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A Continuing Bibliography with Indexes

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NASA SP-7037(229)

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 229)

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 July 1988 in

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

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INTRODUCTION

This issue of *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 455 reports, journal articles and other documents originally announced in July 1988 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA).*

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

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

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

An annual cummulative index will be published.

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

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TYPICAL REPORT CITATION AND ABSTRACT

NASA SPONSORED

ON MICROFICHE

ACCESSION NUMBER → N88-10026*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif. ← CORPORATE SOURCE

TITLE → **HIMAT FLIGHT PROGRAM: TEST RESULTS AND PROGRAM ASSESSMENT OVERVIEW**

AUTHORS → DWAIN A. DEETS, V. MICHAEL DEANGELIS, and DAVID P. LUX

PUBLICATION DATE → Jun. 1986 30 p ← AVAILABILITY SOURCE

REPORT NUMBERS → (NASA-TM-86725; H-1283; NAS 1.15:86725) Avail: NTIS HC

PRICE CODE → A03/MF A01 CSCL 01C ← COSATI CODE

The Highly Manueverable Aircraft Technology (HiMAT) program consisted of design, fabrication of two subscale remotely piloted research vehicles (RPRVs), and flight test. This technical memorandum describes the vehicles and test approach. An overview of the flight test results and comparisons with the design predictions are presented. These comparisons are made on a single-discipline basis, so that aerodynamics, structures, flight controls, and propulsion controls are examined one by one. The interactions between the disciplines are then examined, with the conclusions that the integration of the various technologies contributed to total vehicle performance gains. An assessment is made of the subscale RPRV approach from the standpoint of research data quality and quantity, unmanned effects as compared with manned vehicles, complexity, and cost. It is concluded that the RPRV technique, as adopted in this program, resulted in a more complex and costly vehicle than expected but is reasonable when compared with alternate ways of obtaining comparable results. Author

TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT

ON MICROFICHE

ACCESSION NUMBER → A88-10095#

TITLE → **SYNTHESES OF REDUCED-ORDER CONTROLLERS FOR ACTIVE FLUTTER SUPPRESSION**

AUTHORS → ATSUSHI FUJIMORI and HIROBUMI OHTA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 35, no. 402, 1987, p. 353-362. In Japanese, with abstract in English. refs ← JOURNAL TITLE

Reduced-order controllers for active flutter suppression of a two-dimensional airfoil are studied using two design approaches. One is based on the generalized Hessenberg representation (GHR) in the time domain, and the other, called the Nyquist frequency approximation (NFA), is a method in the frequency domain. In the NFA method, the reduced-order controllers are designed so that the stability margin of the Nyquist plot may be increased over a specific frequency range. To illustrate and to make a comparison between the two methods, numerical simulations are carried out using a thirteenth-order controlled plant. It is to be noted that the GHR method can yield quasi-optimal controllers in the sense of minimizing quadratic performance indices. The designed controllers, however, do not have enough stability margin, and the order reduction resulting from full state controllers may not be satisfactory. On the other hand, reduced-order controllers in the NFA method can be designed with increased stability margin at the expense of the performance index. For all simulation cases, the NFA method yields second-order controllers with a better stability margin than those by the GHR method. Thus, the NFA method provides an effective method for synthesizing robust reduced-order controllers. Author

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AERONAUTICS (GENERAL)

A88-33135#
AERONAUTICS IN GERMANY - A TRADITION OF AVIATION INNOVATION
MANFRED MOMBERGER and ARNO L. SCHMITZ Aerospace America (ISSN 0740-722X), vol. 26, April 1988, p. 50-52, 56, 58,.

A development history and current status evaluation is presented for the German aircraft industry in general and that of the FRG in particular. The aircraft manufacturers with longest histories of leading-edge contribution to military and civil aviation in West Germany today are the Dornier group, and the Messerschmitt-Boelkow-Blohm group. These and other manufacturers frequently participate in joint development and manufacturing programs with other West European manufacturers; products of such efforts include the Panavia Tornado, Alpha Jet, and European Fighter Aircraft, and the RB 199 engine of the Tornado. O.C.

A88-33740
ASTOVL REQUIREMENTS BEGIN TO TAKE SHAPE
BILL SWEETMAN Interavia (ISSN 0020-5168), vol. 43, March 1988, p. 261-264.

An account is given of performance requirements currently being formulated by armed services of the NATO alliance which call for Advanced Short-Takeoff Vertical Landing (ASTOVL) fighter, assault troop-carrier, and transport aircraft. Much effort is being expended on the definition of a supersonic speed-capable fighter/attack configuration ASTOVL; since both these comparatively small, and larger, C-130 cargo capacity-class next-generation aircraft, are also expected to incorporate 'stealth' features, it is essential that propulsion system configurations not compromise low IR emissions and low radar reflection design criteria. O.C.

A88-34026
NAECON 87; PROCEEDINGS OF THE IEEE NATIONAL AEROSPACE AND ELECTRONICS CONFERENCE, DAYTON, OH, MAY 18-22, 1987. VOLUMES 1, 2, 3, & 4
Conference sponsored by IEEE. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. Vol. 1, 337 p.; vol. 2, 474 p.; vol. 3, 471 p.; vol. 4, 467 p. For individual items see A88-34027 to A88-34224.

The present conference discusses topics in VLSI components and their packaging, signal processing, uses of cartographic data, data transmission, advanced avionics architectures, fiber-optics, information control and display, image processing, airborne radar and fire control, navigation, air data, Kalman filtering, power generation and control, spacecraft power structures, aircraft flying qualities, flight management, fault-tolerant computer architectures, actuation technologies, self-repairing flight control system technology, multivariable control, stability and control methods, and AFTI/F-16 flight test reports. Also discussed are the ADA/JOVIAL language and its applications, software acquisition and testing, advanced software concepts, software management, computer graphics and visual systems softwear, ADA in embedded avionics, 16- and 32-bit architectures, voice interaction applications, human/machine systems analysis, human factors and AI, mental workloads and displays, pilot acceleration protection research, communications system technology, space communications, reliability and maintainability, managerial techniques, engineering management, EM compatibility and nuclear hardening, expert systems, AI language/knowledge representation, expert system implementation, machine vision/optical processing, and advanced AI concepts and architectures. O.C.

A88-34173
MAINTENANCE 'PLATEAUS'-A TRANSITION FROM MATHEMATICAL PREDICTIONS TO USER CONTROLLED RELIABILITY LEVELS
JOHN C. REYNOLDS (USAF, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1124-1129.

The authors focus on fielded system reliability and maintainability (R&M). They assert that there is a level of no touch R&M, definable by the user, where the user will decline expensive investments in traditional intermediate equipment, people, technical data, spares and infrastructure, simply because he could not keep his people trained. This level is called the plateau and is based on actual time between removal. The authors develop this concept and outline actions underway to establish these plateaus through a consensus of users. I.E.

A88-35366
ROTORCRAFT FLIGHT CONTROLS AND AVIONICS; PROCEEDINGS OF THE NATIONAL SPECIALISTS' MEETING, CHERRY HILL, NJ, OCT. 13-15, 1987
Meeting sponsored by AHS. Alexandria, VA, American Helicopter Society, 1987, 305 p. For individual items see A88-35367 to A88-35394.

The present conference on rotorcraft cockpit systems discusses digital flight control technology for advanced combat helicopters, far-field mission planning for nap-of-the-earth flight, terrain following/avoidance for helicopters, cognitive engineering for novel cockpit designs, V-22 crew station design, advanced augmentation and split-axes control systems for rotorcraft, and helicopter side arm-integrated controllers. Also discussed are a common module implementation for an avionic digital map system, the rotorcraft application of DARPA's 'pilot's associate', AI's application to diagnostics prognostics of flight control systems, an X-wing rotorcraft flight control system test, counterair applications of AI/knowledge-based systems, and the application of a tilt-rotor flight simulator. O.C.

