials are examined. The characteristics of the resulting materials and their applications are considered. C.D.

A89-53355*# Virginia Polytechnic Inst. and State Univ., Blacksburg.

PLASMA TORCH IGNITER FOR SCRAMJETS

TIMOTHY C. WAGNER, WALTER F. O'BRIEN (Virginia Polytechnic Institute and State University, Blacksburg), G. BURTON NORTHAM, and JAMES M. EGGERS (NASA, Langley Research Center, Hampton, VA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 5, Sept.-Oct. 1989, p. 548-554. Previously announced in STAR as N87-23789. refs
Copyright

A small, uncooled plasma torch was developed and used in combination with an injector designed to study ignition and flameholding in hydrogen-fueled supersonic flows. The plasma torch was operated on mixtures of hydrogen and argon with total flows of 10 to 70 scfh. The fuel injector design consisted of five small upstream pilot fuel injectors, a rearward facing step for recirculation, and three main fuel injectors downstream of the step. The plasma torch was located in the recirculation region, and all injection was perpendicular to the Mach 2 stream. Both semi-freejet and ducted tests were conducted. The experimental results indicate that a low power plasma torch operating on a 1:1 volumetric mixture of hydrogen and argon and located in the recirculation zone fueled by the upstream pilot fuel injectors is a good igniter for flow conditions simulating a flight Mach number of 3.7. The total temperature required to autoignite the hydrogen fuel for this injector geometry was 2640 R. The injector configuration was shown to be a good flameholder over a wide range of total temperature. Spectroscopic measurements were used to verify the presence of air total temperatures below 1610 R. Author

A89-53658

INJECTION MOULDED CERAMIC ROTORS - COMPARISON OF SIC AND SI3N4

K. HUNOLD (Elektroschmelzwerk Kempten GmbH, Federal Republic of Germany), J. GREIM, and A. LIPP Powder Metallurgy International (ISSN 0048-5012), vol. 21, Aug. 1989, p. 17, 18, 21-23. Research supported by BMFT. refs
Copyright

The manufacturing process of silicon carbide and silicon nitride ceramic rotors used in turbocharged engines is described. A suitable injection molding compound is developed for each basic powder additive and adapted to the ceramic powder in its organic bonding content as well as its chemical mixture of plasticizers. Injection molding of the rotors is carried out in microprocessor-controlled and regulated screw injection molding machines. The rotors are heated up in temperature-controlled dewaxing furnaces and then pressurelessly sintered under vacuum or protective gas atmospheres in high-temperature kilns at approx. 2100 C. After sintering, the rotors' external contour is machined on a CNC cylindrical grinder using resin-bonded diamond wheels. In-process nondestructive testing is applied to all manufacturing stages through microfocus X-ray analysis. Thermal shock resistance test, strength test, proof test, and vehicle test are finally performed to confirm the expected advantages of ceramic rotors. Although the material SiC displayed worse results than Si3N4, one factor must be considered: SSiC retains its strength to temperatures greater than 1500 K and, in addition, displays better resistance to corrosion and creep than Si3N4. This could be a decisive advantage in application over a longer period of time at extremely high temperatures. C.E.

A89-54255

COMPARATIVE DURABILITY OF SIX COATING SYSTEMS ON FIRST-STAGE GAS TURBINE BLADES IN THE ENGINES OF A LONG-RANGE MARITIME PATROL AIRCRAFT

J. L. COCKING, P. G. RICHARDS, and G. R. JOHNSTON (Department of Defence, Materials Research Laboratory, Maribyrnong, Australia) IN: Metallurgical coatings 1988; Proceedings of the Fifteenth International Conference, San Diego, CA, Apr. 11-15, 1988. Volume 1. London and New York, Elsevier Applied Science, 1988, p. 37-47.
Copyright

The behavior of six coatings on first-stage high pressure blades in the engines of two long-range maritime patrol aircraft is studied. The trial engines contain blades coated with each of the coatings to allow comparison of their relative performances under identical operating conditions. The trial is aimed to find a coating which will last for 4000 engine operating hours, because the current coating, a conventional nickel aluminide, has a greater than 60 percent rejection rate after 2000 hours. Blades extracted from the trial engines after 500 and 1000 operating hours, already show noticeable trends in the behavior of the different coating systems. The two aluminides modified with precious metals and the conventional nickel aluminide coatings are in much better condition than the aluminide coatings modified with either silicon or chromium plus manganese. C.E.

A89-54426

INTERLAMINAR FRACTURE TOUGHNESS AND TOUGHENING OF LAMINATED COMPOSITE MATERIALS - A REVIEW

N. SELA (Israel Aircraft Industries, Ltd., Tel Aviv) and O. ISHAI (Technion - Israel Institute of Technology, Haifa) Composites (ISSN 0010-4361), vol. 20, Sept. 1989, p. 423-435. refs
Copyright

A review of the state of the art in the subject of interlaminar fracture toughness (IFT), its relation to structural performance and the damage tolerance of polymeric composite materials is presented. The sources of low IFT (high brittleness) of existing materials and methods to improve it by introducing tough interlayers or by using thermoplastic matrices are discussed. The IFT test methods, their analytical basis and utilization are described. Comprehensive IFT data for G(Ic) and G(IIc) for different composite systems and test methods, which were extracted from numerous publications, are presented. Author

A89-54429

A PROPOSED COMPOSITE REPAIR METHODOLOGY FOR PRIMARY STRUCTURE

S. R. HALL, M. D. RAIZENNE, and D. L. SIMPSON (National Aeronautical Establishment, Ottawa, Canada) Composites (ISSN 0010-4361), vol. 20, Sept. 1989, p. 479-483. refs
Copyright

Advanced composite materials are used extensively in aircraft structures. A major problem with the use of these materials is that of structural repair. Composite structures require different repair techniques than do their metal counterparts. Presently, there is very little data available which permits composite structural repairs to be designed and evaluated. This paper details the steps that are required to generate an aircraft composite repair capability for primary structures. Author

A89-54671

SELECTING HIGH-TEMPERATURE STRUCTURAL INTERMETALLIC COMPOUNDS - THE MATERIALS SCIENCE APPROACH

ROBERT L. FLEISCHER and ALAN I. TAUB (GE Corporate Research and Development Center, Schenectady, NY) JOM (ISSN 0148-6608), vol. 41, Sept. 1989, p. 8-11. refs
(Contract N00014-86-C-0353)
Copyright

The problem of overcoming the limited ductility of intermetallic materials so that these materials can be used for high-temperature turbines and engines of the future is addressed. The most likely candidates for these applications can be identified on the basis of melting temperature and density and by considering the effects of composition and crystal structure. The results of the present study suggest that, if single-phase materials are to be found with useful mechanical properties at temperatures as high as 1300 C, they will most likely come from the Re30Ru20Ti50 class of materials. K.K.

A89-54982* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

TRIBOLOGICAL PROPERTIES OF ALUMINA-BORIA-SILICATE FABRIC FROM 25 C TO 850 C

CHRISTOPHER DELLACORTE (NASA, Lewis Research Center, Cleveland, OH) STLE Tribology Transactions (ISSN 0569-8197), vol. 32, July 1989, p. 325-330. Previously announced in STAR as N88-18726. refs

Copyright

Demanding tribological properties are required of the materials used for the sliding seal between the sidewalls and the lower wall of the variable area hypersonic engine. Temperatures range from room temperature and below to operating temperatures of 1000 C in an environment of air, hydrogen, and water vapor. Candidate sealing materials for this application are an alumina-boria-silicate, ceramic, fabric rope sliding against the engine walls which may be made from copper- or nickel-based alloys. Using a pin-on-disk tribometer, the friction and wear properties of some of these potential materials and possible lubrication methods are evaluated. The ceramic fabric rope displayed unacceptably high friction coefficients (0.6 to 1.3) and, thus, requires lubrication. Sputtered thin films of gold, silver, and CaF_2 reduced the friction by a factor of two. Sprayed coatings of boride nitride did not effectively lubricate the fabric. Static heat treatment tests at 950 C indicate that the fabric is chemically attacked by large quantities of silver, CaF_2, and boron nitride. Sputtered films or powder impregnation of the fabric with gold may provide adequate lubrication up to 1000 C without showing any chemical attack. Author

A89-54986

MICROCOMPUTER SIMULATION OF LUBRICANT DEGRADATION IN TURBINE ENGINES USING LABORATORY DATA

F. DEAN PRICE and PHILLIP W. CENTERS (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH) STLE Tribology Transactions (ISSN 0569-8197), vol. 32, July 1989, p. 405-409. refs

Copyright

A FORTRAN, MS-DOS operating system algorithm was constructed and implemented to predict ester-based lubricant behavior in a turbine engine. Input data consists of selected lubricant flow rates, bulk lubricant and bearing temperatures, and laboratory generated data. Execution of the program uses lubricant property data as a function of time at several temperatures to produce mathematical functions describing total acid number, viscosity change and evaporation as a function of temperature at selected times. Static coker data are employed to estimate coking at the hot end bearing cover. The program output data are predicted values of critical lubricant properties as a function of engine hours, reflecting lubricant additions to the system because of evaporative and seal losses and also degradation predicted to occur during cool-down cycles. Computer-generated data are compared with actual engine data; the benefits and limitations of the program are identified. Author

N89-28574# Naval Postgraduate School, Monterey, CA. Dept. of Mechanical Engineering.

COMPOSITE MATERIAL REPAIR AND RELIABILITY M.S. Thesis

SHMUEL MAMAN Mar. 1989 160 p

(AD-A209150) Avail: NTIS HC A08/MF A01 CSCL 11/4

Composite structure repair methodology has been developed to specific applications (typically in small area and limited to secondary structure) and is being extended to Large Area Composite Structure Repair (with target extension to primary structures). Therefore, the repair becomes more critical because we get redistribution of stresses that can also affect the zones outside of the repair area. For this reason, an analytic evaluation of the repair's reliability has to be performed to define a parameter which reflects on the effectiveness of the repair. In this work, we establish a principal guideline to evaluate the redundancy and compare the reliability of the repair to the reliability of the parent structure (i.e., the structure in the undamaged state). The approach adopted is to utilize structural finite element analysis to compute the state and of the candidate repaired state. The reliability of these two spatially non-uniform stresses is computed by a probabilistic failure criterion. Thus, we can optimize the repair configuration by varying the strength and the stiffness of any element in the repair site by varying the lamination angles, and selectively using hybrid materials. GRA

N89-28579*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

FIVE YEAR GROUND EXPOSURE OF COMPOSITE MATERIALS USED ON THE BELL MODEL 206L FLIGHT SERVICE EVALUATION

DONALD J. BAKER (Army Aviation Research and Development Command, Hampton, VA.) Jul. 1989 93 p

(NASA-TM-101645; NAS 1.15:101645; AVSCOM-TM-89-B-007) Avail: NTIS HC A05/MF A01 CSCL 11/4

Part of the results of a U.S. Army/NASA-Langley sponsored research program to establish the long term-term effects of realistic ground based exposure on advanced composite materials is presented. Residual strengths and moisture absorption as a function of exposure time and exposure location are reported for four different composite material systems that were exposed for five years on the North American Continent. Author

N89-28588# Bailey Controls Co., Wickliffe, OH.

ENGINE COMBUSTION OPTIMIZATION BY EXHAUST ANALYSIS Final Report, Dec. 1986 - Jul. 1988

R. K. JAHN, D. J. LEE, S. P. CREMEAN, and R. A. BAYLESS (Columbia Gas System Service Corp., Columbus, OH.) Jan. 1989 186 p

(Contract GRI-5083-231-0956)

(PB89-195788; GRI-88/0312) Avail: NTIS HC A09/MF A01 CSCL 21/2

The application of an air/fuel ratio analyzer and trim control system to a two-cycle turbocharged compressor engine is documented. The trim control strategy is based upon both oxygen and combustibles in the exhaust gases. The use of exhaust gas analysis demonstrated that an improvement in combustion efficiency on two-cycle turbocharged engines is possible. However, the prevention of detonation must be demonstrated with further testing before these controls can be satisfactorily applied to turbocharged engines. The application of the controls on naturally aspirated engines is thought to be more feasible at this time. The potential benefits justify the continuation of work to develop fully operational systems for both turbocharged and naturally aspirated engines. GRA

N89-28610# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.). Inst. fuer Antriebstechnik.

SUPERSONIC COMBUSTION AT THE DFVLR: RESULTS AND EXPERIENCES [UEBERSCHALLVERBRENNUNG IN DER DFVLR. ERGEBNISSE UND ERFAHRUNGEN]

G. WINTERFELD 1988 11 p In GERMAN

(DFVLR-88-044; ETN-89-94381) Avail: NTIS HC A03/MF A01

The research activities of the DFVLR Institute of Jet Engines in the field of supersonic combustion are reviewed. The ignition and stabilization of hydrogen-air diffusion flames are investigated. Many qualitative and quantitative results on the essential effects on thermal self ignition are obtained, which together with the obtained reaction-kinetics data allow a satisfactory calculation of induction lengths during parallel injection of H_2. The possibilies of improving thermal self-ignition by catalytic effects or precombustion, as well as the self-ignition characteristics of several hydrocarbons are studied. With a view to flame stabilization by recirculation domains in the supersonic flow at low temperatures, quantitative data on the characteristic test time at the boundary of the recirculation domain are obtained. The importance of interactions between supersonic flow and local subsonic domains in combustion zones is demonstrated. ESA

N89-28643# Hughes Aircraft Co., El Segundo, CA. Electro-Optical and Data Systems Group.
HIGH TEMPERATURE ADHESIVE SYSTEMS Final Report, 25 Sep. 1985 - 24 Apr. 1989
E. H. CATSIFF, T. K. DOUGHERTY, W. E. ELIAS, D. J. VACHON, G. ANGSTEN, R. W. SEIBOLD, W. G. KNAUSS, S. SHIMABUKURO, and K. M. LIECHTI (Texas Univ., Austin.) Apr. 1989 224 p
(Contract N00014-85-C-0881)
(AD-A209166; HAC-REF-F7896-F) Avail: NTIS HC A10/MF A01 CSCL 11/1

Projected requirements for future high-performance jet engine, missile, and fighter aircraft structures will necessitate extensive use of high temperature structural adhesives. For example, many advanced jet engine and tactical aircraft components will need to perform for hundreds of hours at 700 F (371 C) and above. For advanced air-to-air tactical missiles and air-launched stand-off missiles, composite airframe structures capable of maintaining strength for short periods (minutes) at 1000 F (538 C) and above will be needed. Other needs for adhesives capable of performing at high temperatures include bonding of structures for extended range cruise missiles, bonding of specialty materials for stealth applications, and, potentially, joining of aerospace plane structures. Under this program, a comprehensive technical effort was undertaken with the goal of developing high-temperature adhesive systems with inherent processibility and toughness. The approach was to perform a multidisciplinary integrated research effort involving a combination of polymer chemistry, moisture diffusion analysis, and fracture mechanics to tailor, characterize, and qualify tough adhesive systems for bonding to titanium and ferrous alloys. GRA

N89-28661# Southwest Research Inst., San Antonio, TX. Fuels and Lubricants Research Facility.
A SURVEY OF JP-8 AND JP-5 PROPERTIES Interim Report, Oct. 1987 - Sep. 1988
J. N. BOWDEN, S. R. WESTBROOK, and M. E. LEPERA (Army Research and Development Lab., Fort Belvoir, VA.) Sep. 1988 111 p
(Contract DAAK70-87-C-0043; DA PROJ. 1L2-63001-D-150)
(AD-A207721; BFLRF-253) Avail: NTIS HC A06/MF A01 CSCL 21/4

With the help of the Defense Fuel Supply Center, JP-8, Jet A-1, and JP-5 samples from worldwide sources, representing tenders of products destined for Department of Defense bases, have been received at Belvoir Fuels and Lubricants Research Facility at Southwest Research Institute for evaluation. Inspection data for each sample on DD Form 250 or other data reporting form were also received and entered into a data base. The evaluation of these samples consisted of a few inspection tests for comparison with the data provided by the supplier, and tests related to the use of these fuels in diesel engines, which were measured cetane number, calculated cetane indices by two methods, net heat of combustion, and kinematic viscosity measurements at 40 and 70 C. GRA

N89-29490*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INTERMETALLIC AND CERAMIC MATRIX COMPOSITES FOR 815 TO 1370 C (1500 TO 2500 F) GAS TURBINE ENGINE APPLICATIONS
JOSEPH R. STEPHENS 1989 11 p Proposed for presentation at the Advanced Metal and Ceramic Matrix Composites, Anaheim, CA, 19-22 Feb. 1990; sponsored by The Minerals, Metals and Materials Society and ASM International
(NASA-TM-102326; E-5027; NAS 1.15:102326) Avail: NTIS HC A03/MF A01 CSCL 11/4