A88-35383
A MODEL-BASED APPROACH TO MIL-STD-1553 VERIFICATION AND DIAGNOSIS
ROBIN BOWES and TERRY CAMPBELL (McDonnell Douglas Helicopter Co., Mesa, AZ) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 10 p. refs

An account is given of a production-testing approach applied to the AH-64A Apache helicopter's MIL-STD-1553 multiplex bus, which employs concepts derived from automatic testing and expert systems technology. The Multiplex Expert System is an intelligent assistant for Apache production test personnel, which allows reduction in the time required and in the costs incurred during such testing. Attention is presently given to the usefulness of model-based reasoning as a diagnostic technique for aircraft systems in general, not only on the shop floor but in the field and in flight. O.C.

A86-36666
HOW TO DESIGN AN 'INVISIBLE' AIRCRAFT
JOHN A. ADAM IEEE Spectrum (ISSN 0018-9235), vol. 25, April 1988, p. 26-31. refs
Techniques for reducing radar cross sections to make aircraft harder to detect are examined. Studies to determine what elements contribute to the radar signature are discussed. The use of models and chambers that simulate the impact of radar on a distant target to test the effectiveness of proposed techniques is considered. The need for outdoor testing is discussed. I.E.

N88-20255# Rijksluchtvaartdienst, The Hague (Netherlands).
ACTIVITIES REPORT IN CIVIL AERONAUTICS Annual Report, 1986 [JAARVERSLAG 1986]
1986 51 p In DUTCH
(ETN-88-91344) Avail: NTIS HC A04/MF A01
Air traffic control, regional airports, air transportation policy, and air traffic safety are discussed. The activities of the civil aeronautics school, the national aeronautics and astronautics museum AVIODOME, and the national aeronautics and astronautics medical center are presented. ESA

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AERODYNAMICS

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

A88-32893
MESH-REFINED COMPUTATION OF DISORDERED VORTEX FLOW AROUND A CRANKED DELTA WING - TRANSONIC SPEED
ARTHUR RIZZI (Flygtekniska Forsoksanstalten, Bromma; Kungliga Tekniska Hogskolan, Stockholm, Sweden) and CHARLES J. PURCELL (ETA Systems, Inc., Saint Paul, MN) Communications in Applied Numerical Methods (ISSN 0748-8025), vol. 4, Mar.-Apr. 1988, p. 189-195. refs
A numerical method that produces a high-resolution simulation by solving the Euler equations for compressible flow with mesh refinement is used to explore how a crank in the leading edge of a delta wing may excite short-wave instabilities in the votex sheet shed from the leading edge. The particular case simulated is transonic flow at M(infinity) = 0.9 alpha = 10 deg around a twisted cranked-and-cropped TKF delta wing of MBB. Made possible by the recent inrease in size of computer memory, the study consists of a grid-refinement sequence that starts with a standard-mesh discretization of 80,000 cells and ends with a fine mesh of over 600,000 cells. Instead of it spiralling into a second vortex at the crank, the usual event in low-speed flow, the crank sets off standing-wave oscillations over much of the sheet. Not seen in the standard-mesh solution, the instability begins to appear in the fine-mesh results. Therefore, it is the shortest waves resolved that are most unstable, but the energy contained in them comes from the large-scale motion and seems to be small. Author

A88-33036* Arizona State Univ., Tempe.
THREE-DIMENSIONAL STABILITY OF BOUNDARY LAYERS
WILLIAM S. SARIC and HELEN L. REED (Arizona State University, Tempe) IN: Perspectives in turbulence studies; Proceedings of the International Symposium, Goettingen, Federal Republic of Germany, May 11, 12, 1987 . Berlin and New York, Springer-Verlag, 1987, p. 71-92. refs
(Contract NAG1-280; NAG1-402; NAG1-731)
The most recent efforts on the stability and transition of three-dimensional flows are reviewed. These include flows over swept wings, rotating disks, rotating cones, yawed bodies, corners, and attachment lines. The generic similarities of their stability behavior is discussed. It is shown that the breakdown process is very complex, often leading to contradictory results. Particular attention is paid to opposing observations of stationary and traveling wave disturbances. Author

A88-33040
THE ROLE OF FREE FLIGHT EXPERIMENTS IN THE STUDY OF THREE-DIMENSIONAL SHEAR LAYERS
ARILD BERTELRUD (Flygtekniska Forsoksanstalten, Bromma, Sweden) IN: Perspectives in turbulence studies; Proceedings of the International Symposium, Goettingen, Federal Republic of Germany, May 11, 12, 1987 . Berlin and New York, Springer-Verlag, 1987, p. 250-299. refs
The use of measurements of the viscous flow field of an aircraft in flight to investigate the evolution of turbulent shear layers (including boundary layers, free wakes, separated-flow regions, and wing-body junctions with embedded vortices) is considered. The advantages and limitations of flight experiments are outlined; the history of in-flight measurements is recalled; and results from recent Swedish experiments on swept-back wings in subsonic flight are presented in extensive graphs, diagrams, drawings, and flow visualizations and characterized in detail. The quality of the data obtained is found to be adequate, but a need for further improvements in aircraft instrumentation and data-reduction procedures is indicated. T.K.

A88-33043
THREE-DIMENSIONAL FLOWS WITH IMBEDDED LONGITUDINAL VORTICES
P. BRADSHAW and A. D. CUTLER (Imperial College of Science and Technology, London, England) IN: Perspectives in turbulence studies; Proceedings of the International Symposium, Goettingen, Federal Republic of Germany, May 11, 12, 1987 . Berlin and New York, Springer-Verlag, 1987, p. 382-413. refs
Results for several projects on vortex flows are presented. The theme is the interaction between turbulent boundary layers and longitudinal vortices generated by lateral skewing of the flow further upstream. An obvious example is the passage of foreplane vortices over the main wing of a canard aircraft: however, almost any flow round a surface-mounted obstacle will skew the flow in the boundary layer which has already developed on the surface, and thus produce longitudinal vorticity. The work to be described includes measurements downstream of various delta-wing vortex generators, as well as studies of vortex flows in wing-body junctions, wind-tunnel contractions, and impinging jets. Microcomputer-controlled traverse gear and data-logging procedures are essential for this kind of experiment. Author

A88-33045
THREE-DIMENSIONAL TURBULENT BOUNDARY LAYER CALCULATIONS
J. COUSTEIX and R. MICHEL (ONERA, Centre d'Etudes et de Recherches de Toulouse, France) IN: Perspectives in turbulence studies; Proceedings of the International Symposium, Goettingen, Federal Republic of Germany, May 11, 12, 1987 . Berlin and New York, Springer-Verlag, 1987, p. 439-472. refs
Techniques for the calculation of three-dimensional turbulent boundary-layer flows are examined in an analytical review. The emphasis is on practical methods, although not on their numerical implementation per se. Topics addressed include problems in the use of curvilinear nonorthogonal grids (required to avoid applicability restrictions), geometrical preprocessing and boundary conditions, postprocessing of computed data, the calculation of the laminar-turbulent transition, and the treatment of singularities. Typical numerical results are presented graphically. T.K.

A88-33046
NUMERICAL SIMULATION OF TURBULENT FLOWS USING NAVIER-STOKES EQUATIONS
WOLFGANG SCHMIDT (Dornier GmbH, Friedrichshafen, Federal Republic of Germany) IN: Perspectives in turbulence studies; Proceedings of the International Symposium, Goettingen, Federal Republic of Germany, May 11, 12, 1987 . Berlin and New York, Springer-Verlag, 1987, p. 473-497. refs

Recent advances in CFD are surveyed, with a focus on turbulent-flowfield simulations based on solving the full Navier-Stokes equations. The technological and economic factors driving the increased use of simulations in the aerospace industry are reviewed; the advantages of Navier-Stokes methods over more limited schemes are indicated; and particular attention is given to mesh generation, flow solvers, turbulence models, the experimental validation of numerical solutions, and engineering applications. Typical results are presented graphically, and it is pointed out that the sophistication of present simulations often exceeds that of the experimental validation technology. T.K.

A88-33401
APPLICATION OF AERODYNAMIC RESEARCH AND DEVELOPMENT TO CIVIL AIRCRAFT WING DESIGN (ESSO ENERGY AWARD LECTURE, 1987)
D. H. DYKINS, J. A. JUPP, and D. M. MCRAE (British Aerospace PLC, Civil Aircraft Div., Hatfield, England) Royal Society (London), Proceedings, Series A - Mathematical and Physical Sciences (ISSN 0080-4630), vol. 416, no. 1850, March 8, 1988, p. 43-62.

Civil-aircraft wing development at BAe Hatfield during the period 1967-1987 is described in a historical review and illustrated with diagrams, drawings, graphs, photographs, and tables of numerical data. Topics discussed include the organizational structure of the R&D effort, the political and economic factors affecting the programs, theoretical and computational tools, and experimental facilities. Particular attention is given to the Trident short-haul passenger aircraft, the 125 Business Jet, the 146 Feederliner, and current work on the A330/340. T.K.

A88-33775*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
TIME-ACCURATE UNSTEADY AERODYNAMIC AND AEROELASTIC CALCULATIONS FOR WINGS USING EULER EQUATIONS
GURU P. GURUSWAMY (NASA, Ames Research Center, Moffett Field; Sterling Federal Systems, Inc., Palo Alto, CA) AIAA, ASME, ASCE, and AHS, Structures, Structural Dynamics and Materials Conference, 29th, Williamsburg, VA, Apr. 18-20, 1988. 13 p. refs (AIAA PAPER 88-2281)

A time-accurate approach to simultaneously solve the Euler flow equations and modal structural equations of motion is presented for computing aeroelastic responses of wings. The Euler flow eauations are solved by a time-accurate finite difference scheme with dynamic grids. The coupled aeroelastic equations of motion are solved using the linear acceleration method. The aeroelastic configuration adaptive dynamic grids are time accurately generated using the aeroelastically deformed shape of the wing. The unsteady flow calculations are validated wih experiment, both for a semi-infinite wing and a wall-mounted cantilever rectangular wings. Aeroelastic responses are computed for a rectangular wing using the modal data generated by the finite-element method. The robustness of the present approach in computing unsteady flows and aeroelastic responses that are beyond the capability of earlier approaches using the potential equations are demonstrated. Author

A88-33971
SPATIAL PACKET OF INSTABILITY WAVES IN A SUPERSONIC BOUNDARY LAYER [PROSTRANSTVENNYI PAKET VOLN NEUSTOICHIVOSTI V SVERKHZVUKOVOM POGRANICHNOM SLOE]
A. M. TUMIN Akademiia Nauk SSSR, Sibirskoe Otdelenie, Izvestiia, Seriia Tekhnicheskie Nauki (ISSN 0002-3434), Feb. 1988, p. 14-16. In Russian. refs

A spatial packet of instability waves in a supersonic boundary layer on a flate plate is calculated numerically. Results obtained for a boundary layer at Mach 2 and a perturbation frequency of 20 kHz are compared with experimental results obtained in a supersonic wind tunnel. Some differences between the experimental data and the calculations are briefly discussed. V.L.

A88-34615#
A HIGH-LIFT WING SECTION FOR LIGHT AIRCRAFT
D. J. MARSDEN (Alberta, University, Edmonton, Canada) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 34, March 1988, p. 55-61. refs

Computer analysis has been used to design a wing section for light general aviation aircraft that combines good L/D at Reynolds numbers of the order of 500,000 to 6 million with gentle stall characteristics, low section moment characteristics, and low control hinge moment coefficients. Attention is presently given to the wind tunnel results obtained for a model of the wing section with 1-m chord; performance comparisons with other wing sections show superior performance at the high lift end of the speed range, with good performance overall. The wing section has particular applicability to ultralight category aircraft and very high altitude aircraft. O.C.

A88-34621
A NOTE ON THE EFFECT OF FORWARD FLIGHT ON SHOCK SPACING IN CIRCULAR JETS
P. J. MORRIS (Pennsylvania State University, University Park) Journal of Sound and Vibration (ISSN 0022-460X), vol. 122, April 8, 1988, p. 175-177. refs

The relative change in shock spacing in circular axisymmetric jets has been determined for various jet and freestream Mach numbers, with the jet flowfield modeled as a vortex sheet. Calculations are presented for the case of a conical nozzle. Shock spacing is found to increase with increasing freestream Mach number, although no significant variation is noted until high subsonic freestream velocities are reached. Deficiencies in the vortex sheet model for a jet in a moving stream are pointed out. The present results have application to situations where the external boundary layer on the nozzle is very thin or has been artificially removed. R.R.

A88-35510#
CALCULATION OF THREE-DIMENSIONAL INVISCID FLOWFIELDS IN PROPULSIVE NOZZLES WITH CENTERBODIES
DAVID L. MARCUM and JOE D. HOFFMAN (Purdue University, West Lafayette, IN) Journal of Propulsion and Power (ISSN 0748-4658), vol. 4, Mar.-Apr. 1988, p. 172-179. Previously cited in issue 07, p. 835, Accession no. A86-19885. refs

A88-35534
UNSTEADY SUPERSONIC AERODYNAMICS OF PLANAR LIFTING SURFACES ACCOUNTING FOR ARBITRARY TIME-DEPENDENT MOTION
LIVIU LIBRESCU (Virginia Polytechnic Institute and State University, Blacksburg) IN: Recent trends in aeroelasticity, structures, and structural dynamics; Proceedings of the R. L. Bisplinghoff Memorial Symposium, Gainesville, FL, Feb. 6, 7, 1986 . Gainesville, FL, University Presses of Florida, 1987, p. 173-186. refs

The indirect aerodynamic theory of three- and two-dimensional lifting surfaces undergoing arbitrary small motions in a supersonic flow field is examined which involves the determination of appropriate time-domain kernel functions. The relationship between frequency-domain and the corresponding time-domain kernel functions is established, and the causality property of time-domain kernel functions is demonstrated. This property provides a way to write the integral equation relating a known downwash distribution to an unknown pressure distribution for the case of motion starting at a certain time. The problem analyzed here could be useful in evaluating the structural response of flight vehicles and in the active control of aeroelastic response. V.L.

A88-36257
NON-LINEAR WAVE PROPAGATION IN TRANSONIC NOZZLE FLOWS
M. REIN, G. GRABITZ, and G. E. A. MEIER (Max-Planck-Institut fuer Stroemungsforschung, Goettingen, Federal Republic of Germany) Journal of Sound and Vibration (ISSN 0022-460X), vol. 122, April 22, 1988, p. 331-346. refs

Pressure fluctuations in the subsonic flow downstream of a supersonic flow region with a terminating normal shock wave may cause great changes of the flow field and the shock position. An investigation of this phenomenon is carried out for a transonic Laval nozzle flow with a small supersonic region. The reaction of the shock to sinusoidal pressure disturbances at the nozzle exit is investigated by the method of characteristics. According to the frequency and amplitude of the excitation, the shock motion and the pressure waves depart more or less from the sine form of the pressure disturbance. At low frequencies and amplitudes, downstream of the moving shock wave an unsteady supersonic region may develop, recompressing shock-free to subsonic flow. At higher frequencies and amplitudes by the steepening of the pressure waves additional shocks are formed which coalesce with the original one. Author

A88-36261#
ANALYSIS OF WING FLAP CONFIGURATIONS BY A NONPLANAR VORTEX LATTICE METHOD
B. RAJESWARI and H. N. V. DUTT (National Aeronautical Laboratory, Bangalore, India) Journal of Aircraft (ISSN 0021-8669), vol. 25, Feb. 1988, p. 97, 98.