Light weight and potential high temperature capability of intermetallic compounds, such as the aluminides, and structural ceramics, such as the carbides and nitrides, make these materials attractive for gas turbine engine applications. In terms of specific fuel consumption and specific thrust, revolutionary improvements over current technology are being sought by realizing the potential of these materials through their use as matrices combined with high strength, high temperature fibers. The U.S. along with other countries throughout the world have major research and development programs underway to characterize these composites materials; improve their reliability; identify and develop new processing techniques, new matrix compositions, and new fiber compositions; and to predict their life and failure mechanisms under engine operating conditions. The status is summarized of NASA's Advanced High Temperature Engine Materials Technology Program (HITEMP) and the potential benefits are described to be gained in 21st century transport aircraft by utilizing intermetallic and ceramic matrix composite materials. Author

N89-29497# Colorado State Univ., Fort Collins. Dept. of Chemistry.
SUPERSONIC JET STUDIES OF FLUORENE CLUSTERED WITH WATER, AMMONIA AND PIPERIDINE
H. S. IM, V. H. GRASSIAN, and E. R. BERNSTEIN 1 Jun. 1989 37 p Submitted for publication
(Contract N00014-79-C-0647)
(AD-A209562; AD-E900860; TR-54) Avail: NTIS HC A03/MF A01 CSCL 07/4

Mass resolved excitation spectroscopy and dispersed emission spectroscopy are employed to study van der Waals (vdW) clusters of jet cooled fluorene with ammonia, water and piperidine. For fluorene (H2O)1 and fluorene (NH3)1 clusters, cluster geometries and binding energies can be suggested based on the experimental results and Lennard-Jones (LJ) potential (6-12-1) energy calculations. As the number of solvent molecules in the cluster is increased, spectra of the clusters become more complex and broad, probably due to the many possible stable configurations for these vdW clusters. Although the pKa for fluorene in its first excited singlet state (Forster cycle calculations) is quite acidic (-8.6), and solvent molecules can coordinate to the aliphatic hydrogens of the fluorene molecule in at least some cluster configurations, no direct evidence is found for the occurrence of proton transfer in S1 in these systems. GRA

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ENGINEERING

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

A89-51680
THE EFFECTS OF LONGITUDINAL VORTICES ON HEAT TRANSFER OF LAMINAR BOUNDARY LAYERS
KAHORU TORII and JURANDIR ITIZO YANAGIHARA (Yokohama National University, Japan) JSME International Journal, Series II (ISSN 0914-8817), vol. 32, Aug. 1989, p. 395-402. refs
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The isolated influence of longitudinal vortices 'far enough' from a half-delta wing vortex generator on heat transfer of an otherwise laminar boundary layer was experimentally investigated. The heat transfer measurements were performed using a constant heat-flux surface with 96 embedded thermocouples. The vortex generator's height and angle of attack were varied to account for the influence of the vortex size, position and strength. A large increase in the heat transfer coefficient was found to be associated with the onset of the transition to turbulence rather than to vortical motion. The longitudinal vortices generated inside and outside the boundary layer showed different effects on heat transfer. When the transition did not occur, it was observed that the higher heat transfer coefficients were associated with the downwash region of the vortex, because of the local thinning of the boundary layer. The transition started in the upwash region of the vortex, where the instability was larger. Author

A89-51692* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

CURRENT RESEARCH IN COMPOSITE STRUCTURES AT NASA'S LANGLEY RESEARCH CENTER

MICHAEL F. CARD and JAMES H. STARNES, JR. (NASA, Langley Research Center, Hampton, VA) IN: Composite materials and structures. Bangalore, Indian Academy of Sciences, 1988, p. 5-26. refs

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Research on the mechanics of composite structures at NASA's Langley Research Center is discussed. The advantages and limitations of special purpose and general purpose analysis tools used in research are reviewed. Future directions in computational structural mechanics are described to address analysis short-comings. Research results on the buckling and postbuckling of unstiffened and stiffened composite structures are presented. Recent investigations of the mechanics of failure in compression and shear are reviewed. Preliminary studies of the dynamic response of composite structures due to impacts encountered during crash-landings are presented. Needs for future research are discussed. Author

A89-51755

PSEUDO-SPECTRAL AND ASYMPTOTIC SENSITIVITY INVESTIGATION OF COUNTER-ROTATING VORTICES

A. DAGAN (Ministry of Defence, Scientific Dept., Haifa, Israel) Computers and Fluids (ISSN 0045-7930), vol. 17, no. 4, 1989, p. 509-525. refs

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An asymptotic analysis of the two-dimensional counter rotating vortices is presented in this work, assuming small ratio between vortex core radius and the initial vortex spacing. This analysis indicates that for the short time span the numerical solution is of a fluctuating nature resulting from the distribution of the initial condition. This short time period is proportional to the ratio between the initial vortex core area and the kinematic viscosity. In the limit case the asymptotic analysis yields a vorticity distribution that does not exhibit these fluctuations and can be used as a modified approximation of the numerical initial condition. In order to verify this conclusion, the sensitivity of the numerical problem is checked against the traditional initial condition (Oseen solution), in which a pseudo-spectral approach is chosen as a numerical algorithm. The pseudo-spectral method is shown to be an efficient means of handling the numerical boundary conditions and for validating the conclusions that have been obtained by the asymptotic analysis. Author

A89-52105

ANALYSIS OF ABSORBING CHARACTERISTICS OF THIN-TYPE ABSORBER FOR GENERALIZED CONDITIONS OF INCIDENT WAVE

YASUHIRO KAKIMI, NORINOBU YOSHIDA, and ICHIRO FUKAI (Hokkaido University, Sapporo, Japan) IEEE Transactions on Electromagnetic Compatibility (ISSN 0018-9375), vol. 31, Aug. 1989, p. 323-328. refs

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The treatment of a thin absorber as a boundary condition, taking the arbitrary thickness of the absorber into account, is presented. To verify this approach, the equivalent circuit is applied to the terminal model of a coaxial line and rectangular waveguides. Its validity is verified by changing the medium constant, frequency, and angle and polarization of the obliquely incident wave. To illustrate the application of the approach to a complicated structure, the reflecting and scattering characteristics of an aircraft model are presented. I.E.

A89-52507

SEPARATED FLOW PAST THREE-DIMENSIONAL BODIES AS A SINGULAR PERTURBATION PROBLEM

P. BASSANINI (Roma I, Universita, Rome, Italy) and A. R. ELCRAT (Wichita State University, KS) Journal of Engineering Mathematics (ISSN 0022-0833), vol. 23, June 1989, p. 187-202. Research supported by MPI. refs

(Contract CNR-86,02073,01; CNR-87,01011,01; AF-AFOSR-86-0274)

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This paper proposes a method for computing steady wake flows of an inviscid fluid over a three-dimensional body with polygonal cross-section and arbitrary plan-form. The method is based on the technique of matched asymptotic expansions, assuming a large 'aspect ratio'. The far-field velocity potential is given essentially by a lifting line and a line source. The near-field, treated as two-dimensional, is solved by a suitable version of Tulin's double spiral vortex model which incorporates a downwash correction and an underpressure in the near-wake. The latter is related to the Reynolds number of the corresponding real flow using recent results by Tulin and Hsu and the authors. Numerical results for a few prototype problems (flat-plate airfoil with separation at both the leading edge and upper surface, flat-plate wing with full or partial spoiler) are presented. The method can be efficiently implemented on a parallel computer. Author

A89-52943

TURBULENT SHEAR FLOWS 6; INTERNATIONAL SYMPOSIUM, 6TH, UNIVERSITE DE TOULOUSE III, FRANCE, SEPT. 7-9, 1987, SELECTED PAPERS

JEAN-CLAUDE ANDRE, ED. (Centre National de Recherches Meteorologiques, Toulouse, France), JEAN COUSTEIX, ED. (ONERA, Centre d'Etudes et de Recherches, Toulouse, France), FRANZ DURST, ED. (Erlangen-Nuernberg, Universitaet, Erlangen, Federal Republic of Germany), BRIAN E. LAUNDER, ED. (Manchester, Victoria University, England), FRANK W. SCHMIDT, ED. (Pennsylvania State University, University Park) et al. Symposium sponsored by USAF, U.S. Navy, U.S. Army, CNRS, et al. Berlin and New York, Springer-Verlag, 1989, 462 p. For individual items see A89-52944 to A89-52949.

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The conference presents papers on scalar transport and geophysical flows, aerodynamic flows, complex flows, and numerical simulation. Particular attention is given to an eigenfunction analysis of turbulent thermal convection, turbulent diffusion behind a heated line source in a nearly homogeneous turbulent shear flow, and the evolution of axisymmetric wakes from attached and separated flows. Other topics include the vortex street and turbulent wakes behind a circular cylinder placed inside a rotating rectangular channel and a numerical study of a stably stratified mixing layer. K.K.

A89-52961

PHENOMENA AND MODELLING OF FLOW-INDUCED VIBRATIONS OF BLUFF BODIES

GEOFFREY PARKINSON (British Columbia, University, Vancouver, Canada) Progress in Aerospace Sciences (ISSN 0376-0421), vol. 26, no. 2, 1989, p. 169-224. refs

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A detailed treatment is undertaken of the transverse vibrations of single long bodies of bluff section in steady incident flow normal to their span. 'Bluff section' is understood to refer to one from which the flow separates, producing two shear layers that bound a relatively broad wake. The transverse vibrations are galloping and vortex-induced. Galloping is a self-excited vibration in the conventional sense and is potentially catastrophic due to the continuous increase in amplitude with flow velocity above a critical value. Vortex-induced vibration is a form of nonlinear resonance occurring only over a limited range of flow velocities; the resulting vibration amplitudes are self-limiting. O.C.

A89-53254#

A COMPARISON OF MIXED AND PENALTY FINITE ELEMENT METHODS IN ANALYSIS OF HEAT EXCHANGERS

V. D. MURTY (Portland, University, OR), D. B. PAUL, and M. E. PAJAK (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: ASME 1988 National Heat Transfer Conference, Houston, TX, July 24-27, 1988, Proceedings. Volume 1. New York, American Society of Mechanical Engineers, 1988, p. 137-143. refs

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Heat transfer and fluid flow through pin fin heat exchangers are studied numerically using the penalty and mixed finite element methods. The penalty parameter is varied from 10 to the 6th to 10 to the 15th. It is found that for low values of the penalty parameter (up to 10 to the 14th), it took six iterations for the numerical method to converge; however, for 10 to the 15th, the method did not converge in 20 iterations. The values of pitch to diameter ratio used in this study are 1.25, 1.5, and 1.75, and the values of Prandtl number used are 0.005, 0.7, 5, and 100. Results are presented for various values of Reynolds number up to 400. The predictions of heat transfer rates agree reasonably well with values reported in the literature. Author

A89-53274#

AN EXPERIMENTAL INVESTIGATION OF HEAT TRANSFER COEFFICIENTS AND FRICTION FACTORS IN PASSAGES OF DIFFERENT ASPECT RATIOS ROUGHENED WITH 45 DEG TURBULATORS

M. E. TASLIM (Northeastern University, Boston, MA) and S. D. SPRING (General Electric Co., Lynn, MA) IN: ASME 1988 National Heat Transfer Conference, Houston, TX, July 24-27, 1988, Proceedings. Volume 1. New York, American Society of Mechanical Engineers, 1988, p. 661-668. refs

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Nusselt numbers and friction factors in cooling passages of different aspect ratios roughened on one or two sides with 45 deg turbulators with different geometries and orientations are measured. Passage aspect ratios ranging from 0.5 to 3.5 are tested over a Reynolds number range of 15,000 to 180,000. Each aspect ratio is tested for several turbulator spacings and blockage ratios. The results indicate that the overall heat transfer coefficient on surfaces roughened with 45 deg turbulators is greater than that on surfaces roughened with 90 deg turbulators. Although the two-side-turbulated passages produce a higher overall heat transfer coefficient and pressure drop, local heat transfer coefficients are lower than those for one-side-turbulated passages. Local heat transfer coefficients on surfaces roughened with 45 deg turbulators show a considerable variation in the spanwise direction, suggesting other geometries would further enhance heat transfer in blade cooling passages. C.D.

A89-53282*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

HEAT TRANSFER IN AEROSPACE PROPULSION

R. J. SIMONEAU, R. C. HENDRICKS, and H. J. GLADDEN (NASA, Lewis Research Center, Clevelend, OH) IN: ASME 1988 National Heat Transfer Conference, Houston, TX, July 24-27, 1988, Proceedings. Volume 3. New York, American Society of Mechanical Engineers, 1988, p. 1-22. Previously announced in STAR as N88-23957. refs

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Presented is an overview of heat transfer related research in support of aerospace propulsion, particularly as seen from the perspective of the NASA Lewis Research Center. Aerospace propulsion is defined to cover the full spectrum from conventional aircraft power plants through the Aerospace Plane to space propulsion. The conventional subsonic/supersonic aircraft arena, whether commercial or military, relies on the turbine engine. A key characteristic of turbine engines is that they involve fundamentally unsteady flows which must be properly treated. Space propulsion is characterized by very demanding performance requirements which frequently push systems to their limits and demand tailored designs. The hypersonic flight propulsion systems are subject to severe heat loads and the engine and airframe are truly one entity. The impact of the special demands of each of these aerospace propulsion systems on heat transfer is explored. Author

A89-53286*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

UNSTEADY HEAT TRANSFER IN TURBINE BLADE DUCTS - FOCUS ON COMBUSTOR SOURCES

K. J. BAUMEISTER (NASA, Lewis Research Center, Cleveland, OH) and R. HUFF (Huff and Associates, Cleveland, OH) IN: ASME 1988 National Heat Transfer Conference, Houston, TX, July 24-27, 1988, Proceedings. Volume 3. New York, American Society of Mechanical Engineers, 1988, p. 319-328. Previously announced in STAR as N88-18870. refs

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Thermal waves generated by either turbine rotor blades cutting through nonuniform combustor temperature fields or unsteady burning could lead to thermal fatigue cracking in the blades. To determine the magnitude of the thermal oscillation in blades with complex shapes and material compositions, a finite element Galerkin formulation has been developed to study combustor generated thermal wave propagation in a model two-dimensional duct with a uniform plug flow profile. The reflection and transmission of the thermal waves at the entrance and exit boundaries are determined by coupling the finite element solutions at the entrance and exit to the eigenfunctions of an infinitely long adiabatic duct. Example solutions are presented. In general, thermal wave propagation from an air passage into a metallic blade wall is small and not a problem. However, if a thermal barrier coating is applied to a metallic surface under conditions of a high heat transfer, a good impedance match is obtained and a significant portion of the thermal wave can pass into the blade material. Author

A89-53289#

HIGH-RESOLUTION LIQUID-CRYSTAL HEAT-TRANSFER MEASUREMENTS ON THE ENDWALL OF A TURBINE PASSAGE WITH VARIATIONS IN REYNOLDS NUMBER

S. A. HIPPENSTEELE and L. M. RUSSELL (NASA, Lewis Research Center, Cleveland, OH) IN: ASME 1988 National Heat Transfer Conference, Houston, TX, July 24-27, 1988, Proceedings. Volume 3. New York, American Society of Mechanical Engineers, 1988, p. 443-453. Previously announced in STAR as N89-18664. refs

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Local heat-transfer coefficients were experimentally mapped on the end-wall surface of a three-times turbine vane passage in a static, single-row cascade operated with room-temperature inlet air over a range of Reynolds numbers. The test surface was a composite of commercially available materials: a Mylar sheet with a layer of cholesteric liquid crystals, which change color with temperature, and a heater made of a polyester sheet coated with vapor-deposited gold, which produces uniform heat flux. After the initial selection and calibration of the composite sheet, accurate, quantitative, and continuous heat-transfer coefficients were mapped over the end-wall surface. The local heat-transfer coefficients (expressed as nondimensional Stanton number) are presented for inlet Reynolds numbers (based on vane axial chord) from 0.83 x 10(5) to 3.97 x 10(5). Author

A89-53307*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

CFD IN THE CONTEXT OF IHPTET - THE INTEGRATED HIGH PERFORMANCE TURBINE ENGINE TECHNOLOGY PROGRAM

ROBERT J. SIMONEAU (NASA, Lewis Research Center, Cleveland, OH) and DALE A. HUDSON (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) AIAA, ASME, SAE, and ASEE, Joint Propulsion Conference, 25th, Monterey, CA, July 10-12, 1989. 20 p. Previously announced in STAR as N89-26174. refs

(AIAA PAPER 89-2904) Copyright

The Integrated High Performance Turbine Engine Technology (IHPTET) Program is an integrated DOD/NASA technology program designed to double the performance capability of today's most advanced military turbine engines as we enter the twenty-first century. Computational Fluid Dynamics (CFD) is expected to play an important role in the design/analysis of specific configurations within this complex machine. In order to do this, a plan is being developed to ensure the timely impact of CFD on IHPTET. The developing philosophy of CFD in the context of IHPTET is discussed. The key elements in the developing plan and specific examples of state-of-the-art CFD efforts which are IHPTET turbine engine relevant are discussed. Author

A89-53322

AE MONITORING OF AIRFRAME STRUCTURE DURING FULL SCALE FATIGUE TEST

D. BOZZETTI, A. SALA (CISE S.p.A., Milan, Italy), G. BORZACCHIELLO, and C. SABATINO (Aeritalia S.p.A., Pomigliano d'Arco, Italy) International Acoustic Emission Symposium, 9th, Kobe, Japan, Nov. 14-17, 1988, Paper. 9 p.