A nonplanar vortex lattice method is described for calculating the potential flow aerodynamic characteristics of complex planforms, with an emphasis on wings with spanwise segmented partial-span flaps. A new technique has been developed for proper modeling of flow in the region between the flap edges and the wing in the case of part-span flaps. The effects of compressibility have been accounted for by the use of the Prandtl-Glauert rule with no approximation being made regarding freestream incidence, wing camber, and flap deflection. The method has been tested for a number of cases to assess its utility. Author

A88-36263*# Texas A&M Univ., College Station.
EXPERIMENTAL STUDY OF THREE-LIFTING SURFACE CONFIGURATION
C. OSTOWARI and D. NAIK (Texas A & M University, College Station) (ICAS, Congress, 15th, London, England, Sept. 7-12, 1986, Proceedings. Volume 2, p. 1213-1224) Journal of Aircraft (ISSN 0021-8669), vol. 25, Feb. 1988, p. 106-112. Previously cited in issue 24, p. 3533, Accession no. A86-49104. refs
(Contract NAG1-344)

A88-36266#
FREE-VORTEX FLOW SIMULATION USING A THREE-DIMENSIONAL EULER AERODYNAMIC METHOD
P. RAJ, J. S. SIKORA, and J. M. KEEN (Lockheed-California Co., Computational and Advanced Aerodynamics Dept., Burbank) (ICAS, Congress, 15th, London, England, Sept. 7-12, 1986, Proceedings. Volume 1, p. 604-617) Journal of Aircraft (ISSN 0021-8669), vol. 25, Feb. 1988, p. 128-134. Research supported by the Lockheed-California Independent Research and Development Program and USAF. Previously cited in issue 24, p. 3531, Accession no. A86-49043. refs

A88-36769#
SOLUTION OF TRANSONIC FLOW IN DFVLR AXIAL COMPRESSOR ROTOR BY QUASI-3D ITERATION BETWEEN S1 AND S2 STREAM SURFACES
ZHENGMING WANG, HONGJI CHEN, YAONAN HUA, and CHUNG-HUA WU (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) Journal of Engineering Thermophysics (ISSN 0253-231X), vol. 9, Feb. 1988, p. 25-31. In Chinese, with abstract in English. refs

According to the 'General Theory of Three-Dimensional Flow in Turbomachines', the quasi-three-dimensional calculation of the transonic flow field has been achieved for a compressor rotor. The calculation is composed of the iteration between the stream function calculations on a mean S2 stream surface and several S1 stream surfaces of revolution in which the artificial compressibility is used for the solution of the transonic flow on S1 and the elliptic equation algorithm is used for the inverse problem of S2. This method appears to be quite efficient. As an example, the flow in a DFVLR test axial compressor rotor at the design operating condition has been calculated. A properly-varying relaxation factor was employed to make the iteration convergent. Through nine cycles of iterations, the convergent result was obtained and was satisfactory in comparison with the measured data. Author

N88-20257*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AN EXPERIMENTAL INVESTIGATION OF THE FLAP-LAG-TORSION AEROELASTIC STABILITY OF A SMALL-SCALE HINGELESS HELICOPTER ROTOR IN HOVER
DAVID L. SHARPE Jan. 1986 86 p Prepared in cooperation with Army Aviation Research and Development Command, Moffett Field, Calif.
(NASA-TP-2546; REPT-85142; NAS 1.60:2546; AVSCOM-TR-85-A-9) Avail: NTIS HC A05/MF A01 CSCL 01A

A small scale, 1.92 m diam, torsionally soft, hingeless helicopter rotor was investigated in hover to determine isolated rotor stability characteristics. The two-bladed, untwisted rotor was tested on a rigid test stand at tip speeds up to 101 m/sec. The rotor mode of interest is the lightly damped lead-lag mode. The dimensionless lead-lag frequency of the mode is approximately 1.5 at the highest tip speed. The hub was designed to allow variation in precone, blade droop, pitch control stiffness, and blade pitch angle. Measurements of modal frequency and damping were obtained for several combinations of these hub parameters at several values of rotor speed. Steady blade bending moments were also measured. The lead-lag damping measurements were found to agree well with theoretical predictions for low values of blade pitch angle. The test data confirmed the predicted effects of precone, droop, and pitch control stiffness parameters on lead-lag damping. The correlation between theory and experiment was found to be poor for the mid-to-high range of pitch angles where the theory substantially overpredicted the experimental lead-lag damping. The poor correlation in the mid-to-high blade pitch angle range is attributed to low Reynolds number nonlinear aerodynamics effects not included in the theory. The experimental results also revealed an asymmetry in lead-lag damping between positive and negative thrust conditions. Author

N88-20258# Aeronautical Research Labs., Melbourne (Australia).
AUSTRALIAN AERODYNAMIC DESIGN CODES FOR AERIAL TOW BODIES
N. MATHESON 27 Aug. 1987 25 p
(AD-A189048; ARL-AERO-TM-389; DODA-AR-004-553) Avail: NTIS HC A03/MF A01 CSCL 01A

An overview is presented of the design codes developed in Australia that are directly applicable or related to the Aerodynamics of towed bodies. In view of the continuing need for increasingly sophisticated towed targets, often as an alternative to costly subscale targets, a collaborative activity was undertaken to: (1) review the availability and applicability of existing design codes for the free flight phase of deployed aerial tow bodies in the subsonic and supersonic flight regimes; and (2) recommend either an existing design approach or cooperative action to provide a satisfactory capability. In this report, an overview of the design codes developed in Australia that are directly applicable or related to the aerodynamics of towed bodies is presented. GRA

N88-20261# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
INTERACTION BETWEEN TWO-DIMENSIONAL SONIC JETS AND SUPERSONIC FLOW TO MODEL HEAT ADDITION IN A SUPERSONIC COMBUSTOR M.S. Thesis

JOHN M. TRAXLER Dec. 1987 113 p
(AD-A189572; AFIT/GA/AA/87D-07) Avail: NTIS HC A06/MF A01 CSCL 21B

Displacement effects of heated addition to a supersonic flow through a simulated combustor were simulated with mass addition. The structure of precombustion shocks was experimentally investigated by an optical and pressure study of two parallel sonic jets expanding into a two-dimensional supersonic test cavity. Base flow and recompression shocks were studied for two test section depths. A test section to add heat to a two dimensional flow was demonstrated. It was determined that the performance of the constant-area test section was dominated by frictional, rather than shock effects. An off-design nozzle, used for preliminary investigation, caused turbulence and high losses in the channel. The structure of the precombustion zone was found to be a base flow problem and was analyzed using a simple one dimensional model. Static pressure measurements on the sidewalls of the test cavity were found to differ from the static pressure in the center of the two dimensional test cavity, due to diffusion of pressure upstream and downstream through the boundary layer. A welding torch was used to inject premixed oxygen and acetylene into the base region on the end of a centerbody between two supersonic nozzles. The flame was successfully ignited and burned continuously in the flowstream. GRA

N88-20262*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NUMERICAL SIMULATION OF SUBSONIC AND TRANSONIC PROPELLER FLOW Ph.D. Thesis
AARON SNYDER Apr. 1988 191 p
(NASA-TM-100163; E-3725; NAS 1.15:100163) Avail: NTIS HC A09/MF A01 CSCL 01A

The numerical simulation of 3-D transonic flow about a system of propeller blades is investigated. In particular, it is shown that the use of helical coordinates significantly simplifies the form of the governing equation when the propeller system is assumed to be surrounded by an irrotational flow field of an inviscid fluid. The unsteady small disturbance equation, valid for lightly loaded blades and expressed in helical coordinates, is derived from the general blade-fixed potential equation, given for an arbitrary coordinate system. The use of a coordinate system which inherently adapts to the mean flow results in a disturbance equation requiring relatively few terms to accurately model the physics of the flow. Furthermore, the helical coordinate system presented here is novel in that it is periodic in the circumferential direction while, simultaneously, maintaining orthogonal properties at the mean blade locations. The periodic characteristic allows a complete cascade of blades to be treated, and the orthogonality property affords straightforward treatment of blade boundary conditions. An ADI numerical scheme is used to compute the solution of the steady flow as an asymptotic limit of an unsteady flow. As an example of the method, solutions are presented for subsonic and transonic flow about a 5 percent thick bicircular arc blade of an 8-bladed cascade. Both high and low advance ratio cases are computed and include a lifting as well as nonlifting cases. The nonlifting solutions obtained are compared to solutions from a Euler code. Author

N88-20263*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
APPLICATION OF A NONISENTROPIC FULL POTENTIAL METHOD TO AGARD STANDARD AIRFOILS
WOODROW WHITLOW, JR. Jan. 1988 16 p Presented at the AIAA 26th Aerospace Sciences Meeting, Reno, Nev., 11-14 Jan. 1988 Previously announced in IAA as A88-22535
(NASA-TM-100560; NAS 1.15:100560; AIAA-88-0710) Avail: NTIS HC A03/MF A01 CSCL 01A

An entropy-correction method for the unsteady full potential equation is presented. The unsteady potential equation is modified to model the entropy jumps across shock waves. The conservative form of the modified equation is solved in generalized coordinates using an implicit, approximate factorization method. A flux-biasing differencing method, which generates the proper amounts of artificial viscosity in supersonic regions, is used to discretize the flow equations in space. Calculated results are presented for the NLR 7301, NACA 0012, and NACA 64A010A airfoils. Comparisons of the present method and solutions of the Euler equations are presented for the NLR 7301 airfoil, and comparisons of the present method and experimental data are presented for all three airfoils. The comparisons show that the present method more accurately models solutions of the Euler equations and experiment than does the isentropic potential formulation. In addition, it is shown that modeling shock-generated entropy extends the range of validity of the full potential method. Author

N88-20264*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
A REVIEW OF TECHNOLOGIES APPLICABLE TO LOW-SPEED FLIGHT OF HIGH-PERFORMANCE AIRCRAFT INVESTIGATED IN THE LANGLEY 14- X 22-FOOT SUBSONIC TUNNEL
JOHN W. PAULSON, JR., P. FRANK QUINTO, DANIEL W. BANKS, GUY T. KEMMERLY, and GREGORY M. GATLIN May 1988 94 p
(NASA-TP-2796; L-16364; NAS 1.60:2796) Avail: NTIS HC A05/MF A01 CSCL 01A

An extensive research program has been underway at the NASA Langley Research Center to define and develop the technologies required for low-speed flight of high-performance aircraft. This 10-year program has placed emphasis on both short takeoff and landing (STOL) and short takeoff and vertical landing (STOVL) operations rather than on regular up and away flight. A series of NASA in-house as well as joint projects have studied various technologies including high lift, vectored thrust, thrust-induced lift, reversed thrust, an alternate method of providing trim and control, and ground effects. These technologies have been investigated on a number of configurations ranging from industry designs for advanced fighter aircraft to generic wing-canard research models. Test conditions have ranged from hover (or static) through transition to wing-borne flight at angles of attack from -5 to 40 deg at representative thrust coefficients. Author

N88-20265# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
ARSPNSC: A METHOD TO CALCULATE SUBSONIC STEADY AND UNSTEADY POTENTIAL FLOW ABOUT COMPLEX CONFIGURATIONS
M. H. L. HOUNJET Dec. 1986 24 p Sponsored in part by the Royal Netherlands Air Force Material Directorate
(NLR-TR-86122-U; ETN-88-91723) Avail: NTIS HC A03/MF A01

A panel method (ARSPSC) for the calculation of steady and time-linearized unsteady subsonic potential flow about complex 2D and 3D configurations is described. The code is an extension of the ARSPNS code for rotating structures in incompressible flow. The ARSPSC method enables the calculation of steady and unsteady incompressible and subsonic potential flow and deals with arbitrary configurations involving lifting and nonlifting components. Lifting components with small thickness may be modeled by a thin lifting surface approximation. The wakes which start at the sharp trailing edges of the lifting components can be modeled in a fairly arbitrary way and are extended towards infinity as planar wakes in the direction of the x-axis. The load integration scheme is as applied in the ARSPNS code, which allows the correct determination of the suction force in a lifting surface approximation and improves the drag prediction in a full body approximation. Applications to a 2D oscillating flat plate, a 2D multicomponent airfoil with oscillating flap, and a 3D fighter-type wing are described. ESA

N88-20266# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
TESTS ON THE AFWAL 65 DEG DELTA WING AT NLR: A STUDY OF VORTEX FLOW DEVELOPMENT BETWEEN MACH = 0.4 AND 4
S. J. BOERSEN and A. ELSENAAR Sep. 1986 18 p Presented at the Joint International Vortex Flow Symposium, Stockholm,

Sweden, 13 Oct. 1986
(NLR-MP-86058-U; B8725238; ETN-88-91731) Avail: NTIS HC A03/MF A01

As a part of a vortex flow experiment, force and pressure measurements were carried out in transonic and supersonic wind tunnels on a 65 deg swept delta wing configuration. Experimental results concern one configuration with a sharp and one with a rounded leading edge, both tested over a range of Mach numbers between 0.4 and 4.0. A classification of the various types of flow as observed in the experiment is given. Typical aspects of the flow are discussed, including conicity, the occurrence of shocks in the flow field, and the effect of the leading edge shape on the separation development and subsequent vortex formation. The data represent an excellent test case for the evaluation and validation of computational methods such as Euler and Navier-Stokes codes. ESA

N88-20267# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
THE INTERNATIONAL VORTEX FLOW EXPERIMENT: A TEST CASE FOR COMPRESSIBLE EULER CODES
A. ELSENAAR 31 Oct. 1986 19 p Presented at the GAMM Workshop on the Numerical Simulation of Compressible Euler Flows, Rocquencourt, France, 10-13 Jun. 1986
(NLR-MP-86076-U; B8725240; ETN-88-91733) Avail: NTIS HC A03/MF A01

As part of a vortex flow experiment, force and pressure measurements were carried out on a 65 deg delta wing configuration in transonic and supersonic wind tunnels. Three test cases were selected. The test cases are all for the configuration with a sharp leading edge without the canard wing. Three flow conditions are to be used for comparison with the results of Euler codes: the model at an angle of attack of 10 deg at free stream Mach numbers of 0.4, 0.85, and 1.2. The following experimental data is available: overall loads (lift, drag and pitching moment); pressure distributions; surface streamlines, obtained from oil flow pictures (note however that they visualize limiting streamlines in the boundary layer and not inviscid streamlines); and flow field surveys by pressure probes. ESA

N88-20268# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung Trans-Ueberschall-Entwurfsverfahren.
ON THE KUTTA CONDITION FOR FLOWS AROUND LIFTING AIRFOILS AND WINGS
ARABINDO DAS Oct. 1987 88 p
(DFVLR-FB-87-40; ISSN-0171-1342; ETN-88-91923) Avail: NTIS HC A05/MF A01; DFVLR, VB-PL-DO, Postfach 90 60 58, 5000, Cologne, Federal Republic of Germany, 28 deutsche marks

Analyses were performed to examine the flow conditions at the trailing edge of lifting airfoils and wings moving in inviscid medium, and to reveal the significance of the Kutta condition. The analysis includes the origin of dipole and vortex system of lifting surfaces moving in a medium at rest; flow fields of lifting airfoils; flows around edges and wedges in incompressible and compressible medium; and the setting in of the Kutta condition in the numerical methods using Euler equations. In all these cases it is shown that the Kutta condition corresponds to a natural physical process, without resorting to the viscosity of the medium. ESA

N88-20269*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
STEADY AND UNSTEADY TRANSONIC SMALL DISTURBANCE ANALYSIS OF REALISTIC AIRCRAFT CONFIGURATIONS
JOHN T. BATINA, DAVID A. SEIDEL, ROBERT M. BENNETT, HERBERT J. CUNNINGHAM, and SAMUEL R. BLAND Mar. 1988 33 p Presented at the Transonic Symposium, Hampton, Va., 19-21 Apr. 1988
(NASA-TM-100557; NAS 1.15:100557) Avail: NTIS HC A03/MF A01 CSCL 01A

A transonic unsteady aerodynamic and aeroelasticity code CAP-TSD (Computational Aeroelasticity Program-Transonic Small Disturbance) has been developed for application to realistic aircraft configurations. The code uses a time-accurate approximate factorization (AF) algorithm for solution of the unsteady transonic small-disturbance potential equation. The paper gives an overview of the CAP-TSD code development effort and reports on recent algorithm modifications. The algorithm modifications include: an Engquist-Osher (E-O) type-dependent switch to treat regions of supersonic flow, extension of the E-O switch for second-order spatial accuracy, nonisentropic effects to treat strong-shock cases, nonreflecting far field boundary conditions for unsteady applications, and several modifications to accelerate convergence to steady state. The modifications have significantly improved the stability of the AF algorithm and hence the reliability of the CAP-TSD code in general. Calculations are also presented from a flutter analysis of a 45-deg sweptback wing which agree well with experimental data. The paper present descriptions of the CAP-TSD code and algorithm details along with results. Author