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The acoustic emission (AE) technique was used in a long-term fatigue test simulating various flight conditions, on a full scale airframe-structure. The rear bulkhead of the airframe is monitored by six AE sensors, 1300 cycles are performed for more than 7000 flights, and the main characteristics of AE events are recorded. A microprocessor performs the preconditioning of the AE data and controls the data logging. The data are subsequently analyzed off-line by special software programs implemented on a minicomputer. The AE technique accuracy test to detect and locate the AE sources in a wide area and a noisy environment resulted in the use of wide-band sensors for a more accurate measurement of event features. C.E.

A89-53353#

NONCIRCULAR JET DYNAMICS IN SUPERSONIC COMBUSTION

E. GUTMARK, K. C. SCHADOW, and K. J. WILSON (U.S. Navy, Naval Weapons Center, China Lake, CA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 5, Sept.-Oct. 1989, p. 529-533. Research supported by the U.S. Navy. Previously cited in issue 20, p. 3229, Accession no. A87-47005. refs

A89-53364*# Akron Univ., OH.

COMPUTERIZED LIFE AND RELIABILITY MODELING FOR TURBOPROP TRANSMISSIONS

M. SAVAGE (Akron, University, OH), K. C. RADIL, D. G. LEWICKI (U.S. Army, Aviation Research and Technology Activity, Cleveland, OH), and J. J. COY (NASA, Lewis Research Center, Cleveland, OH) Journal of Propulsion and Power (ISSN 0748-4658), vol. 5, Sept.-Oct. 1989, p. 610-614. Previously cited in issue 20, p. 3364, Accession no. A88-48031. refs

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A89-53499

FINITE ELEMENT ANALYSIS OF GYROSCOPIC EFFECTS

GERHARD SAUER (Bayern, Technischer Ueberwachungsverein, Munich, Federal Republic of Germany) and MICHAEL WOLF (Muenchen, Fachhochschule, Munich, Federal Republic of Germany) Finite Elements in Analysis and Design (ISSN 0168-874X), vol. 5, July 1989, p. 131-140. refs

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An approach which considers gyroscopic effects when analyzing the dynamic response of rotating structures using the finite element method is presented. The equation of motion for linear continuous structures containing gyroscopic effects is formulated and a consistent gyroscopic beam matrix for analysis with the FEM is derived. An analytical eigenfrequency formula to test the consistent gyroscopic matrix is given and a method to calculate the critical numbers of revolution is outlined. The influence of gyroscopic effects on eigenfrequencies and motion behavior under base excitation is shown for a rotating pump motor rotor. Author

A89-54119

FATIGUE LIFE OF DOVETAIL JOINTS - VERIFICATION OF A SIMPLE BIAXIAL MODEL

M. J. HE (Nanjing Aeronautical Institute, People's Republic of China) and C. RUIZ (Oxford, University, England) Experimental Mechanics (ISSN 0014-4851), vol. 29, June 1989, p. 126-131. Research supported by Rolls-Royce, PLC and Ministry of Defence. refs

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A biaxial fatigue specimen, designed to model the state of stress of the blade to disk joint in a typical gas turbine, has been analyzed and tested. The method of analysis was shown to predict the location of the worst damage and of crack initiation. This paper describes the analysis and testing of a simplified model that may be used in preference to the previous one. Author

A89-54348

FLASH LAMP PLANAR IMAGING

A. J. SABER, MICHAEL GEORGALLIS, U. KOREN, and MICHAEL SCHENKE (Concordia University, Montreal, Canada) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 257-262. Research supported by NSERC. refs

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The development of flash lamp light slicing (planar imaging) and its employment in gas flow visualization is discussed. A 30 Joule xenon flash lamp pulsing over about 1 microsec provides abundant broad spectrum light. The system is illustrated using transient gas jets discharging into the atmosphere and the gas dynamics and mixing are observed. Gas flow Mach numbers for discharges of air into the atmosphere are about 0.4. The technique is well-suited for investigations of hypersonic flows, including those associated with engine intakes. Author

A89-54424*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

HIGH SPEED CORNER AND GAP-SEAL COMPUTATIONS USING AN LU-SGS SCHEME

WILLIAM J. COIRIER (NASA, Lewis Research Center, Cleveland, OH) AIAA, ASME, SAE, and ASEE, Joint Propulsion Conference, 25th, Monterey, CA, July 10-12, 1989. 15 p. Previously announced in STAR as N89-27103. refs

(AIAA PAPER 89-2669) Copyright

The hybrid Lower-Upper Symmetric Gauss-Seidel (LU-SGS) algorithm was added to a widely used series of 2D/3D Euler/Navier-Stokes solvers and was demonstrated for a particular class of high-speed flows. A limited study was conducted to compare the hybrid LU-SGS for approximate Newton iteration and diagonalized Beam-Warming (DBW) schemes on a work and convergence history basis. The hybrid LU-SGS algorithm is more efficient and easier to implement than the DBW scheme originally present in the code for the cases considered. The code was validated for the hypersonic flow through two mutually perpendicular flat plates and then used to investigate the flow field in and around a simplified scramjet module gap seal configuration. Due to the similarities, the gap seal flow was compared to hypersonic corner flow at the same freestream conditions and Reynolds number. Author

A89-54488#

CONSTANT MONITORING OF THE FATIGUE DAMAGE OF AIRCRAFT LIFTING STRUCTURES [CIAGLA OCENA ZUZYCIA ZMECZENIOWEGO STRUKTUR NOSNYCH SAMOLOTOW]

MAREK DEBSKI Technika Lotnicza i Astronautyczna (ISSN 0040-1145), vol. 44, Feb. 1989, p. 17-20. In Polish.

A technique for measuring the fatigue damage of lifting structures is presented along with the equipment for performing these measurements during aircraft operation. A technique for the constant monitoring of fatigue damage (and thus the evaluation of service life) is proposed which is based not on the number of flight hours logged but on the degree of fatigue damage assumed for the structure. B.J.

A89-54585
A STUDY OF THE STRESS-STRAIN STATE OF CONNECTIONS IN AN ORTHOTROPIC MATERIAL [ISSLEDOVANIE NAPRIAZHENNO-DEFORMIROVANNOGO SOSTOIANIIA SOEDINENII IZ ORTOTROPNOGO MATERIALA]
V. I. GRISHIN, T. K. BEGEEV, and V. B. LITVINOV (Ukhtomskii Vertoletnyi Zavod, Ukhta, USSR) Mekhanika Kompozitnykh Materialov (ISSN 0203-1272), July-Aug. 1989, p. 650-654. In Russian. refs
Copyright
A method is proposed for calculating the stress-strain state of connections between parts in aircraft structures that are in direct contact. The method involves the use of a specialized set of strength analysis software, FITTING-1. The stress-strain state of a typical connection made by the winding of an orthotropic material over a metal bushing is analyzed as an example. V.L.

A89-54611
SOLUTION OF THE INVERSE BOUNDARY VALUE PROBLEM OF AEROHYDRODYNAMICS WITH ALLOWANCE FOR THE BOUNDARY LAYER [RESHENIE OBRATNOI KRAEVOI ZADACHI AEROGIDRODINAMIKI S UCHETOM POGRANICHNOGO SLOIA]
A. N. IL'INSKII and A. V. POTASHEV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), July-Aug. 1989, p. 28-32. In Russian. refs
Copyright
The problem of the construction of a wing profile in the path of a flow of a viscous (incompressible and compressible) fluid from a specified velocity distribution as a function of the arc abscissa is solved in the approximation of the boundary layer theory. Solvability conditions are obtained. From the velocity distributions corresponding to nonseparated flow, wing profile contours are determined. The effect of viscosity and compressibility on the solution is examined. V.L.

A89-54890
DETERMINING CURE CYCLES FOR THERMOSETTING EPOXY RESINS
JACQUELINE B. PAYNE (Beech Aircraft Corp., Wichita, KS) Society of Manufacturing Engineers, Fabricating Composites '88 Conference, Philadelphia, PA, Sept. 12-15, 1988. 11 p.
(SME PAPER EM88-533) Copyright
The techniques used by Beech Aircraft to determine the optimum cure cycles for the advanced composites used in the fabrication of a turboprop business aircraft, Starship 1, are discussed. A new method for determining the cure cycle that will crosslink the polymeric resin system by heat and pressure is investigated. The Rheometrics Dynamic Spectrometer (RDS) is used in formulating the cure cycle, to measure the viscous and elastic characteristics of graphite/epoxy prepregs. Many important variables considered include thickness and temperature gradients of parts and tools, part construction, gas evolution temperature, minimum viscosity, and gel point. C.E.

A89-54900
ULTRASONIC EVALUATION OF MATRIX CRACKING IN GRAPHITE BMI
MICHAEL D. FULLER (Martin Marietta Aero and Naval Systems, Baltimore, MD) Society of Manufacturing Engineers, Fabricating Composites '88 Conference, Philadelphia, PA, Sept. 12-15, 1988. 14 p. refs
(SME PAPER EM88-549) Copyright
Two NDE methods developed and deployed for reliable, accurate detection and quantification of microcracking in the radii of precooler ducts made of graphite and Nextel bismaliimide (BMII) fibers are dicussed. The first makes use of guided ultrasonic waves or Lamb waves; the other resembles traditional approaches made possible by zero impedance matching at the probe-duct interface. Conventional nondestructive testing techniques are shown to be inapplicable to this problem of fabric composite construction and the geometric constraints imposed by the radii. Acceptance criteria and reference standards are the most suitable means to meet the inspection requirements. The paper examines proof of principle demonstration through inspection procedure development, background material on the inspection requirement, and the unique inspection philosophy for this problem. C.E.

A89-54981
ESTIMATE OF SURFACE TEMPERATURES DURING ROLLING CONTACT
J. W. KANNEL and S. A. BARBER (Battelle Columbus Laboratories, OH) STLE Tribology Transactions (ISSN 0569-8197), vol. 32, July 1989, p. 305-310. refs
(Contract F33615-86-C-2623)
Copyright
A simple model for estimating the accumulative surface-temperature rise of contacts in rolling element bearings during ball or roller slippage is presented. The analysis assumes a single dimensional heat flow into the rolling element and a convective heat transfer from the element. Results of calculations indicate that the surface temperature of a solid lubricated air-cooled angular-contact bearing designed for use in a man-rated turbine engine may exceed the temperature capabilities of all known structural materials used for bearings. It is suggested that an alternative concept of a 'minimum cooled bearing', using liquid lubrication and air cooling, may exhibit considerably lower temperatures when used in this application. I.S.

N89-28754# Scientific Research Associates, Inc., Glastonbury, CT.
HYPERSONIC VEHICLE ENVIRONMENT SIMULATION, PHASE 1 Final Report, 1 Aug. 1988 - 31 Mar. 1989
F. J. DEJONG, J. S. SABNIS, and H. MCDONALD May 1989 41 p
(Contract DAAL03-88-C-0028)
(AD-A209030; ARO-26239.1-EG-SBI) Avail: NTIS HC A03/MF A01 CSCL 20/4
The hypersonic, viscous, chemically reacting flow around a vehicle in the upper layers of the atmosphere influences vehicle performance, thermal environment, and sensor visibility. Under the Phase 1 effort, a unique hybrid Navier-Stokes/Monte Carlo method has been successfully developed for the simulation of said hypersonic flows. This method combines a continuum description of the gas mixture with a statistical (or particle) description of the species transport and the chemical reactions, thereby allowing easy use of available chemical kinetics data. As such, the hybrid approach is capable of exploiting both the efficiency of a continuum approach for the fluid dynamic calculations and the benefits in physical modeling of the Monte Carlo approach for chemical reactions. The viability of this hybrid approach for practical hypersonic flow calculations has been demonstrated in the Phase 1 effort via the calculation of the chemically reacting flow field over an axisymmetric cone. A proposed Phase 2 effort would continue the development of this method by improving the numerical efficiency of the particle transport scheme, and by incorporating physical models for catalytic walls, recombination reactions, and ionization. In addition, radiation would be included via a radiation transport model. GRA

N89-28755# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
WAKE DISSIPATION AND TOTAL PRESSURE LOSS IN A TWO-DIMENSIONAL COMPRESSOR CASCADE WITH CRENULATED TRAILING EDGES M.S. Thesis
JANET LYLE VEESART Jun. 1989 92 p
(AD-A209176; AFIT/GAE/ENY/89J-3) Avail: NTIS HC A05/MF A01 CSCL 20/4
Wake dissipation and total pressure loss in a two-dimensional, subsonic, compressor cascade with crenulated trailing edges were investigated in the Cascade Test Facility. Three blade configurations, a baseline NACA 64-905 airfoil and two crenulated edge patterns were used. Hot wire anemometry and a total pressure rake were used to collect the flow data. The smaller crenulation configuration exhibited the greatest turning angle and the least total pressure losses. The most rapid wake dissipation was

generated by the larger crenulations' counterrotating vortices accompanied by slightly higher pressure losses than those created by the small crenulations. Both crenulated blade configurations had better wake dissipation, increased turning angles, and smaller pressure loss coefficients than the uncrenulated baseline blade.
GRA

N89-28765# National Aerospace Lab., Tokyo (Japan). V/STOL Aircraft Research Group.
FINITE ELEMENT ANALYSIS OF INCOMPRESSIBLE VISCOUS FLOWS AROUND SINGLE AND MULTI-ELEMENT AEROFOILS IN HIGH REYNOLDS NUMBER REGION
MASASHI SHIGEMI Dec. 1988 18 p
(NAL-TR-1010T; ISSN-0389-4010) Avail: NTIS HC A03/MF A01
Incompressible viscous flows around aerofoils are solved by a finite element method. This finite element method makes use of the penalty function method as well as the streamline-upwind Petrov-Galerkin (SUPG) method and, therefore, it can be applied to the computations of the flow at a high Reynolds number. In unsteady formulations, pressure distributions are evaluated by solving Poisson's equation with regard to pressure, rather than by direct application of the penalty function equation, since the latter tends to introduce violent oscillations in the solution. Though the present computation assumes that the flows are laminar, good agreement is obtained with experimentally measured results, particularly when the flow shows laminar separation. It is shown that this method can be applied to problems of flow around complicated geometries, and it is stated that the extension of the method to three-dimensional problems is promising. Author

N89-28774# Institut Franco-Allemand de Recherches, Saint-Louis (France).
LASER VELOCIMETRY IN THE CLOSE WAKE OF AN AXISYMMETRIC REAR BODY [MESURES DE VELOCIMETRIE LASER DANS LE SILLAGE PROCHE D'ARRIERE-CORPS A SYMETRIE DE REVOLUTION]
C. BERNER, V. PETITDAMAGE, and J. P. DUPEROUX 24 Jun. 1987 48 p In FRENCH
(ISL-R-114/87; ETN-89-94855) Avail: NTIS HC A03/MF A01
Experimental data were obtained with axisymmetric specimens placed in a cold jet for Mach number = 0.35. The velocimeter is a two dimensional argon laser (two colors, three beams, 5W). The analysis of the average velocity and turbulent fluctuations show strong variations with the geometry of the body with strong velocity gradients and large shear stress causing turbulent flow in the mixing zone. The Reynolds tensions are 30 percent lower than indicated in the literature. ESA

N89-28800# Technische Univ., Berlin (Germany, F.R.). Inst. fuer Luft- und Raumfahrt.
PIEZOELECTRIC FOILS AS SENSORS IN EXPERIMENTAL FLOW MECHANICS Final Report [PIEZOELEKTRISCHE FOLIEN ALS SENSOR IN DER EXPERIMENTELLEN STROEMUNGSMECHANIK]
WOLFGANG NITSCHE Oct. 1988 23 p In GERMAN
(ILR-MITT-214; FIP-12/10; ETN-89-94563) Avail: NTIS HC A03/MF A01
The use of piezoelectric foils as sensors for the analysis of complex aerodynamic flow fields is discussed. The sensors consist of a thin (9 to 100 micrometer) and highly elastic thermoplastic film. It can be mounted, trouble-free, on the surface of very complex flow configurations, and is thus a completely covering array of sensors, allowing large-scale surface force determination. The piezofoil is an active signal source which only requires a suitable amplifier. Wind tunnel tests on wing profiles show that flow instabilities and the characteristics of laminar-turbulent boundary layer transition can be determined. These results were confirmed by free flight tests, which also demonstrate the possibility of on-line data evaluation. Examples of the use of piezoelectric matrix, and taster sensors for the recognition of global flow structures, are given. ESA