N88-20271*# Old Dominion Univ., Norfolk, Va. Dept. of Mechanical Engineering and Mechanics.
COMPUTATIONAL TECHNIQUE FOR COMPRESSIBLE VORTEX FLOWS USING THE INTEGRAL EQUATION SOLUTION Final Report, 31 Jul. 1986
OSAMA A. KANDIL Apr. 1988 3 p
(Contract NAG1-591)
(NASA-CR-182695; NAS 1.26:182695) Avail: NTIS HC A02/MF A01 CSCL 01A

The steady full-potential equation is written in the form of Poisson's equation, and the solution for the velocity field is expressed in terms of an integral equation. The integral solution consists of two surface integrals and one volume integral. The solution is obtained through successive iteration cycles. Each cycle of iteration consists of two sub-cycles, an inner cycle for wake relaxation and an out cycle for the strength of the source distribution integrals representing the flow compressibility. The density gradients in the source distribution is computed by using a type-differencing scheme of the Murman-Cole type. The method is applied to delta wings and the numerical examples show that a curved shock is captured on the wing suction side beneath the leading edge vortex sheet. Recently, a modified version of the scheme was applied to rectangular wings. In this modified scheme, the surface integral terms were computed by using a bilinear distribution of vorticity on triangular vortex panels which represent the wing and its wake. The results were compared with the available experimental data and they are in good agreement. Author

N88-20272*# National Aeronautics and Space Administration, Washington, D.C.
FINITE ELEMENT CALCULATIONS FOR AERODYNAMIC COEFFICIENTS OF A 3-DIMENSIONAL BODY IN SUBSONIC FLOW USING GREEN'S FUNCTION METHOD
MITSUNORI YANAGIZAWA and KAZUO KIKUCHI Mar. 1988 46 p Transl. into ENGLISH of report (Tokyo, Japan, National Aerospace Lab.) p 1-28 Original language document was announced as N83-18661 Transl. by Scientific Translation Service, Santa Barbara, Calif.
(Contract NASW-4307)
(NASA-TT-20208; NAS 1.77:20208) Avail: NTIS HC A03/MF A01 CSCL 01A

An accurate method for evaluating the derivatives along circular paths on the surface is proposed. Calculations are made on various practical configurations such as wing-body combinations, tandem wings, wings with dihedral angles at sideslip, ground effects, interference between a sphere and wind tunnel, etc. Comparisons with experiment show good agreement. Author

N88-20273*# Computer Sciences Corp., Hampton, Va. Applied Technology Div.
CODAC (COCKPIT ORIENTED DISPLAY OF AIRCRAFT CONFIGURATIONS) VERSION 1.4 USER'S GUIDE
BRADFORD D. BINGEL, ERMA L. WILSON, and MICHELLE S. HOLLIS Jan. 1988 65 p
(Contract NAS1-17999)

(NASA-CR-181650; NAS 1.26:181650) Avail: NTIS HC A04/MF A01 CSCL 01A

The Cockpit Oriented Display of Aircraft Configurations (CODAC) package is an interactive FORTRAN 77 graphics program which produces high quality publication grade hidden line images of three dimensional wireframe objects. The term, Cockpit Oriented, is used because CODAC rotates objects relative to the changing aircraft axis system (rather than about a fixed global axis system) and uses the more familiar directions of yaw, roll, and pitch. In addition, CODAC accepts geometry data in a variety of formats (LaWGS, Craidon, Hess, and FVS data check), and automatically selects the appropriate panel driver. Finally, CODAC makes full use of the Precision Visuals' DI-3000 metafile option, allowing users to save, edit, and print images for group presentations or research publications. Author

N88-20274*# Vigyan Research Associates, Inc., Hampton, Va.

THE EFFECT OF STING INTERFERENCE AT LOW SPEEDS ON THE DRAG COEFFICIENT OF AN ELLIPSOIDAL BODY USING A MAGNETIC SUSPENSION AND BALANCE SYSTEM

A. W. NEWCOMB Feb. 1988 79 p
(Contract NAS1-17919)
(NASA-CR-181611; NAS 1.26:181611) Avail: NTIS HC A05/MF A01 CSCL 01A

A Boltz body of revolution (fineness ratio 7.5:1) was tested in the Southampton University Magnetic Suspension and Balance System. The effects of sting interference on the drag coefficient of the model at zero angle of attack were noted as well as the effects on drag coefficient values at boundary layer trips. The drag coefficient values were compared with other sources and seemed to show agreement. The pressure distribution over the rear of the model with no sting interference was investigated including the use of boundary layer trips. Author

N88-20275# Technische Hogeschool, Eindhoven (Netherlands). Vakgroep Transportfysica.

VERIFICATION OF THE MOMEMTUM THEORY FOR ROTORS USING MEASUREMENTS ON A MODEL HELICOPTER [VERIFICATIE VAN DE IMPULSTHEORIE VOOR ROTOREN MIDDELS METINGEN AAN EEN MODELHELIKOPTER]

H. VANDERHOEK and L. PEL Feb. 1987 42 p In DUTCH
(R-840-S; ETN-88-91315) Avail: NTIS HC A03/MF A01

Measurements were performed on the rotor of a model helicopter in order to test classical momemtum theory, in the framework of a research project for the improvement of the aerodynamic theory of wind mills. Pressure and velocity measurements were conducted in two planes underneath the rotor. The hot-wire anemometer measurements in the first only provide an angle-averaged picture of the velocity vectors; the total pressure in this plane was determined using a rake. In the second plane the flow velocity was measured with a hot-wire anemometer; the measurements with the total-pressure tube are unreliable. The goal of the measuring campaign is not obtained. ESA

N88-20277# Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.

THE CONSTRUCTION OF A THREE-DIMENSIONAL FINITE VOLUME GRID GENERATOR FOR A WING IN A WIND TUNNEL WITH APPLICATION TO NAVIER-STOKES FLOW SOLVERS

TONY LINDEBERG 15 Oct. 1987 64 p
(FFA-TN-1987-58; ETN-88-91879) Avail: NTIS HC A04/MF A01

A grid generation method for three-dimensional single block finite volume meshes is presented. A wing in a wind tunnel with application to Navier-Stokes flow solvers serves as a test example. The selected topology of the mesh is of O-O-type, which gives an inherent grid point concentration near the wing surface. The approach is to define a transformation, which maps the region between the wing and the wind tunnel onto a unit cube in a computational space. A surface mesh on the wing as well as a surface mesh on the wind tunnel walls are generated. The three-dimensional grid is then obtained from transfinite interpolation between the two surfaces. A stretching function makes it possible to control the grid spacing near the wing and the wind tunnel wall surfaces in order to resolve the very thin boundary layers which are needed for a Navier-Stokes flow simulation. A simple second order grid smoother is used in the generation of the two surface meshes. ESA

N88-20278*# National Aeronautics and Space Administration, Washington, D.C.

CALCULATION OF THE DISTRIBUTED LOADS ON THE BLADES OF INDIVIDUAL MULTIBLADE PROPELLERS IN AXIAL FLOW USING LINEAR AND NONLINEAR LIFTING SURFACE THEORIES

N. N. PESETSKAYA, I. YA. TIMOFEEV, and S. D. SHIPILOV May 1988 14 p Transl. into ENGLISH from TsAGI, Uchenye Zapiski (USSR), v. 16, no. 3, 1985 p 122-126 Original language document was announced in IAA as A86-48804 Transl. by Scientific Translation Service, Santa Barbara, Calif.
(Contract NASW-4307)
(NASA-TT-20173; NAS 1.77:20173; ISSN-0321-3429) Avail: NTIS HC A03/MF A01 CSCL 01A

In recent years much attention has been given to the development of methods and programs for the calculation of the aerodynamic characteristics of multiblade, saber-shaped air propellers. Most existing methods are based on the theory of lifting lines. Elsewhere, the theory of a lifting surface is used to calculate screw and lifting propellers. In this work, methods of discrete eddies are described for the calculation of the aerodynamic characteristics of propellers using the linear and nonlinear theories of lifting surfaces. Author

N88-20279*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.