N89-28835# Dayton Univ., OH. Research Inst.
LUBRICANT EVALUATION AND PERFORMANCE Final Technical Report, Jan. 1987 - Jun. 1988
COSTANDY S. SABA, HOOVER A. SMITH, MICHAEL A. KELLER, ROBERT E. KAUFFMAN, and VINOD K. JAIN Apr. 1989 553 p
(Contract F33615-85-C-2507)
(AD-A208925; UDR-TR-88-95; AFWAL-TR-89-2008) Avail: NTIS HC A24/MF A01 CSCL 11/8
The development of improved methods for defining and measuring turbine engine lubricant performance is examined along with the development of improved techniques for lubricant monitoring, lubrication system health monitoring, investigating antiwear characteristics and load carrying capacities of lubricants. Arrhenius plots were developed for describing the effective life of MIL-L-7808, MIL-L-23699 and 4 cSt viscosity candidate lubricants as a function of time and temperature for selected limiting values of changes in physical and chemical properties. Significant improvement in AE spectrometer sensitivity for analyzing wear metal particles was achieved when using a cup-tip electrode with the reversible polarity pin stand. The COBRA, a dielectric constant (DC) tester and a dielectric breakdown strength device were evaluated as lubricant monitoring devices. An assessment of the literature on lubricant load carrying capacity (LCC) test methods was made. A software system was developed and implemented on the Zenith Z-100 microcomputer for storage, retrieval and correlation of MIL-L-7808 lubricant qualification data. Finally, the remaining useful life of a lubricant evaluation rig (RULLER) was developed for MIL-L-7808 and MIL-L-23699 type lubricants and was based on reductive cyclic voltammetry. GRA

N89-28839# Creare, Inc., Hanover, NH.
SUPERCONDUCTING MEISSNER EFFECT BEARINGS FOR CRYOGENIC TURBOMACHINES, PHASE 1 Final Report, Sep. 1988 - Mar. 1989
VICTOR IANNELLO, JEFFREY S. MARSHALL, and W. D. STACY May 1989 52 p
(Contract F49620-88-C-0137)
(AD-A209875; CREARE-TM-1352; AFOSR-89-0825TR) Avail: NTIS HC A04/MF A01 CSCL 20/3
State of the art miniature expansion turbines and centrifugal compressors used in spaceborne sensor cryocoolers employ self-acting gas bearings to achieve high reliability and long operating life. Because these bearings must run at room temperature to achieve adequate stiffness and stability, they result in an avoidable source of heat leak to the process gas, thereby lowering overall cycle efficiency and increasing the system launch weight. This report shows that the gas bearings can be replaced by Meissner effect bearings fabricated from high temperature superconducting materials. Analyses are presented to predict Meissner bearing performance, and a preliminary design of a miniature expansion incorporating Meissner bearings is conceptualized. Because these bearings operate at cryogenic temperatures, a substantial reduction in heat leak to the process gas can be achieved. For a typical cryocooler providing 1 watt of cooling at 10 K, a 40 percent reduction in input cycle power can be achieved by replacing the self-acting gas bearings by Meissner bearings in the cold expansion turbine. GRA

N89-28841*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
TURBOMACHINERY ROTOR SUPPORT WITH DAMPING Patent Application
GEORGE L. VONPRAGENAU, inventor (to NASA) 26 May 1989 19 p
(NASA-CASE-MFS-28345-1; NAS 1.71:MFS-28345-1; US-PATENT-APPL-SN-364743) Avail: NTIS HC A03/MF A01 CSCL 13/9
Damping seals, damping bearings, and a support sleeve are presented for the ball bearings of a high speed rotor. The ball bearings consist of a duplex set having the outer races packaged tightly within the sleeve while the sleeve provides a gap with a support member so that the bearings may float with the sleeve.

The sleeve has a web extending radially between the pair of out races and acts in conjunction with one or more springs to apply an axial preload to the outer races. The sleeves have a series of slits which provide the sleeve with a spring-like quality so that the spring acts to center the rotor upon which the bearings are mounted during start up and shut down. A damping seal or a damping bearing may be used in conjunction with the ball bearings and supporting sleeve, the damping seal and damping bearing having rotor portions including rigid outer surfaces mounted within the bore of a stator protion having triangular shaped pockets on the surface facing the rotor. Axial gates are provided between adjacent pockets in sections of the stator permitting fluid to flow with less resistance axially relative to the flow of fluids circumferentially between the rotor and the stator. NASA

N89-28870*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ONE-DEGREE-OF-FREEDOM MOTION INDUCED BY MODELED VORTEX SHEDDING
L. A. YATES, A. UNAL (Army Aviation Research and Development Command, Moffett Field, CA.), M. SZADY, and G. T. CHAPMAN Jul. 1989 50 p
(NASA-TM-101038; A-88302; NAS 1.15:101038) Avail: NTIS HC A03/MF A01 CSCL 20/11

The motion of an elastically supported cylinder forced by a nonlinear, quasi-static, aerodynamic model with the unusual feature of a motion-dependent forcing frequency was studied. Numerical solutions for the motion and the Lyapunov exponents are presented for three forcing amplitudes and two frequencies (1.0 and 1.1 times the Strouhal frequency). Initially, positive Lyapunov exponents occur and the motion can appear chaotic. After thousands of characteristic times, the motion changes to a motion (verified analytically) that is periodic and damped. This periodic, damped motion was not observed experimentally, thus raising questions concerning the modeling. Author

N89-28871# Aeronautical Research Labs., Melbourne (Australia).
STRESSES AND STRAINS IN A COLD-WORKED ANNULUS
G. S. JOST Sep. 1988 52 p
(AR-005-548; ARL-STRUC-R-434) Copyright Avail: NTIS HC A04/MF A01

Analytically-derived plane strain stresses and strains in an annulus pressurized sufficiently to cause plastic flow are given. Unloading giving rise to reyielding around the bore is then examined, along with the effect of reaming. Cold-working is then included in the analysis in terms of interference between mandrel and hole. Finally, comparisons of stress and strain predictions are made with those from a finite element analysis. Author

N89-29310# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH.
AEROTHERMODYNAMIC INSTRUMENTATION
RICHARD D. NEUMANN *In* AGARD, Special Course on Aerothermodynamics of Hypersonic Vehicles 40 p Jun. 1989
Copyright Avail: NTIS HC A15/MF A01

The features of thermal instrumentation, thermal model simplifications implicit in thermal instrumentations, thermal gage definition, thermal gages, and the products of simplifications are discussed. Author

N89-29698# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
PHYSICAL MECHANISMS AND DISTURBANCES RELATED TO THE ATTACHMENT OF AN ELECTRIC ARC TO A CONDUCTIVE CYLINDER Ph.D. Thesis - Paris VI Univ.
PATRICK LEVESQUE 1988 193 p In FRENCH; ENGLISH summary Original report will also be announced as translation (ESA-TT-1168)
(ONERA-NT-1988-2; ISSN-0078-3781; ETN-89-95288) Avail: NTIS HC A09/MF A01

The physics of the interaction between medium length electric arcs (5 to 35 cm) and a structure simulating an aircraft fuselage on a small scale are discussed. The classical physical analysis of electrical discharges is reviewed. A certain number of typical discharge configurations in air, over small and large distances are presented. The electrical characteristics of the experimental device and the various electrical and optical diagnostic systems used are described. The main experimental results are given. A critical analysis and a physical interpretation of the different phases of the phenomena is provided. The special role of high current streamers and of the propagation of high conductivity leaders is outlined. A qualitative analysis of the correlations between the different phases of the arc-over and the voltages induced inside the simulated aircraft structure summarizes the results. ESA

N89-29726*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
TIME DOMAIN NUMERICAL CALCULATIONS OF UNSTEADY VORTICAL FLOWS ABOUT A FLAT PLATE AIRFOIL
S. I. HARIHARAN, PING YU (Akron Univ., OH.), and J. R. SCOTT Sep. 1989 24 p
(Contract C99066G)
(NASA-TM-102318; E-5014; ICOMP-89-19; NAS 1.15:102318)
Avail: NTIS HC A03/MF A01 CSCL 20/4

A time domain numerical scheme is developed to solve for the unsteady flow about a flat plate airfoil due to imposed upstream, small amplitude, transverse velocity perturbations. The governing equation for the resulting unsteady potential is a homogeneous, constant coefficient, convective wave equation. Accurate solution of the problem requires the development of approximate boundary conditions which correctly model the physics of the unsteady flow in the far field. A uniformly valid far field boundary condition is developed, and numerical results are presented using this condition. The stability of the scheme is discussed, and the stability restriction for the scheme is established as a function of the Mach number. Finally, comparisons are made with the frequency domain calculation by Scott and Atassi, and the relative strengths and weaknesses of each approach are assessed. Author

N89-29789*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NASA WORKSHOP ON COMPUTATIONAL STRUCTURAL MECHANICS 1987, PART 2
NANCY P. SYKES, ed. (Analytical Services and Materials, Inc., Hampton, VA.) Feb. 1989 374 p Workshop held in Hampton, VA, 18-20 Nov. 1987; sponsored by NASA, Langley Research Center, Hampton, VA, and NASA, Lewis Research Center, Cleveland, OH
(NASA-CP-10012-PT-2; NAS 1.55:10012-PT-2) Avail: NTIS HC A16/MF A01 CSCL 20/11

Advanced methods and testbed/simulator development topics are discussed. Computational Structural Mechanics (CSM) testbed architecture, engine structures simulation, applications to laminate structures, and a generic element processor are among the topics covered.

N89-29792*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
COMPUTATIONAL STRUCTURAL MECHANICS ENGINE STRUCTURES COMPUTATIONAL SIMULATOR
C. C. CHAMIS *In* NASA, Langley Research Center, NASA Workshop on Computational Structural Mechanics 1987, Part 2 p 459-485 Feb. 1989
Avail: NTIS HC A16/MF A01 CSCL 20/11

The Computational Structural Mechanics (CSM) program at Lewis encompasses: (1) fundamental aspects for formulating and solving structural mechanics problems, and (2) development of integrated software systems to computationally simulate the performance/durability/life of engine structures. Author

N89-29793*# Sverdrup Technology, Inc., Cleveland, OH.
INTERFACING MODULES FOR INTEGRATING DISCIPLINE SPECIFIC STRUCTURAL MECHANICS CODES
NED M. ENDRES *In* NASA, Langley Research Center, NASA

Workshop on Computational Structural Mechanics 1987, Part 2 p 487-519 Feb. 1989
Avail: NTIS HC A16/MF A01 CSCL 20/11

An outline of the organization and capabilities of the Engine Structures Computational Simulator (Simulator) at NASA Lewis Research Center is given. One of the goals of the research at Lewis is to integrate various discipline specific structural mechanics codes into a software system which can be brought to bear effectively on a wide range of engineering problems. This system must possess the qualities of being effective and efficient while still remaining user friendly. The simulator was initially designed for the finite element simulation of gas jet engine components. Currently, the simulator has been restricted to only the analysis of high pressure turbine blades and the accompanying rotor assembly, although the current installation can be expanded for other applications. The simulator presently assists the user throughout its procedures by performing information management tasks, executing external support tasks, organizing analysis modules and executing these modules in the user defined order while maintaining processing continuity. Author

N89-29794*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CSM RESEARCH: METHODS AND APPLICATION STUDIES
NORMAN F. KNIGHT, JR. *In its* NASA Workshop on Computational Structural Mechanics 1987, Part 2 p 521-570 Feb. 1989
Avail: NTIS HC A16/MF A01 CSCL 20/11

Computational mechanics is that discipline of applied science and engineering devoted to the study of physical phenomena by means of computational methods based on mathematical modeling and simulation, utilizing digital computers. The discipline combines theoretical and applied mechanics, approximation theory, numerical analysis, and computer science. Computational mechanics has had a major impact on engineering analysis and design. When applied to structural mechanics, the discipline is referred to herein as computational structural mechanics. Complex structures being considered by NASA for the 1990's include composite primary aircraft structures and the space station. These structures will be much more difficult to analyze than today's structures and necessitate a major upgrade in computerized structural analysis technology. NASA has initiated a research activity in structural analysis called Computational Structural Mechanics (CSM). The broad objective of the CSM activity is to develop advanced structural analysis technology that will exploit modern and emerging computers, such as those with vector and/or parallel processing capabilities. Here, the current research directions for the Methods and Application Studies Team of the Langley CSM activity are described. Author

N89-29800*# Pratt and Whitney Aircraft, East Hartford, CT. Commerical Engine Business.
BOUNDARY ELEMENTS FOR STRUCTURAL ANALYSIS
In NASA. Langley Research Center, NASA Workshop on Computational Structural Mechanics 1987, Part 3 p 763-829 Feb. 1989
Avail: NTIS HC A18/MF A01 CSCL 20/11

The intent here is to discuss the status of the boundary element method (BEM) for structural analysis, both in terms of the present and anticipated capabilities of the method and in terms of the incorporation of the method in the design/analysis process, particularly for gas turbine engine components. Author

N89-29804*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THE 3-D INELASTIC ANALYSES FOR COMPUTATIONAL STRUCTURAL MECHANICS
D. A. HOPKINS and C. C. CHAMIS *In* NASA. Langley Research Center, NASA Workshop on Computational Structural Mechanics 1987, Part 3 p 943-979 Feb. 1989
Avail: NTIS HC A18/MF A01 CSCL 20/11

The 3-D inelastic analysis method is a focused program with the objective to develop computationally effective analysis methods and attendant computer codes for three-dimensional, nonlinear time and temperature dependent problems present in the hot section of turbojet engine structures. Development of these methods was a major part of the Hot Section Technology (HOST) program over the past five years at Lewis Research Center.
Author

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GEOSCIENCES

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

A89-54363
A STUDY OF THE SENSITIVITY OF STRATOSPHERIC OZONE TO HYPERSONIC AIRCRAFT EMISSIONS
DOUGLAS E. KINNISON, DONALD J. WUEBBLES (Lawrence Livermore National Laboratory, Livermore, CA), and HAROLD S. JOHNSTON (California, University, Berkeley) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 389-394. refs
(Contract W-7405-ENG-48; DE-AC03-76SF-00098)
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The sensitivity of stratospheric ozone to NO(x), HO(x), and ClX emissions is examined in order to study the possible environmental impact of emissions from hypersonic aircraft. The one- and two-dimensional chemical-radiative transport models used in the study are described. The sensitivity of the models to emissions with various magnitudes, altitudes, and latitudes is tested. It is found that significant decreases in the total ozone column may result from stratospheric NO(x) emissions, if the global emission rate is large enough. The effects of emissions on total ozone increase with increasing altitude, up to a maximum injection altitude of about 30 km. R.B.

A89-54776
INTERNATIONAL CONFERENCE ON THE AVIATION WEATHER SYSTEMS, 3RD, ANAHEIM, CA, JAN. 30-FEB. 3, 1989, PREPRINTS
Conference sponsored by the American Meteorological Society and World Meteorological Organization. Boston, MA, American Meteorological Society, 1989, 505 p. For individual items see A89-54777 to A89-54868.
Copyright

Papers on aviation meteorology are presented covering topics such as the detection of microbursts and low-level wind shear, an algorithm for gust front detection, satellite soundings to determine microburst storm conditions, a low-level wind shear alert system, airport surveillance radars, and meteorological support to range and aerospace systems. Other topics include Shuttle lightning threat analysis, wind profiling radars for Shuttle launch support, automated weather observations, snowstorm observations, forecasts for runway surfaces, forecasts of icing conditions, experimental nowcasting concepts, forecasting clear air turbulence probability, and aviation weather training and education. Additional subjects are wind profile temporal variability, Monte Carlo turbulence simulation for Shuttle reentry, GOES water vapor imagery for thunderstorm forecasting, lightning detection, FAA aviation weather systems, legal aspects of aviation weather forecasting, and aviation weather information systems. R.B.