FLIGHT TESTS OF EXTERNAL MODIFICATIONS USED TO REDUCE BLUNT BASE DRAG

SHERYLL GOECKE POWERS 1988 17 p Proposed for presentation at the AIAA 6th Applied Aerodynamics Conference, Williamsburg, Va., 6-8 Jun. 1988
(NASA-TM-100433; H-1472; NAS 1.15:100433; AIAA-88-2553) Avail: NTIS HC A03/MF A01 CSCL 01A

The effectiveness of a trailing disk (the trapped vortex concept) in reducing the blunt base drag of an 8-in diameter body of revolution was studied from measurements made both in flight and in full-scale wind-tunnel tests. The experiment demonstrated the significant base drag reduction capability of the trailing disk to Mach 0.93. The maximum base drag reduction obtained from a cavity tested on the flight body of revolution was not significant. The effectiveness of a splitter plate and a vented-wall cavity in reducing the base drag of a quasi-two-dimensional fuselage closure was studied from base pressure measurements made in flight. The fuselage closure was between the two engines of the F-111 airplane; therefore, the base pressures were in the presence of jet engine exhaust. For Mach numbers from 1.10 to 1.51, significant base drag reduction was provided by the vented-wall cavity configuration. The splitter plate was not considered effective in reducing base drag at any Mach number tested. Author

N88-20280*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

STATIC PERFORMANCE OF AN AXISYMMETRIC NOZZLE WITH POST-EXIT VANES FOR MULTIAXIS THRUST VECTORING

BOBBY L. BERRIER and MARY L. MASON May 1988 54 p
(NASA-TP-2800; L-16371; NAS 1.60:2800) Avail: NTIS HC A04/MF A01 CSCL 01A

An investigation was conducted in the static test facility of the Langley 16-Foot Transonic Tunnel to determine the flow-turning capability and the nozzle internal performance of an axisymmetric convergent-divergent nozzle with post-exit vanes installed for multiaxis thrust vectoring. The effects of vane curvature, vane location relative to the nozzle exit, number of vanes, and vane deflection angle were determined. A comparison of the post-exit-vane thrust-vectoring concept with other thrust-vectoring

concepts is provided. All tests were conducted with no external flow, and nozzle pressure ratio was varied from 1.6 to 6.0.
Author

N88-21117*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
THE NASA LANGLEY LAMINAR-FLOW-CONTROL (LFC) EXPERIMENT ON A SWEPT, SUPERCRITICAL AIRFOIL: DESIGN OVERVIEW
CHARLES D. HARRIS, WILLIAM D. HARVEY, and CUYLER W. BROOKS, JR. May 1988 128 p
(NASA-TP-2809; L-16324; NAS 1.60:2809) Avail: NTIS HC A07/MF A01 CSCL 01A

A large-chord, swept, supercritical, laminar-flow-control (LFC) airfoil was designed and constructed and is currently undergoing tests in the Langley 8 ft Transonic Pressure Tunnel. The experiment was directed toward evaluating the compatibility of LFC and supercritical airfoils, validating prediction techniques, and generating a data base for future transport airfoil design as part of NASA's ongoing research program to significantly reduce drag and increase aircraft efficiency. Unique features of the airfoil included a high design Mach number with shock free flow and boundary layer control by suction. Special requirements for the experiment included modifications to the wind tunnel to achieve the necessary flow quality and contouring of the test section walls to simulate free air flow about a swept model at transonic speeds. Design of the airfoil with a slotted suction surface, the suction system, and modifications to the tunnel to meet test requirements are discussed. Author

N88-21119# Technische Hogeschool, Eindhoven (Netherlands). Vakgroep Transportfysica.
MEASUREMENTS ON A HELICOPTER ROTOR [METINGEN AAN EEN HELICOPTERROTOR]
P. BEEKMAN Nov. 1985 104 p In DUTCH
(R-764-S; ETN-88-91309) Avail: NTIS HC A06/MF A01

A model setup and a measuring system were realized, with which the flow field about and through a helicopter rotor was measured, in order to check correction term in rotor aerodynamics formulas. The flow about and through a helicopter rotor, classical momentum theory, and an extension and improvement of this theory are discussed. The pressure and velocity in the far wake were reliably measured with a Pitot tube. The absolute velocity and flow direction right underneath the rotor were accurately determined with a hot-wire anemometer. The measuring setup proves to be suited to revise the momentum theory. It is shown that momentum theory formulas for rotor aerodynamics have only a limited validity. ESA

N88-21121# Bristol Univ. (England). Dept. of Aerospace Engineering.
VORTEX FLOW OVER A DELTA WING WITH APEX FLAPS USING LASER FLOW VISUALISATION B.E. Thesis
D. M. EARNSHAW and P. A. HOLTOM Jun. 1987 55 p
(BU-356; ETN-88-91896) Avail: NTIS HC A04/MF A01

The flow produced by apex flaps on a 70 deg swept delta wing was studied, using specially developed titanium tetrachloride smoke and laser light sheet flow visualization. The results for the flat plate delta are consistent with the work of other authors. The apex flap deflection has a significant effect on the flow, and may have applications in lift/pitch or roll control; it is, however, found to be a nonlinear device. A double vortex burst phenomenon is encountered at various configurations, while the addition of a fuselage to the model considerably modifies the flow. Detailed results on burst position as a function of apex flap angle, together with photographs indicating vortex structure are presented. ESA

N88-21122# Bristol Univ. (England). Dept. of Aerospace Engineering.
AN INVESTIGATION OF CRUCIFORM PARACHUTES AND TOWED TARGETS B.E. Thesis
B. V. KEMP and J. PUGH Jun. 1987 50 p
(BU-360; ETN-88-91900) Avail: NTIS HC A03/MF A01

Drag and stability characteristics of cruciform parachutes and means of reducing the drag on a towed target were studied. The test cruciform parachutes and banner materials were flown in different configurations in the 7 ft x 5 ft wind tunnel at speeds of 5 to 40 m/sec. The forces acting on the parachute and banners during flight were recorded, and visual observations of the flying characteristics noted. Maximum drag is provided by the zero porosity parachutes which are also the most unstable and have the highest spin rates. The most stable parachute, which also exhibits the lowest rate of spin is the high porosity parachute. For towed targets, netting material gives substantially less drag than solid material. Altering the shape of the banner has no great effect and the rectangular shaped banner has a lower C sub D than the pennant shaped banner. Slashes in the material detune ripples passing along the banner, thereby reducing drag. ESA

N88-21123# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Aerodynamics Dept.
ACTIVITIES REPORT OF THE AERODYNAMICS DEPARTMENT Annual Report, 1986
Sep. 1987 53 p Original contains color illustrations
(ETN-88-91979) Avail: NTIS HC A04/MF A01

Computation of nonviscous real gas flows at equilibrium with an upwind scheme; computation of turbulent flows by numerical solution of the Navier-Stokes equations; inverse solution of the 3D Euler equations; simulation of laminar-turbulent transition in natural convection; simulations of transitional channel-flow; application of the vortex particle method to a marine propeller and fairing; prediction of buffeting by a method of unsteady viscous-inviscid interaction; a boundary layer method for predicting viscous sheet separation in three-dimensional flow; homogeneous turbulence subjected to rotation effects; three-dimension separation in incompressible flow; flow of an incompressible fluid around a delta wing; boundary-layer computations applied to the study of three-dimensional flow; applications of hydrodynamic visualizations; definition of glider airfoils; design and test of a laminar horizontal tail; effect of the computation parameters on flows computed by 3D potential methods; separated flows on helicopter fuselage; wind tunnel tests of a helicopter blade tip; aerodynamics of hypersonic vehicles; determination of missile air intake characteristics; flow into the air intake of a fighter aircraft; computation of real gas glow through a hypersonic wind tunnel nozzle; and a method of analysis of surface temperatures in determining heat fluxes are discussed. ESA