A89-54777*
A RELATIONSHIP BETWEEN PEAK TEMPERATURE DROP AND VELOCITY DIFFERENTIAL IN A MICROBURST
FRED H. PROCTOR (MESO, Inc., Hampton, VA) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American

Meteorological Society, 1989, p. 5-8. refs
(Contract NAS1-18336)
Copyright
Results from numerical microburst simulations using the Terminal Area Simulation System (Proctor, 1987) are used to develop a relationship between wind velocity differential and peak temperature drop. The numerical model and the relationships derived from the model are described. The relationship between peak temperature drop and differential wind velocity is shown to be valid during microburst development, for all precipitation shaft intensities and diameters. It is found that the relationship is not valid for low-reflectivity microburst events or in the presence of ground-based stable layers. The use of the relationship in IR wind shear detection systems is considered. R.B.

A89-54779
DALLAS MICROBURST STORM ENVIRONMENTAL CONDITIONS DETERMINED FROM SATELLITE SOUNDINGS
GARY ELLROD (NOAA, Satellite Applications Laboratory, Washington, DC) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 15-20. refs
Copyright
The environmental conditions of the thunderstorm that lead to the commercial airliner crash at the Dallas-Ft. Worth Airport on August 2, 1985 are analyzed. The conditions are derived from GOES VAS data in 12 spectral bands, including three water vapor absorption channels. The synoptic setting, air mass contrast, and midtropospheric moisture associated with the storm are described. The various stages of storm development are examined, showing that none of the VAS-derived parameters alone could have forecast the storm accurately. Consideration is given to the possibility of combining satellite and conventional data to improve forecasts of storms that occur within a very short time span. R.B.

A89-54780
THE DETECTION OF LOW LEVEL WINDSHEAR WITH AIRPORT SURVEILLANCE RADAR
DAVID ATLAS IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 21-24.
Copyright
A method is presented for detecting hazardous low-level wind shear windshear using wide fan beam airport surveillance radars, such as the ASR-9. The method provides the wind speed components at the null and near the surfaces. These wind speed components are used to determine the various components of wind shear. Consideration is given to the sensitivity and accuracy of the method and to clutter discrimination. The advantages and limitations of the method are outlined. R.B.

A89-54783
MICROBURST DETECTION FROM MESONET DATA
LARRY B. CORNMAN and F. WELSEY WILSON, JR. (National Center for Atmospheric Research, Boulder, CO) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 35-40. Research supported by NSF. refs
(Contract DTFA01-82-7-10513)
Copyright
A procedure is presented for the automatic detection of microbursts using an anemometer mesonet. The procedure is based on the numerical estimation of divergence in the horizontal wind field. Numerical methods have been developed for computing divergence and thresholding for microburst detection from anemometer data on an irregular grid. The methods are described and examples are presented, demonstrating the application of the methodology to the Low-Level Wind Shear Alert System and the Terminal Doppler Weather Radar. R.B.

A89-54784
EVALUATION OF THE 12-STATION ENHANCED LOW LEVEL WIND SHEAR ALERT SYSTEM (LLWAS) AT DENVER STAPLETON INTERNATIONAL AIRPORT
GLENN R. SMYTHE (Data Transformation Corp., Atlantic City, NJ) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 41-46.
Copyright
Results are presented from an operational test and evaluation of the 12-sensor enhanced Low-Level Wind Shear Alert System (LLWAS) conducted at Denver Stapleton International Airport between August 3 and September 4, 1987. The enhancements to the LLWAS are described, including the centerfield average (CFA) algorithm and a wind shear and microburst detection (WSMD) algorithm. The performance of the system is assessed and examples of specific weather events are described. It is found that the WSMD algorithm outperformed the CFA algorithm in wind shear and microburst detection and in the reduction of false alarms. R.B.

A89-54785
MICROBURST DETECTION AND DISPLAY BY TDWR - SHAPE, EXTENT, AND ALARMS
KRISTI BRISLAWN, F. WESLEY WILSON, JR., WILLIAM MAHONEY, GERRY WIENER, KENT GOODRICH (National Center for Atmospheric Research, Boulder, CO) et al. IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 47-52. Research supported by NSF.
(Contract DTFA01-82-Y-10513)
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The production of alarms associated with microburst wind shear for the Terminal Doppler Weather Radar program is described. The algorithms which determine microburst shapes on the geographical situation display are examined. The creation of the alphanumeric message which is relayed to pilots by air traffic controllers is discussed, emphasizing the algorithm responsible for the content of the message. Examples of specific microburst events are presented to demonstrate the use of the algorithms. R.B.

A89-54786
DIVERGENCE ESTIMATION BY A SINGLE DOPPLER RADAR
F. WESLEY WILSON, JR., KRISTI BRISLAWN, and R. KENT GOODRICH (National Center for Atmospheric Research, Boulder, CO) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 53-56. Research supported by the National Center of Atmospheric Research.
(Contract DTFA01-82-Y-10503)
Copyright
Two approaches for determining the outflow segments of the microburst detection algorithm (Merritt, 1987) of the Terminal Doppler Weather Radar program are compared. The loss-based approach seeks a nearly sustained increase of radial velocity along the radar beam. The shear-based approach is based on the requirement that the velocity gradient exceed a positive threshold at most gates. An algorithm is presented for determining outflow segments using a shear criterion. Examples using both of the approaches are given. It is suggested that the shear-based approach may locate hazards more accurately. R.B.

A89-54787
ESTIMATION OF MICROBURST ASYMMETRY WITH A SINGLE DOPPLER RADAR
MICHAEL D. EILTS (NOAA, National Severe Storms Laboratory, Norman, OK) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 57-61. refs
(Contract DTFA01-80-Y-10524)
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Preliminary results are presented from a study on the estimation of microburst asymmetry using single Doppler radar data. Various techniques for estimating microburst asymmetry are reviewed and the process of estimating the two-dimensional wind field with a single Doppler radar is described. Horizontal vector wind field estimates from single Doppler radar data are compared with those obtained from dual-Doppler wind fields using the reflectivity gradient technique. The results suggest that the proposed method estimates the angle and magnitude of the maximum shear axis fairly well when the shear axis is less than 60 deg from the radial azimuth. However, the method does not seem to model microburst wind fields well enough to estimate wind shears along individual flight paths. R.B.

A89-54788

NUMERICAL SIMULATION OF MICROBURSTS - AIRCRAFT TRAJECTORY STUDIES

MICHAEL R. BABCOCK and KELVIN K. DROEGEMEIER (Oklahoma, University, Norman) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 62-67. refs
(Contract NSF ATM-87-57013)
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The problem of providing wind shear scenarios in flight simulators is examined with simulations of microburst evalution using a fully time-dependent cloud model. The time sequence of meteorological parameters are measured along a prescribed flight path. Simulations of 16 microbursts are used to study the relationship of meteorological conditions along the flight path to variations in time, location, slope, and penetration speed. Also, correlations between quantities observed at the aircraft and those ahead of the aircraft are determined in order to identify signals for severe wind shears. The applications of the results for the development of on-board detection devices and full-motion simulators are discussed. R.B.

A89-54789

WEATHER SENSING WITH AIRPORT SURVEILLANCE RADARS

MARK E. WEBER (MIT, Lexington, MA) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 68-74. Research sponsored by FAA. refs
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The use of six-level weather reflectivity reports from the ARS-9 airport surveillance radars to control airport terminal regions is discussed. The design of the ASR-9 six-level reflectivity processor is described. Consideration is given to the statistical stability of the displayed weather regions, the ASR-9 method for ground clutter suppression, and the system's fan-shaped elevation beam pattern. A possible processor upgrade to enable airport surveillance radars to measure the velocity of precipitation wind tracers and to detect regions of hazardous low altitude wind shear. Results from experiments testing the capabilities of ARS-9 are reviewed. R.B.

A89-54795

IMPACT OF AUTOMATED WEATHER OBSERVING SYSTEMS ON AVIATION

KENNETH KRAUS (FAA, Washington, DC) and LARRY MAYOU (Martin Marietta Corp., Washington, DC) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 108-111.
Copyright

The implementation of the Automated Weather Observing System (AWOS) into the Federal Aviation Regulations is discussed. The development of the AWOS and the AWOS acquisition programs are reviewed. The advantages of the AWOS and the possibility of creating national weather communication networks are examined. The requirements for automated observations are noted, focusing on the certification procedure under FAA Advisory Circular 150/5220-16. Also, consideration is given to the Automated Surface Observing System and the AWOS Data Acquisition System. R.B.

A89-54797

A 3-HOUR MESOSCALE ASSIMILATION SYSTEM USING ACARS AIRCRAFT DATA COMBINED WITH OTHER OBSERVATIONS

STANLEY G. BENJAMIN, KEITH A. BREWSTER, RENATE BRUMMER, BRIAN F. JEWETT, THOMAS W. SCHLATTER (NOAA, Environmental Research Laboratories, Boulder, CO) et al. IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 117-122. refs
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The development of the Mesoscale Analysis and Prediction System (MAPS) is discussed. MAPS is planned to provide frequent and detailed analyses of diverse surface and tropospheric data over the U.S. in addition to very short-term numerical forecasts. Emphasis is placed on the MAPS 3-h data assimilation cycle configured in isentropic coordinates. The assimilated data include rawinsonde data, aircraft reports, wind profiler observations, and surface observations. The aircraft data are obtained through ACARS, a communications addressing and reporting system. Consideration is given to quality control of the observations and the isentropic forecast model in the MAPS assimilation cycle. The influence of aircraft and profiler observations in the assimilation cycle is examined by comparing results of the 3-h cycle with a 12-h model. R.B.

A89-54801

LDIS (LIGHTNING DATA AND INFORMATION SYSTEMS) - A NEW RESOURCE FOR AVIATION METEOROLOGY

W. A. LYONS, K. G. BAUER, D. A. BRYAN, D. A. MOON, N. J. PETIT (R-Scan Corp., Minnesota Supercomputer Center, Minneapolis) et al. IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 140-145. refs
Copyright

Consideration is given to the development of Lightning Data and Information Systems (LDIS), which use remote sensing data to detect, locate, and track electrically active convective storms throughout the U.S. The establishment of the National Lightning Detection Network to integrate LDIS data for the continental U.S. is discussed. The methods for obtaining and using real-time lightning data for forecasting are examined. Also, the aviation applications of LDIS technology are noted. R.B.

A89-54806

A COOPERATIVE STUDY ON WINTER ICING CONDITIONS IN THE DENVER AREA

WAYNE R. SAND, MARCIA K. POLITOVICH (National Center for Atmospheric Research, Boulder, CO), JOHN MCGINLEY (NOAA, Boulder, CO), and LEON OSBORNE (North Dakota, University, Grand Forks) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 169-172. Research supported by the National Center for Atmospheric Research and NSF.
(Contract DTFA01-87-C-00019; DTFA01-82-Y-10513)
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Preliminary results are presented from a study in which in situ and remote icing environment measurements were combined to study the problem of aircraft icing. The study was conducted in the area surrounding Denver, CO, between November 1987 and April 1988. The data include 5- and 10-cm Doppler radar, microwave radiometers, and laser ceilometer measurements combined with integrated NWS observations, satellite visible and IR imagery, NOAA radiometer and wind profiler measurements, and mesonet surface weather data. The resulting data set is described. R.B.

A89-54809
USING FEATURES ALOFT TO IMPROVE TIMELINESS OF TDWR HAZARD WARNINGS
STEVEN D. CAMPBELL and MARK A. ISAMINGER (MIT, Lexington, MA) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 184-189. Research supported by FAA. refs
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Results are presented that demonstrate the ability of the prototype microburst recognition algorithm of the Terminal Doppler Weather Radar (TDWR) to recognize features aloft for microburst events observed at Huntsville, Alabama, in 1986 and Denver, Colorado in 1987. Five days of data from each location were used, and ground truth was established for 126 microburst events. Of these, seven high-reflectivity events were tested for the effect of using features aloft on the alarm timeliness. The average precursor warning time for the seven events was 6.2 min, which corresponds well with the conceptual model for high-reflectivity events proposed by Roberts and Wilson (1986). The use of features aloft was found to increase the alarm timeliness for these events by 1.3 minutes. I.S.

A89-54813
EVALUATION OF MICROBURST NOWCASTING DURING TDWR 1987
RITA D. ROBERTS and MARK R. HJELMFELT (National Center for Atmospheric Research, Boulder, CO) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 206-211. Research supported by the National Center for Atmospheric Research and NSF. refs
(Contract DTFA01-82-Y-10513)
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This paper presents the results of a nowcasting exercise carried out in Denver, Colorado, to test the ability of the Terminal Doppler Weather Radar (TDWR) to provide air traffic controllers and pilots with warnings of microburst hazards. The TDRW radar mesonetwork at the Denver Stapleton Airport and the instrumentation used are described, together with the operational procedure of nowcasting, the nowcasting forms, and the nowcasting statistics. Results are presented on radar signatures obtained for 57 low, moderate, and high-reflectivity storms when correct and incorrect microburst nowcasts were issued. High probability of detection, low false-alarm ratio, and reasonable critical success index scores were found, demonstrating the potential of the TDWR for warning of an impending microburst occurrence. I.S.

A89-54817
MET 90, A PROJECT FOR THE DEVELOPMENT OF THE FUTURE SWEDISH AVIATION WEATHER SYSTEM
BJORN HELLROTH and ESBJORN OLSSON (Sveriges Meteorologiska och Hydrologiska Institut, Norrkoping, Sweden) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 228-232.
Copyright

A89-54824
VERIFICATION OF AERODROME FORECASTS
NEIL D. GORDON (New Zealand Meteorological Service, Wellington) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 264-269. refs
Copyright

The procedure of the objective verification of airport forecasts in the international standard TAF format is considered. The airport forecasts are in well-defined format, but contain information about temporal fluctuations of the elements in a form which is not readily verified from conventional airport observations (METARs and SPECI). To verify temporal fluctuations, the TAFs must be converted to probability forecasts. Techniques for automatically interpreting the temporal fluctuation characteristics of airport forecasts in standard TAF code are described and are illustrated with sample verifications from three New Zealand airports for the winter of 1988. I.S.

A89-54825
ANALYSIS OF VERIFICATION PARAMETERS FOR NON-CONVECTIVE SIGMETS
ROGER M. WILLIAMS (U.S. National Weather Service, Kansas City, MO) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 270-273.
Copyright

This paper describes a program designed to verify nonconvective Sigmets ('significant meteorology' to pilots) issued by the National Aviation Weather Advisory Unit. In this program, Sigmets issued for 508 Sigmet areas were correlated with 4,045 pilot reports for January, February, and March of 1986, using a manual data reduction process in the analysis. It was found that, of the 508 Sigmet areas, 114 were nonverifiable; the average SII for the three months was 2.14. However, it is noted that there were limitations to this program due both to the nature of the reporting procedures of pilot reports and to the limited data base of the pilot reports used in the analysis. Thus, pilot reports describing conditions as 'light or smooth' turbulence of 'light or trace' icing were not plotted. It is suggested that the process of accounting for pilot reports is automated, thus making it possible to account for all pilot reports. This would reduce the number of unverifiable Sigmets. I.S.

A89-54827
THE WORLD AREA FORECAST SYSTEM
JERALD UECKER and ESTHER L. MCKAY (U.S. National Weather Service, Silver Spring, MD) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 280-283.
Copyright

The history of establishing the World Area Forecast System (WAFS) is discussed, with special attention given to the development of various forecast centers. The WAFS network consists of two World Area Forecast Centers (WAFCs), one in Washington and one in London; a number of regional area forecast centers (RAFCs) associated with one or the other WAFC (there are eight RAFCs associated with London and seven with Washington), and the communications links for the transmission of large volumes of grid-point data in digital form between the two WAFCs and between each WAFC and its associated RAFCs. The two ongoing major efforts underway in WAFS include one concerned with the dissemination of data via satellite broadcast systems and the second with the automation of data on the significant weather elements. I.S.

A89-54831
VERY SHORT-RANGE AERODROME FORECASTS USING REGRESSION TECHNIQUES
JIM RENWICK (New Zealand Meteorological Service, Wellington) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 297-300.
Copyright

This paper describes a modified model-output-statistics (MOS) system that combines information from an unsophisticated numerical weather prediction (NWP) model with that from current in situ observations. Data on wind speed, the u and v wind components, horizontal visibility, ceiling, air temperature, relative humidity, dewpoint temperature, and mean sea-level pressure were extracted from the New-Zealand-Meteorological-Service climatological archive for the Christchurch airport, using reports for every hour between January 1, 1979 and December 31, 1986. Of these, the first six years were used as dependent data for the derivation of forecast equations, and the remaining two years were used for testing. The modified MOS technique was found to perform well against two sets of control forecasts for prognosis periods from one to thirteen hours. I.S.

A89-54840

DOPPLER WEATHER RADAR SERVICE AT THE CHIANG KAI-SHEK INTERNATIONAL AIRPORT

HUNG-PENG CHU and YEONG-JHY TSAI (Civil Aviation Administration of China, Air Navigation and Weather Services, Taipei, Republic of China) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 335-338.

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A89-54841

AN INDEX FOR CLEAR AIR TURBULENCE BASED ON HORIZONTAL DEFORMATION AND VERTICAL WIND SHEAR

GARY P. ELLROD (NOAA, Satellite Applications Laboratory, Washington, DC) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 339-344. refs

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This paper describes an objective clear-air-turbulence (CAT) index which can be computed quickly using either numerical model winds or winds from remote sensors. The turbulence index, which is based on the product of horizontal deformation and vertical wind shear, was found to provide a fairly reliable indication of CAT potential. When derived from the Nested Grid Model described by Hoke (1984) over the United States on 33 days, the specific CAT index was found to correctly analyze significant areas of CAT about 70 percent of the time, with a false alarm ratio of 20 percent. I.S.

A89-54844

IMPROVEMENT OF THE PERFORMANCE OF SENSORS IN THE LOW-LEVEL WIND SHEAR ALERT SYSTEM (LLWAS)

KENNETH D. JAFFE (Data Transformation Corp., Atlantic City, NJ) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 356-361. refs

Copyright

A low-level wind shear alert system (LLWAS) commonly consists of a network of six anemometers, one near the center of the airport, and five remote sensors scattered around its periphery, usually 2 miles or more apart. Data from many LLWAS installed nationwide revealed a loss in performance due to the sheltering phenomenon at many sensor locations, caused by surrounding obstructions. This paper discusses the methods used for the LLWAS site evaluation, the means used to determine the sensor height required to reduce sheltering by an upwind obstruction, and the minimal distance for the sensor from an obstruction. Special attention is given to the enhanced LLWAS network comprised of a dense array of ten sensors, which is being installed at the Denver Stapleton Airport, and to ground rules that are involved in the search for enhanced LLWAS sites. I.S.

A89-54846

A CASE STUDY OF LOCAL SEVERE WEATHER AT CHANG KAI SHEK INTERNATIONAL AIRPORT

KOUNG-YING LIU and TIAN-YOW SHYU (Chinese Air Force, Taipei, Republic of China) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 370-375. Research supported by the National Science Council of the Republic of China.

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A89-54852

GUST FRONT DETECTION ALGORITHM FOR THE TERMINAL DOPPLER WEATHER RADAR. II - PERFORMANCE ASSESSMENT

DIANA KLINGE-WILSON, STEPHEN H. OLSON (MIT, Lexington, MA), WESLEY WILSON, WILLIAM P. MAHONEY, III (National Center for Atmospheric Research, Boulder, CO), STEVEN D. SMITH, ARTHUR WITT (NOAA, National Severe Storms Laboratory, Norman, OK) et al. IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 398-402. Research supported by FAA. refs

Copyright

This paper describes the Gust Front Algorithm for the detection of gust front and wind shift, designed for use in the Terminal Doppler Weather Radar (TDWR) system, and the results of its performance assessment during the 1988 TDWR Operational Test and Evaluation, conducted near Denver, Colorado. Special attention is given to the data-editing, product-generation, ground-truth, and scoring issues. Scoring results are presented, and problems identified during the test are discussed. I.S.

A89-54854

THE FEDERAL AVIATION ADMINISTRATION'S LOW LEVEL WINDSHEAR ALERT SYSTEM - A PROJECT MANAGEMENT PERSPECTIVE

CRAIG R. GOFF (FAA, Washington, DC) and RICHARD H. GRAMZOW (Martin Marietta Corp., Washington, DC) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 408-413. refs

Copyright

The Low-Level Windshear Alert System (LLWAS) is a network of conventional wind sensing devices linked by radio to a central computer which issues wind-shear advisories to air-traffic controllers. This paper discusses the first significant improvements since the initial LLWAS was installed in 1977, which consist of increasing the network density by adding new wind sensor sites to the original six; making software and network design enhancements to distinguish microburst windshears from other types of shear, provide the air-traffic controllers and pilots with runway-oriented windshear information, and provide shear detection capability at centerfield. I.S.

A89-54855

THE FAA TERMINAL DOPPLER WEATHER RADAR (TDWR) PROGRAM

DONALD TURNBULL (FAA, Washington, DC) and JOHN MCCARTHY (National Center for Atmospheric Research, Boulder, CO) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 414-419. Research supported by FAA. refs

Copyright

The FAA Terminal Doppler Weather Radar (TDWR) program was initiated to design a reliable automated system for detecting low-altitude wind shear in the aircraft's approach-and-departure corridor and to provide timely warnings to pilots of its presence and its relative severity. This paper describes the history of the TDWR development, the user needs, the TDWR processing equipment and the automatic detection algorithm, and the planned TDWR products, initial and future. Results are presented for the 1988 testing of TDWR in the Denver, Colorado, area. The system was found to detect 90 percent of all microbursts with wind changes greater than 10 m/s, and 97 percent of microbursts with wind shears greater than 15 m/s. I.S.

A89-54856

GROUND BASED WEATHER RADAR FOR AVIATION

ARTHUR L. HANSEN (FAA, Washington, DC) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 420, 421.

Copyright

The operational requirements for aviation weather are discussed together with the use of weather radar data for flight planning support. The weather radar can help to determine the temporal and spatial scales of weather parameters of greatest concern for aviation safety, such as wind, wind shear, turbulence, hail, lightning, and visibility, as these are related to the various phases of flight. Because of the rapid descent of the microburst and the subsequent generation of low-level wind shear, high-speed computers are needed to process the data. The installation (in 1994) of the FAA's Real-Time Weather Processor will add alphanumeric notations, graphic outlines, and symbols to the radar products forwarded by the Central Weather Service Units to the air traffic controllers and traffic-management specialists. I.S.

A89-54857

THE STATUS OF THE FAA CENTRAL WEATHER PROCESSOR (CWP) PROGRAM

ERIC MANDEL, KEVIN YOUNG (FAA, Washington, DC), DAVID PANZER, and HAL LUDWIG (Stanford Telecommunication, Inc., Washington, DC) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 422-425. refs

Copyright

This paper describes the FAA Central Weather Processor (CWP) system that is to be deployed in 1994, together with its two complementary subsystems, the Real-Time Weather Processor and the Meteorologist Weather Processor, with special attention given to the upgraded weather-data-collection, processing, and distribution facilities. This integrated system will provide weather data distribution, processing, and services tailored to all of the personnel responsible for meteorology within the NAS. I.S.

A89-54860

THE DEVELOPMENT OF NUMERICALLY-BASED AND EXPERT SYSTEM APPROACHES FOR AIRFIELD NOWCASTING/VERY SHORT RANGE FORECASTING

DONALD A. CHISHOLM, ALAN R. BOHNE, and ROSEMARY M. DYER (USAF, Geophysics Laboratory, Hanscom AFB, MA) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 433-436. refs

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The new capabilities planned for the weather-report locations supporting the Air-Force and Army operations are NEXRAD Doppler weather radar, DMSP and GOES satellite imagery and soundings, conventional observations and model-generated analyses, and forecasted gridded fields via the Automated Weather Distribution System. To manage the large amounts of data into an integrated information processing system, the program called Advanced Meteorological Processing System (AMPS) was initiated, which will provide modules for the extrapolation procedures to nowcast/forecast NEXRAD and/or GOES imagery, the numerically-based prediction models dealing with the processes of convective initiation and with nonconvective cloud and precipitation systems, and artificial intelligence. This paper discusses the AMPS experimental facility and the development program. I.S.

A89-54862

AN OVERVIEW OF THE NATIONAL PROGRAM TO IMPROVE AIRCRAFT ICING FORECASTS

JOHN W. HINKELMAN, JR. (National Center for Atmospheric Research, Boulder, CO) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 443-445.

Copyright

This paper outlines the National Plan (OFCM 1986) for developing the capability to detect, monitor, and forecast aircraft icing conditions through the use of research aircraft, and new remote sensing technology. The plan objective is the timely, accurate delineation of actual and expected icing areas by location, altitude, duration, and potential severity. Author

A89-54865

FEDERAL PLANS TO SATISFY AVIATION WEATHER INFORMATION REQUIREMENTS IN THE 1990'S

MICHAEL A. TOMLINSON (U.S. National Weather Service, Silver Spring, MD) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 459-462.

Copyright

New aviation weather services provided by the National Weather Service (NWS) and FAA use the data and data-analysis capabilities provided by new sensors and interactive workstations. As the new technology of the Next Generation Weather Radar, next generation weather satellites, Automated Surface Observation Systems and other remote sensing systems, and the next-generation supercomputer for NMC become available, the NWS forecasters will require an advanced interactive processing and display system to fully utilize the new data sets and high-resolution information. These requirements will be met by the Advanced Weather Interactive Processing System for the 1990s (AWIPS-90). I.S.

A89-54866

WEATHER INFORMATION SYSTEMS FOR PILOTS - THE MINNESOTA EXPERIENCE

DEAN C. LARSON (Minnesota Dept. of Transportation, Saint Paul) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 463-465.

Copyright

The Minnesota weather information system for pilots, designed by the Office of Aeronautics of the Minnesota Department of Transportation is described, with special attention given to the Minnesota Weather Access System (MnWAS) program. Presently, the information obtained from 14 Supplemental Aviation Weather Reporting Stations in Minnesota is sent at 20-min intervals, via a computer-phone linkup, to the National Weather Service (NWS) in Kansas City, Missouri, which then distributes this information nationally over the NWS/FAA weather circuits. The MnWAS is a weather information distribution program with 77 computer terminals installed in 52 airports, which are linked via phone line to a control data computer. The control data computer operates 24 hours a day as a server, collecting data from the NWS/FAA weather circuits and other sources, formatting the data and distributing them upon phone request to the MnWAS terminals. The terminals provide paper printouts of the weather data and maps for pilots. I.S.

A89-54868

TECHNIQUES FOR THE DETECTION OF MICROBURST EVENTS USING AIRPORT SURVEILLANCE RADARS - CROSS-SPECTRAL VELOCITY ESTIMATION

JOHN R. ANDERSON and ROBERT N. GIFFORD (Wisconsin, University, Madison) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 489-492. Research supported by FAA.

Copyright

This paper describes a cross-spectral velocity estimation technique for the detection of microburst events with airport surveillance radars, which exploits the elevation-dependent phase differences between two beams. It is shown that the cross-spectral velocity estimator can be derived in a form similar to the traditional mean velocity angle equation, but involves a weighting function which is designed to minimize the contributions of velocity components which have phase angles not consistent with low elevation angles. A sample result is presented, showing the measurement of wind fields associated with a shallow microburst outflow at a range of 19 km from the radar. I.S.

15

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.

A89-52564*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INTEGRATED STRUCTURE/CONTROL LAW DESIGN BY MULTILEVEL OPTIMIZATION
MICHAEL G. GILBERT (NASA, Langley Research Center, Hampton, VA) and DAVID K. SCHMIDT (Arizona State University, Tempe) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 376-385. Previously announced in STAR as N89-26623. refs
(AIAA PAPER 89-3470) Copyright

A new approach to integrated structure/control law design based on multilevel optimization is presented. This new approach is applicable to aircraft and spacecraft and allows for the independent design of the structure and control law. Integration of the designs is achieved through use of an upper level coordination problem formulation within the multilevel optimization framework. The method requires the use of structure and control law design sensitivity information. A general multilevel structure/control law design problem formulation is given, and the use of Linear Quadratic Gaussian (LQG) control law design and design sensitivity methods within the formulation is illustrated. Results of three simple integrated structure/control law design examples are presented. These results show the capability of structure and control law design tradeoffs to improve controlled system performance within the multilevel approach. Author

A89-52585#
A SURROGATE SYSTEM APPROACH TO ROBUST CONTROL DESIGN
SIVA S. BANDA, HSI-HAN YEH, and SHARON A. HEISE (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 576-582. refs
(AIAA PAPER 89-3492)

The design of robust control systems in the presence of real-parameter uncertainty and high frequency unmodelled dynamics is considered. Concepts of applying H(infinity) and LQG optimizations to a surrogate system representation of an uncertain system are discussed. An algorithm is explicitely stated detailing the design of control laws guaranteeing both robust stability and robust performance for the uncertain system. Advantages and limitations to this design procedure are outlined, and possible directions for future research are revealed. Author

A89-52603*# Mississippi State Univ., Mississippi State.
EXTENDED OBSERVABILITY OF LINEAR TIME-INVARIANT SYSTEMS UNDER RECURRENT LOSS OF OUTPUT DATA
ROGELIO LUCK (Mississippi State University, Mississippi State), ASOK RAY (Pennsylvania State University, University Park), and YORAM HALEVI (Technion - Israel Institute of Technology, Haifa) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 741-748. refs
(Contract NAG3-823; NSF DMC-87-07648)
(AIAA PAPER 89-3510) Copyright

Recurrent loss of sensor data in integrated control systems of an advanced aircraft may occur under different operating conditions that include detected frame errors and queue saturation in computer networks, and bad data suppression in signal processing. This paper presents an extension of the concept of observability based on a set of randomly selected nonconsecutive outputs in finite-dimensional, linear, time-invariant systems. Conditions for testing extended observability have been established. Author

A89-52657#
OPTIMAL OUTPUT FEEDBACK FOR LINEAR TIME-PERIODIC SYSTEMS
ANTHONY J. CALISE, DANIEL P. SCHRAGE (Georgia Institute of Technology, Atlanta), and MARK E. WASIKOWSKI IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1232-1237. refs
(Contract DAAL03-88-C-0003)
(AIAA PAPER 89-3574) Copyright

An approach is developed for applying optimal output feedback control theory to the design of fixed gain controllers for time periodic systems. Constant feedback gains based on available plant outputs are calculated by minimizing a linear quadratic performance cost functional. The envelope of the periodic system state and control response are penalized in the cost functional, with the objective of improving modal damping. A computationally efficient algorithm is developed using Floquet-Liapunov theory and a generalized harmonic expansion technique. The theory is applied to the control of a helicopter rotor blade in forward flight. It is shown that constant gain output feedback can be used to augment the stability of time-periodic systems. Thus, the implementation complexity associated with active control of periodic systems is reduced considerably. Author

A89-52658*# Information and Control Systems, Inc., Hampton, VA.
A VARIABLE-GAIN OUTPUT FEEDBACK CONTROL DESIGN APPROACH
NESIM HAYLO (Information and Control Systems, Inc., Hampton, VA) IN: AIAA Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1989, p. 1238-1248. refs
(Contract NAS1-17493)
(AIAA PAPER 89-3575) Copyright

A multi-model design technique to find a variable-gain control law defined over the whole operating range is proposed. The design is formulated as an optimal control problem which minimizes a cost function weighing the performance at many operating points. The solution is obtained by embedding into the Multi-Configuration Control (MCC) problem, a multi-model robust control design technique. In contrast to conventional gain scheduling which uses a curve fit of single model designs, the optimal variable-gain control law stabilizes the plant at every operating point included in the design. An iterative algorithm to compute the optimal control gains is presented. The methodology has been successfully applied to reconfigurable aircraft flight control and to nonlinear flight control systems. Author

A89-52715*# Arizona State Univ., Tempe.
ON THE CONTROL OF ELASTIC VEHICLES - MODEL SIMPLIFICATION AND STABILITY ROBUSTNESS
DAVID K. SCHMIDT (Arizona State University, Tempe) and BRETT NEWMAN AIAA, Guidance, Navigation and Control Conference, Boston, MA, Aug. 14-16, 1989. 22 p. refs
(Contract NAG1-758)
(AIAA PAPER 89-3558) Copyright

Quantitative criteria are presented for model simplification, or order reduction, such that the reduced order model may be used to synthesize and evaluate a control law, and the stability and stability robustness obtained using the reduced-order model will be preserved when controlling the full-order system. The error introduced due to model simplification is treated as modeling uncertainty, and some of the results from multivariable robustness theory are brought to bear on the model simplification problem. A numerical procedure developed previously is shown to lead to results that meet the necessary criteria. The procedure is applied to reduce the model of a flexible aircraft. Also, the importance of the control law itself, in meeting the modeling criteria, is underscored. An example is included that demonstrates that an apparently robust control law actually amplifies modest modeling errors in the critical frequency region, and leads to undesirable results. The cause of this problem is identified to be associated with the canceling of lightly-damped transmission zeroes in the plant. Author

A89-52802

ASYMPTOTIC SOLUTION OF A NONLINEAR BOUNDARY VALUE PROBLEM WITH A PARTLY UNKNOWN BOUNDARY [ASIMPTOTICHESKOE RESHENIE NELINEINOI KRAEVOI ZADACHI S CHASTICHNO NEIZVESTNOI GRANITSEI]

A. M. ANTONOVA and L. I. DZVONIK (Kievskii Gosudarstvennyi Universitet, Kiev, Ukrainian SSR) Matematicheskaia Fizika i Nelineinaia Mekhanika (ISSN 0233-7568), no. 11, 1989, p. 36-40. In Russian.

Copyright

The three-dimensional problem of flow of a gas at high supersonic velocities past a plane delta wing is analyzed for the case of intensive mass transfer at the wing surface. A nonlinear boundary value problem is stated for an injection region with a partly unknown boundary. An asymptotic solution is obtained for the principal gasdynamic parameters, and the boundary shape is determined for power-law injection. V.L.

A89-53152*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

SUPERCOMPUTER REQUIREMENTS FOR SELECTED DISCIPLINES IMPORTANT TO AEROSPACE

VICTOR L. PETERSON, JOHN KIM, TERRY L. HOLST, GEORGE S. DEIWERT, DAVID M. COOPER, ANDREW B. WATSON, and F. RON BAILEY (NASA, Ames Research Center, Moffett Field, CA) IEEE, Proceedings (ISSN 0018-9219), vol. 77, July 1989, p. 1038-1055. refs

Speed and memory requirements placed on supercomputers by five different disciplines important to aerospace are discussed and compared with the capabilities of various existing computers and those projected to be available before the end of this century. The disciplines chosen for consideration are turbulence physics, aerodynamics, aerothermodynamics, chemistry, and human vision modeling. Example results for problems illustrative of those currently being solved in each of the disciplines are presented and discussed. Limitations imposed on physical modeling and geometrical complexity by the need to obtain solutions in practical amounts of time are identified. Computational challenges for the future, for which either some or all of the current limitations are removed, are described. Meeting some of the challenges will require computer speeds in excess of exaflop/s (10 to the 18th flop/s) and memories in excess of petawords (10 to the 15th words). I.E.

A89-53416

AN OPTIMAL MATERIAL REMOVAL STRATEGY FOR AUTOMATED REPAIR OF AIRCRAFT CANOPIES

DENNIS J. WENZEL and DAVID S. MCFALLS (Southwest Research Institute, San Antonio, TX) IN: 1989 IEEE International Conference on Robotics and Automation, Scottsdale, AZ, May 14-19, 1989, Proceedings. Volume 1. Washington, DC, IEEE Computer Society Press, 1989, p. 370-376. refs

(Contract F42650-86-C-3276)

Copyright

A description is given of the Robotic Canopy Polishing System (RCPS). The RCPS work cell contains three robotic arms that are used to assist an expert canopy polisher in inspecting and reworking plastic aircraft canopy transparencies. Particular attention is given to the methodology by which the RCPS determines where best to remove plastic from the canopy, given the raw data indicating flaw positions and severity. This process is driven by the following requirements: to completely remove the flaws; to minimize the number of grinding patterns laid on the canopies; and to minimize the distortion by overlapping grinding patterns. The features of the template-mismatch technique used are described. I.E.

A89-53951

1989 AMERICAN CONTROL CONFERENCE, 8TH, PITTSBURGH, PA, JUNE 21-23, 1989, PROCEEDINGS. VOLUMES 1, 2, & 3

Conference sponsored by the American Automatic Control Council. New York, Institute of Electrical and Electronics Engineers, 1989, p. Vol. 1, 1017 p.; vol. 2, 931 p.; vol. 3, 1029 p. For individual items see A89-53952 to A89-54007, A89-54009 to A89-54117.

Copyright

Papers are presented on such topics as the robust control of robotic manipulators, aircraft control, intelligent control systems, computer networking for real-time control, robust adaptive control, and nonlinear process control. Consideration is also given to advances in distributed detection, control issues for large flexible manipulators, aerospace guidance and control, optimization in biochemical engineering, advanced robotics, fuzzy logic and process control, vibration control, and special architectures in real-time control systems. B.J.

A89-53970

A KNOWLEDGE BASED TOOL FOR FAILURE PROPAGATION ANALYSIS

P. S. NESS, D. BEREKET, M. HAKIMI, T. UTHUS, and A. CHAKRAVARTY (Boeing Commercial Airplanes, Seattle, WA) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 1. New York, Institute of Electrical and Electronics Engineers, 1989, p. 344-348.

Copyright

A knowledge-based tool for failure propagation analysis is discussed. The first version of the computer program simulated the propagation of a single avionics or electrical power failure through a network of avionics systems. Recent work focuses on two program modifications. The first expands the failure propagation capability to simulate failures of multiple avionics line replaceable units. The second adds a backchaining (diagnostic) function to the program. This function enables the Avionics Failure Propagation Analysis Tool to deduce the source of a failure propagation from a set of flight deck failure effects. I.E.

A89-53975

LINEAR TOKEN PASSING BASED BUS INTERFACE UNIT FOR A FAULT TOLERANT MULTIPROCESSOR TESTBED

DANIEL B. THOMPSON (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 1. New York, Institute of Electrical and Electronics Engineers, 1989, p. 507-510.

Copyright

An inhouse testbed based on the concepts developed in the Advanced Multiprocessor Control Architecture Development (AMCAD) project is discussed. The author addresses the design of the bus interface unit (BIU) used to connect each processing module to a linear token-passing bus based network. This network comprises four independent buses and is implemented using MC68824 IEEE 802.4 bus controller chips. The concepts of the AMCAD project, as well as the functional composition of the BIU design, are described. I.E.

A89-54007

FAULT-TOLERANT SENSOR AND ACTUATOR SELECTION FOR CONTROL OF FLEXIBLE STRUCTURES

WILLIAM N. MCCASLAND (USAF, Washington, DC) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 2. New York, Institute of Electrical and Electronics Engineers, 1989, p. 1111-1116. refs

Copyright

Consideration is given to sensor and actuator placement for structural control with the possibility of failures. Norms on controllability or observability gramians are selected as a performance measure and algorithms are developed. Scaling of the state space is based on selection of a throughput path. Examples are shown for a simply supported beam and a large-scale finite-element model. I.E.

A89-54022
IDENTIFICATION OF STATE-SPACE PARAMETERS IN THE PRESENCE OF UNCERTAIN NUISANCE PARAMETERS
JOHN P. GARNER (Computational Engineering, Inc., Laurel, MD) and JAMES C. SPALL (Johns Hopkins University, Laurel, MD) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 2. New York, Institute of Electrical and Electronics Engineers, 1989, p. 1226-1230. refs
(Contract N00039-87-C-5301)
Copyright
A methodology is presented to account for the uncertainty in maximum-likelihood estimates of state-space parameters in the presence of uncertain nuisance parameters. The technique uses the asymptotic normality of the uncertainty in the estimates and the implicit function theorem to determine a correction to the estimate uncertainty evaluated from the Fisher information matrix. Efficient evaluation of the correction using Kalman filtering is discussed, and a numerical example for the X-22A aircraft is presented. I.E.

A89-54024
A SYSTEMATIC APPROACH TO GAIN SUPPRESSION USING EIGENSTRUCTURE ASSIGNMENT
K. M. SOBEL, W. YU (City College, New York), and E. Y. SHAPIRO (HR Textron, Inc., Valencia, CA) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 2. New York, Institute of Electrical and Electronics Engineers, 1989, p. 1292-1294. refs
Copyright
The authors derive expressions for the partial derivatives of the eigenvectors with respect to the gains and use them to compute the expected shift in the eigenvectors if the ij-th gain were suppressed to zero. This establishes a complete systematic method for designing constrained output feedback controllers by a priori choosing to set those gains to zero which have the smallest influence on the system eigenstructure. The authors illustrate this approach by designing control laws a highly-augmented fighter aircraft. I.E.

A89-54106
EXPERIENCE WITH IMPLEMENTATION OF A TURBOJET ENGINE CONTROL PROGRAM ON A MULTIPROCESSOR
PHILLIP L. SHAFFER (General Electric Co., Schenectady, NY) IN: 1989 American Control Conference, 8th, Pittsburgh, PA, June 21-23, 1989, Proceedings. Volume 3. New York, Institute of Electrical and Electronics Engineers, 1989, p. 2715-2720. refs
Copyright
A control program for turbojet engines has been implemented on a four-processor bus-based multiprocessor with private memory for each processor's code and data, and shared memory for data passed between processors. A speedup of 3.38 times the speed of a sequential version of the same program on a single processor has been achieved. The concurrent program was produced by subjecting a sequential program to global, hierarchical interprocedural data-flow analysis and timing measurements. A static schedule for the constituent tasks of the control program on the four processors was determined using a heuristic algorithm based on the critical path method. An application-independent supervisor program on each processor controls the execution of tasks by ensuring that all data dependencies are met, copying values from shared memory before execution of each task, and then copying values to shared memory and notifying tasks on the other processors after a task has completed execution. I.E.

A89-54540
FIXED-SIGN CONDITION FOR INTEGRAL QUADRATIC FORMS AND STABILITY OF SYSTEMS WITH DISTRIBUTED PARAMETERS [USLOVIE ZAKONOOPREDELENNOSTI INTEGRAL'NYKH KVADRATICHNYKH FORM I USTOICHIVOST' SISTEM S RASPREDELENNYMI PARAMETRAMI]
F. D. BAIRAMOV and T. K. SIRAZETDINOV Prikladnaia Matematika i Mekhanika (ISSN 0032-8235), vol. 53, July-Aug. 1989, p. 567-575. In Russian. refs
Copyright
An approach to the stability analysis of distributed-parameter systems described by linear partial differential equations is proposed whereby new variables are introduced into the initial equations in order to reduce them to first-order equations with respect to time and spatial coordinates. Liapunov functions in this case are constructed in the form of single integral expressions. New necessary and sufficient conditions for the fixed sign of these expressions are obtained. These criteria are then used to obtain sufficient stability conditions for systems with distributed parameters. The stability of the torsional vibrations of an aircraft wing is examined as an example. V.L.

A89-54858* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
JPL REALTIME WEATHER PROCESSOR SYSTEM DEVELOPED FOR FAA
PHILIP C. CHEN (California Institute of Technology, Jet Propulsion Laboratory, Pasadena) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 426-429.
Copyright
Modifications made to the Central Weather Processor (CWP) project are discussed. In 1987, the development plan was revised and the CWP was split into the following parts: a meteorological weather processor and a realtime weather processor (RWP). The JPL is in charge of RWP development. Consideration is given to the major product categories (NEXRAD products, alphanumeric weather products, binary encoded products, graphic products), and the system architecture (the individual radar processor, the radar mosaic processor, and the communication and control processor). K.K.

A89-54904* Stanford Univ., CA.
REPRESENTATION AND DISPLAY OF VECTOR FIELD TOPOLOGY IN FLUID FLOW DATA SETS
JAMES HELMAN and LAMBERTUS HESSELINK (Stanford University, CA) Computer (ISSN 0018-9162), vol. 22, Aug. 1989, p. 27-36. refs
(Contract NAG2-489)
Copyright
The visualization of physical processes in general and of vector fields in particular is discussed. An approach to visualizing flow topology that is based on the physics and mathematics underlying the physical phenomenon is presented. It involves determining critical points in the flow where the velocity vector vanishes. The critical points, connected by principal lines or planes, determine the topology of the flow. The complexity of the data is reduced without sacrificing the quantitative nature of the data set. By reducing the original vector field to a set of critical points and their connections, a representation of the topology of a two-dimensional vector field that is much smaller than the original data set but retains with full precision the information pertinent to the flow topology is obtained. This representation can be displayed as a set of points and tangent curves or as a graph. Analysis (including algorithms), display, interaction, and implementation aspects are discussed. I.E.

A89-54907* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SCIENTIFIC VISUALIZATION IN COMPUTATIONAL AERODYNAMICS AT NASA AMES RESEARCH CENTER

GORDON V. BANCROFT, TODD PLESSEL, FERGUS MERRITT, PAMELA P. WALATKA, and VAL WATSON (NASA, Ames Research Center, Moffett Field, CA) Computer (ISSN 0018-9162), vol. 22, Aug. 1989, p. 89-95. refs
Copyright

The visualization methods used in computational fluid dynamics research at the NASA-Ames Numerical Aerodynamic Simulation facility are examined, including postprocessing, tracking, and steering methods. The visualization requirements of the facility's three-dimensional graphical workstation are outlined and the types hardware and software used to meet these requirements are discussed. The main features of the facility's current and next-generation workstations are listed. Emphasis is given to postprocessing techniques, such as dynamic interactive viewing on the workstation and recording and playback on videodisk, tape, and 16-mm film. Postprocessing software packages are described, including a three-dimensional plotter, a surface modeler, a graphical animation system, a flow analysis software toolkit, and a real-time interactive particle-tracer. R.B.

N89-29032*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A REAL TIME MICROCOMPUTER IMPLEMENTATION OF SENSOR FAILURE DETECTION FOR TURBOFAN ENGINES
JOHN C. DELAAT and WALTER C. MERRILL Aug. 1989 27 p
(NASA-TM-102327; E-5029; NAS 1.15:102327) Avail: NTIS HC A03/MF A01 CSCL 09/2

An algorithm was developed which detects, isolates, and accommodates sensor failures using analytical redundancy. The performance of this algorithm was demonstrated on a full-scale F100 turbofan engine. The algorithm was implemented in real-time on a microprocessor-based controls computer which includes parallel processing and high order language programming. Parallel processing was used to achieve the required computational power for the real-time implementation. High order language programming was used in order to reduce the programming and maintenance costs of the algorithm implementation software. The sensor failure algorithm was combined with an existing multivariable control algorithm to give a complete control implementation with sensor analytical redundancy. The real-time microprocessor implementation of the algorithm which resulted in the successful completion of the algorithm engine demonstration, is described. 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.

A89-53932#
NOZZLE GEOMETRY EFFECTS ON SUPERSONIC JET INTERACTION
R. W. WLEZIEN (McDonnell Douglas Research Laboratories, Saint Louis, MO) AIAA Journal (ISSN 0001-1452), vol. 27, Oct. 1989, p. 1361-1367. Research supported by McDonnell Douglas Independent Research and Development Program. Previously cited in issue 04, p. 569, Accession no. A88-16548. refs
Copyright

A89-53945#
USE OF THE KIRCHHOFF METHOD IN ACOUSTICS
A. S. LYRINTZIS and A. R. GEORGE (Cornell University, Ithaca, NY) AIAA Journal (ISSN 0001-1452), vol. 27, Oct. 1989, p. 1451-1453. Research supported by McDonnell Douglas Helicopter Co. Previously cited in issue 06, p. 864, Accession no. A88-20178. refs
Copyright

A89-54487#
NOISE PRODUCED BY A JET AIRCRAFT DURING THE ENGINE TEST RUN [HALAS WYTWARZANY PRZEZ SAMOLOT ODRZUTOWY PODCZAS PROBY SILNIKA]
KAZIMIERZ JANUSIAK and STEFAN SZCZECINSKI Technika Lotnicza i Astronautyczna (ISSN 0040-1145), vol. 44, Jan. 1989, p. 17, 18. In Polish.

The paper presents results of noise measurements conducted on the TS-11 aircraft during the engine test run. Recommendations essential to engine-test personnel are formulated on the basis of an analysis of acoustic spectra and the directional distribution of noise as a function of frequency and engine rpm. B.J.

N89-29152*# United Technologies Research Center, East Hartford, CT.
NOISE PRODUCED BY TURBULENT FLOW INTO A ROTOR: USERS MANUAL FOR NOISE CALCULATION Final Report
R. K. AMIET, C. G. EGOLF, and J. C. SIMONICH Jun. 1989 38 p
(Contract NAS1-17763)
(NASA-CR-181790; NAS 1.26:181790) Avail: NTIS HC A03/MF A01 CSCL 20/1

A users manual for a computer program for the calculation of noise produced by turbulent flow into a helicopter rotor is presented. These inputs to the program are obtained from the atmospheric turbulence model and mean flow distortion calculation, described in another volume of this set of reports. Descriptions of the various program modules and subroutines, their function, programming structure, and the required input and output variables are included. This routine is incorporated as one module of NASA's ROTONET helicopter noise prediction program. Author

N89-29154*# United Technologies Research Center, East Hartford, CT.
NOISE PRODUCED BY TURBULENT FLOW INTO A ROTOR: USERS MANUAL FOR ATMOSPHERIC TURBULENCE PREDICTION AND MEAN FLOW AND TURBULENCE CONTRACTION PREDICTION Final Report
J. C. SIMONICH and B. CAPLIN Jun. 1989 43 p
(Contract NAS1-17763)
(NASA-CR-181791; NAS 1.26:181791) Avail: NTIS HC A03/MF A01 CSCL 20/1

A users manual for a computer program for predicting atmospheric turbulence and mean flow and turbulence contraction as part of a noise prediction scheme for nonisotropic turbulence ingestion noise in helicopters is described. Included are descriptions of the various program modules and subroutines, their function, programming structure, and the required input and output variables. This routine is incorporated as one module of NASA's ROTONET helicopter noise prediction program. Author

N89-29155*# Southwest Research Inst., San Antonio, TX.
AIRCRAFT PROPELLER INDUCED STRUCTURE-BORNE NOISE
JAMES F. UNRUH Washington Oct. 1989 113 p
(Contract NAS1-17921)
(NASA-CR-4255; NAS 1.26:4255; SRI-04-8542-1) Avail: NTIS HC A06/MF A01 CSCL 20/1

A laboratory-based test apparatus employing components typical of aircraft construction was developed that would allow the study of structure-borne noise transmission due to propeller induced wake/vortex excitation of in-wake structural appendages. The test apparatus was employed to evaluate several aircraft installation effects (power plant placement, engine/nacelle mass loading, and wing/fuselage attachment methods) and several structural response modifications for structure-borne noise control (the use of wing blocking mass/fuel, wing damping treaments, and tuned mechanical dampers). Most important was the development of in-flight structure-borne noise transmission detection techniques using a combination of ground-based frequency response function testing and in-flight structural response measurement. Propeller wake/vortex excitation simulation techniques for improved ground-based testing were also developed to support the in-flight structure-borne noise transmission detection development. Author

N89-29156 Forschungsinstitut fuer Hochfrequenzphysik, Werthhoven (Germany, F.R.).

ACOUSTICAL TRACKING OF FAST MANEUVERING AIRCRAFT BY DISTRIBUTED SENSORS

F. DOMMERMUTH Aug. 1988 41 p In GERMAN; ENGLISH summary
(Contract BMVG-T/RF-31/G-0022/G-1312)
(REPT-6-88; LFD-275; ETN-89-94401) Copyright Avail: Forschungsinstitut fuer Hochfrequenzphysik, Wachtberg-Werthhoven, Fed. Republic of Germany

A method for the aeroacoustic tracking of nearly arbitrarily maneuvering subsonic sound sources is presented. With the proposed procedure, the target position can be determined at any instant, if the measured data of at least two acoustical sensors (consisting of three or four microphones each) are available. The pertaining error covariance matrix is given. The application to simulated data shows that even very fast maneuvering targets can be tracked reliably. A data update rate of 5 Hz allows a near real time tracking, including the extensive measuring data treatment of four sensors. The application to real data is shown to have good results. ESA

N89-29158# Southampton Univ. (England). Inst. of Sound and Vibration Research.

THE ACOUSTIC CALIBRATION OF AIRCRAFT FUSELAGE STRUCTURES, PART 1

J. M. MASON and F. J. FAHY 23 Jan. 1989 35 p Sponsored by the Department of Trade and Industry, London, United Kingdom
(ISVR-TR-169-PT-1; ETN-89-94961) Avail: NTIS HC A03/MF A01

A new technique for calibrating a fuselage as a transducer of pressure from the external surface to the interior is described. The data generated may be combined with any impinging sound field to obtain a prediction of cabin sound pressure level. As a preliminary to tests on scale model fuselage structures, the technique is validated for sound transmission through flat panels attached to a rigid walled box. The results of these tests are described. ESA

N89-29193# Dayton Univ., OH. Research Inst.

DISPLAY CHARACTERISTICS OF EXAMPLE LIGHT-VALVE PROJECTORS Final Technical Report, Mar. 1987 - Feb. 1989

CELESTE M. HOWARD Jun. 1989 78 p
(Contract F33615-84-C-0066; F33615-87-C-0012)
(AD-A209580; UDR-TR-88-124; AFHRL-TR-88-44) Avail: NTIS HC A05/MF A01 CSCL 20/6

Quantitative data is provided on performance characteristics of light valve projectors in simulator displays as well as in optimal laboratory conditions. Two types of light valve projectors are discussed: a single light-valve projector (also called Talaria) and a multiple light-valve projector. The data show that: (1) these projectors do not achieve brightnesses above the mesopic level in large screen simulator displays, (2) color output includes a dark-field haze which must be dealt with like ambient illumination, and (3) light/dark ratios (L/D) above 5:1 are obtainable only when the light region is white or yellow-green. GRA

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SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

A89-52024

THE IMPORTANCE OF WEIGHT IN A CHANGING COST ESTIMATING ENVIRONMENT

LOU GORDON (Lockheed Aeronautical Systems Co., Marietta, GA) SAWE, Annual Conference, 47th, Plymouth, MI, May 23, 24, 1988. 21 p.
(SAWE PAPER 1854) Copyright

Until recently, bottoms-up has been the primary method of cost estimating in the aerospace industry. Parametric estimates were used internally only for trade studies and should-cost analyses and were not submitted with the proposal. Lockheed is working to reverse the cost estimating process, i.e., parametric as the primary method and bottoms-up as the last resort. This paper presents one such method. The process focuses primarily on engineering labor costs for a new aircraft, but touches briefly on production costs. The presentation addresses why bottoms-up estimating is being diminished and how yesterday's databases can be adjusted for today's technology. This paper is intended to demonstrate that parametric cost estimating is being implemented as a primary method and, as a result, weight as a cost driver is extremely important. Author

A89-53330* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

TECHNICAL COMMUNICATION IN AERONAUTICS - RESULTS OF AN EXPLORATORY STUDY

THOMAS E. PINELLI (NASA, Langley Research Center, Hampton, VA), MYRON GLASSMAN (Old Dominion University, Norfolk, VA), WALTER E. OLIU (U.S. Nuclear Regulatory Commission, Washington, DC), and REBECCA O. BARCLAY (Rensselaer Polytechnic Institute, Troy, NY) IN: International Technical Communication Conference, 36th, Chicago, IL, May 14-17, 1989, Proceedings. San Diego, CA, Univelt, Inc., 1989, p. RT-42 to RT-45.
Copyright

A study was undertaken that explored several aspects of technical communications in aeronautics. The study utilized survey research. A self-administered mail questionnaire was sent to 2,000 randomly selected members of the American Institute of Aeronautics and Astronautics (AIAA) in the U.S. with academic, government, or industrial affiliations. Six hundred and six (606) usable questionnaires were received. The findings add considerable information to the knowledge of technical communications among aeronautical engineers and scientists; reinforce some of the conventional wisdom about technical communications and question other widely-held notions; and hold significant implications for technical communicators, information managers, research and development managers, and curriculum developers. Author

A89-54337

SST/CONCORDE - LESSONS FOR HYPERSONIC PROGRAMS

ROBERT L. BLEDSOE and JOAN JOHNSON-FREESE (Central Florida, University, Orlando, FL) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 159-165. refs
Copyright

The development of hypersonic aircraft in the coming years will involve great technological complexity, unforseeable development costs, and as yet unclear definitions of project goals. Given current Federal budgetary constraints, it becomes conceivable that the U.S. Government and/or the aerospace industry will seek a collaborative arrangement for the development of a second-generation SST and/or some type of hypersonic cruise-capable aircraft. Attention is presently given to the collaborative development and manufacturing management experience gained by French and British industry in the course of the Concorde SST program. O.C.

A89-54351
ECONOMICS OF HYPERSONIC FLIGHT
ROBERT P. LACALLI and HENRY OMAN (Boeing Aerospace, Seattle, WA) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 284-289. refs
Copyright

On the assumptions that hydrogen fuel produced electrolytically by off-peak hydroelectric power will in due course become available, and that the HST vehicle design ultimately developed will cruise with an efficiency requiring 750 lbs of LH2/passenger, for a fuel cost of $410, the present comparative study of alternative transportation modes shows that hypersonic travel costs need not be prohibitive. It is noted that even a small, 100-passenger Mach 10-cruise HST is capable of displacing two B 747s for the U.S. West Coast-Japan route; crew costs are also significantly reduced through speed enhancements on this scale. O.C.

A89-54352
HYPERSONIC FLIGHT AND WORLD TOURISM
RICHARD D. WOOD (U.S. Naval Postgraduate School, Monterey, CA) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 290-300. refs
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An economic, political, and social evaluation is made of the consequences for the Pacific Rim community (encompassing Australasia, the Far East, and the west coasts of North and South America) of SST and HST air-travel systems. Attention is given to the markets that might emerge for tourism as well as to the prospects for travel and overseas settlement by affluent retirees. The analysis presented differentiates between customer lifestyles characterized in marketing terms and those characterized in cultural terms. O.C.

A89-54353
HYPERSONIC FLIGHT - FUTURE COMMERCIAL POTENTIAL
H. ROBERT WASIUTA (North Dakota, University, Grand Forks) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 301-306. refs
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Determining what potential economic markets exist for the NASP is the central focus of this paper. The thesis of this work suggests that hypersonic aircraft will fly at Mach 25 only if there is a commercial market willing to absorb the costs of producing such a vehicle. Subsequently, this paper will outline political and economic factors that contribute to establishing the infrastructure capable of servicing commercial aviation, the space program, and the national security requirements of the nation. Author

A89-54354
THE U.S. SUPERSONIC TRANSPORT - THREE LESSONS FOR NASP FROM HISTORY
ARNOLD GOLDBURG IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 307-310. refs
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The present assessment of the relevance of 1968 experiences with the U.S. SST program to current interest in the commercial development of the National Aerospace Plane notes that collaborative work should be undertaken with the academic/public interest advisory establishment, in which the most compelling opposition can arise, from the outset. It is further recommended that the aerospace industry be provided with a cadre of highly expert commentators capable of instilling a sense of such advanced transportation technologies' importance, and that the development of such technology be firmly embedded in an international framework in order to cushion it from the political vicissitudes of national policy. O.C.

A89-54356
TRANSNATIONAL LEGAL PROBLEMS FOR COMMERCIAL HYPERSONIC FLIGHT
NATHAN C. GOLDMAN IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 316-318. refs
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The National Aerospace Plane's (NASP) hypersonic flight will break more than the sound barrier when it flies in the 1990s: it will break the technological and legal barriers between air and space. This paper narrowly focusses on the legal issues. Indeed, narrowing the subject further, the paper will deal specifically with the problems and possible solutions raised by flight and landing rights for a U.S. Aerospace plane in foreign territories. Author

A89-54357
THE ORIENT EXPRESS - THE EMPEROR'S NEW AIRPLANE
THEODORE R. HARPER (Graham and James, Los Angeles, CA) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 319-325. refs
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The legal aspects of the development of the Orient Express, a commercial aircraft based on X-30 spinoff technology, is discussed. The regulations that could affect the development and operation of a high-speed civil transport are examined, including regulations dealing with aircraft noise, sonic booms, ozone degradation, the use of dangerous fuels, technology exports, and weight, size, and the use of existing airport facilities. Consideration is given to the sources of these regulations and the possibility of future changes in regulations. R.B.

A89-54358
HYPERSONIC FLIGHT AND THE WARSAW CONVENTION
WILLIAM E. THOMS (North Dakota, University, Grand Forks) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 333, 334. refs
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The relationship between the 1929 Warsaw Convention laws on tort liability and the development of hypersonic commercial aircraft is considered. Problems associated with the the Warsaw agreement limitations on liability are discussed. The applicability of the Warsaw Convention to hypersonic flight is examined, including the question of whether or not hypersonic flight is 'carriage by air' or 'carriage by space'. R.B.

A89-54364
HYPERSONIC FLIGHT, DOMESTIC MILITARY POLICY, AND INTERNATIONAL RELATIONS
PAUL W. HOAG (Wichita State University, KS) IN: International Conference on Hypersonic Flight in the 21st Century, 1st, Grand Forks, ND, Sept. 20-23, 1988, Proceedings. Grand Forks, ND, University of North Dakota, 1988, p. 395-402. refs
Copyright

The military implications of hypersonic flight are examined, including enhanced ocean surveillance capability, changes in antisatellite forces, strengthened strategic bomber capability, the weaponization of space, and versatile and quick strategic reconnaissance. Other possible military applications include rapid deployment and resupply, dominance in tactical air operations, less need for forward deployed tactical air forces, lowering of the nuclear threshold, and flexible basing. The possibility that there is a specific military objective of the National Aerospace Plane (NASP) program is discussed. The effect of the military potential of the NASP program on international relations is considered. R.B.

A89-54863

WEATHER TESTIMONY IN LITIGATION

WILLIAM H. HAGGARD (Climatological Consulting Corp., Asheville, NC) IN: International Conference on the Aviation Weather System, 3rd, Anaheim, CA, Jan. 30-Feb. 3, 1989, Preprints. Boston, MA, American Meteorological Society, 1989, p. 448-450.

Copyright

The role of the Certifed Consulting Meteorologist in aviation litigation is discussed. It is is noted that, in this type of litigation, the courts seem to find no negligence if the pilot was properly briefed about a forecast which was wrong. However, negligence is found if the briefer deviated from the forecast, whether it was right or wrong. It is argued that such concepts as simplicity in Court, visual demonstration, and the use of a solid factual basis for all opinions pertain to all types of weather-related litigation. K.K.

A89-54908

CAD/CAM - MANAGERIAL CHALLENGES AND RESEARCH ISSUES

PAUL S. ADLER (Stanford University, CA) IEEE Transactions on Engineering Management (ISSN 0018-9391), vol. 36, Aug. 1989, p. 202-215. Research supported by McKinsey and Co. refs

Copyright

Results are reported of an exploratory investigation into the managerial problems of integrating computer-aided design (broadly construed to include engineering design and drafting), and computer-aided manufacturing (encompassing machine control, materials handling, manufacturing scheduling, planning and administration, testing and quality assurance). The focus is on engineering, design, fabrication, assembly, and test of printed circuit boards used in the electronics industry and on design and fabrication of hydraulic tubing in the aircraft industry. Nine U.S. electronics businesses and four U.S. aircraft companies were visited with the aim of synthesizing the elements of 'best practice'. Managerial problems and research issues are identified at each of five key levels of organizational learning: skills, procedures, structure, strategy, and culture. I.E.

19

GENERAL

A89-52923

INVESTIGATIONS IN THE HISTORY AND THEORY OF THE DEVELOPMENT OF AVIATION AND ROCKET AND SPACE SCIENCE AND TECHNOLOGY, NO. 6 [ISSLEDOVANIIA PO ISTORII I TEORII RAZVITIIA AVIATSIONNOI I RAKETNO-KOSMICHESKOI NAUKI I TEKHNIKI, NO. 6]

B. V. RAUSHENBAKH, ED. Moscow, Izdatel'stvo Nauka, 1988, 224 p. In Russian. No individual items are abstracted in this volume.

Copyright

This collection of papers treats the main trends in the development of aviation and astronautics in the technical, biomedical, social and philosophical, and legal areas. This volume is distinguished by the fact that the authors are leading specialists and organizers in the areas of Soviet aviation and astronautics. B.J.

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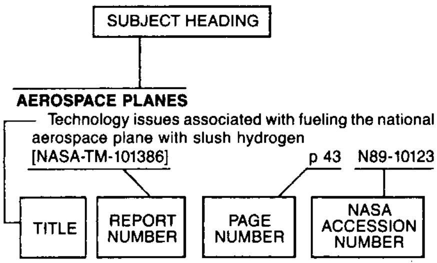

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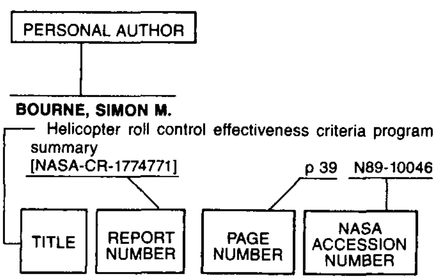

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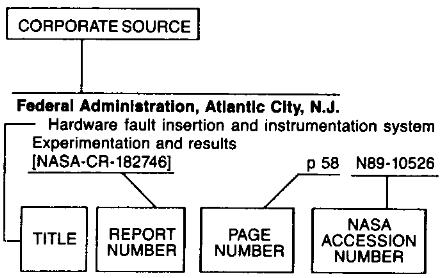

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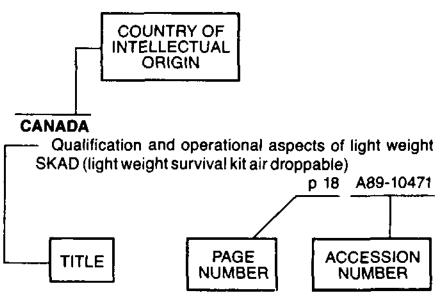

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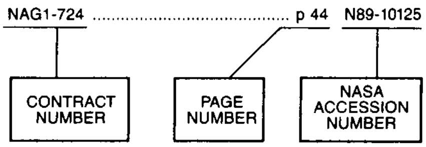

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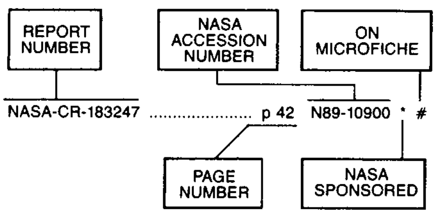

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N89-10844 * # p 15

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