N88-21124*# Lockheed Aeronautical Systems Co., Marietta, Ga.
APPLICATION OF HYBRID LAMINAR FLOW CONTROL TO GLOBAL RANGE MILITARY TRANSPORT AIRCRAFT
ROY H. LANGE Apr. 1988 101 p
(Contract NAS1-18036)
(NASA-CR-181638; NAS 1.26:181638) Avail: NTIS HC A06/MF A01 CSCL 01A

A study was conducted to evaluate the application of hybrid laminar flow control (HLFC) to global range military transport aircraft. The global mission included the capability to transport 132,500 pounds of payload 6500 nautical miles, land and deliver the payload and without refueling return 6500 nautical miles to a friendly airbase. The preliminary design studies show significant performance benefits obtained for the HLFC aircraft as compared to counterpart turbulent flow aircraft. The study results at M=0.77 show that the largest benefits of HLFC are obtained with a high wing with engines on the wing configuration. As compared with the turbulent flow baseline aircraft, the high wing HLFC aircraft shows 17 percent reduction in fuel burned, 19.2 percent increase in lift-to-drag ratio, an insignificant increase in operating weight, and a 7.4 percent reduction in gross weight. Author

N88-21127*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
SURFACE FLOW VISUALIZATION OF SEPARATED FLOWS ON THE FOREBODY OF AN F-18 AIRCRAFT AND WIND-TUNNEL MODEL

DAVID F. FISHER, DAVID M. RICHWINE, and DANIEL W. BANKS May 1988 20 p Presented at the 4th Flight Test Conference, San Diego, Calif. 18-20 May 1988
(NASA-TM-100436; H-1481; NAS 1.15:100436; AIAA-88-2112)
Avail: NTIS HC A03/MF A01 CSCL 01A

A method of in-flight surface flow visualization similar to wind-tunnel-model oil flows is described for cases where photo-chase planes or onboard photography are not practical. This method, used on an F-18 aircraft in flight at high angles of attack, clearly showed surface flow streamlines in the fuselage forebody. Vortex separation and reattachment lines were identified with this method and documented using postflight photography. Surface flow angles measured at the 90 and 270 degrees meridians show excellent agreement with the wind tunnel data for a pointed tangent ogive with an aspect ratio of 3.5. The separation and reattachment line locations were qualitatively similar to the F-18 wind-tunnel-model oil flows but neither the laminar separation bubble nor the boundary-layer transition on the wind tunnel model were evident in the flight surface flows. The separation and reattachment line locations were in fair agreement with the wind tunnel data for the 3.5 ogive. The elliptical forebody shape of the F-18 caused the primary separation lines to move toward the leeward meridian. Little effect of angle of attack on the separation locations was noted for the range reported. Author

N88-21128*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
CONSTRUCTING GLOVED WINGS FOR AERODYNAMIC STUDIES
MARTA R. BOHN-MEYER May 1988 20 p Presented at the 4th Flight Test Conference, San Diego, Calif., 18-20 May 1988
(NASA-TM-100440; H-1487; NAS 1.15:100440; AIAA-88-2109)
Avail: NTIS HC A03/MF A01 CSCL 01A

Recently, two aircraft from the Dryden Flight Research Facility were used in the general study of natural laminar flow (NLF). The first, an F-14A aircraft on short-term loan from the Navy, was used to investigate transonic natural laminar flow. The second, an F-15A aircraft on long-term loan from the Air Force, was used to examine supersonic NLF. These tests were follow-on experiments to the NASA F-111 NLF experiment conducted in 1979. Both wings of the F-14A were gloved, in a two-phased experiment, with full-span(upper surface only) airfoil shapes constructed primarily of fiberglass, foam, and resin. A small section of the F-15A right wing was gloved in a similar manner. Each glove incorporated provisions for instrumentation to measure surface pressure distributions. The F-14A gloves also had provisions for instrumentation to measure boundary layer profiles, acoustic environments, and surface pitot pressures. Discussions of the techniques used to construct the gloves and to incorporate the required instrumentation are presented. Author

N88-21129# George Washington Univ., Washington, D.C. School of Engineering and Applied Science.
WALL INTERFERENCE ASSESSMENT AND CORRECTIONS FOR TRANSONIC ADAPTIVE WALL AIRFOIL DATA M.S. Thesis
LAWRENCE LEE RICHARD GREEN Apr. 1988 199 p
Avail: NTIS HC A09/MF A01

A nonlinear, 4-wall, post-test wall interference assessment/correction (WIAC) codes is developed. This code is applicable to transonic airfoil data from solid-wall wind tunnels with flexibly adaptable top and bottom walls. The WIAC code has been applied to several sets of NACA 0012 airfoil data, including many fully adapted test points. The data represent a broad range of model/tunnel configurations and possible wall-interference effects. Small corrections to the measured Mach numbers and angles of attack are obtained from the WIAC code even for fully adapted data; these corrections generally improve the correlation among the various sets of airfoil data. Application, with no optimization, of the WIAC code to fully adapted data has unfortunately been more difficult and time consuming than initially expected from similar previous experience with WIAC application to slotted-wall data. In several instances, however, the WIAC corrections for partially to fully adapted wall airfoil data are shown to be significantly smaller than those for comparable straight, solid- and slotted-wall cases. This indicates a lesser degree of wall interference present in these adapted wall cases. Author

N88-21133 Joint Publications Research Service, Arlington, Va.
TRANSONIC FLOW FIELD ANALYSIS FOR REAL FUSELAGE CONFIGURATIONS Abstract Only
ZHAOQIAN WANG *In its* JPRS Report: Science and Technology. China p 31 5 Jun. 1987 Transl. into ENGLISH from Kongqi Donglixue Xuebao (Mianyang, People's Republic of China), v. 5, no. 1, 1987 p 31-37 Original language document was announced in IAA as A87-37554
Avail: Issuing Activity

The modified small disturbance equation is solved by a relaxed-line method. Crude and fine grid systems are used alternatively in the solving process. Engquist-Osher and Jameson difference schemes are combined, and the lateral relaxed-line method is used at local lines of the fuselage side. Faster convergence is obtained in a numerical experiment using this method. Several examples prove that fewer interactions are required, and that computing results agree with experimental results quite well. Author

N88-21139*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
INFLOW MEASUREMENT MADE WITH A LASER VELOCIMETER ON A HELICOPTER MODEL IN FORWARD FLIGHT. VOLUME 2: RECTANGULAR PLANFORM BLADES AT AN ADVANCE RATIO OF 0.23
JOE W. ELLIOTT, SUSAN L. ALTHOFF, and RICHARD H. SAILEY (PRC Kentron, Inc., Hampton, Va.) Apr. 1988 391 p
(NASA-TM-100542; NAS 1.15:100542; AVSCOM-TM-88-B-005)
Avail: NTIS HC A17/MF A01 CSCL 01A

An experimental investigation was conducted in the 14- by 22-Foot Subsonic Tunnel at NASA Langley Research Center to measure the inflow into a scale model helicopter rotor in forward flight (mu sub infinity = 0.23). The measurements were made with a two-component Laser Velocimeter (LV) one chord above the plane formed by the path of the rotor tips (tip path plane). A conditional sampling technique was employed to determine the azimuthal position of the rotor at the time that each velocity measurement was made so that the azimuthal fluctuations in velocity could be determined. Measurements were made at a total of 180 separate locations in order to clearly define the inflow character. This data is presented without analysis. Author

03

AIR TRANSPORTATION AND SAFETY

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

A88-34580
THE PASSENGER IS NOT FOR BURNING
J. M. RAMSDEN Flight International (ISSN 0015-3710), vol. 133, March 19, 1988, p. 18-20.

A new fire-protection water-mist system, Save, designed for arresting on-ground aircraft fires, is described. The Save's water-mist system invented by J. Steel will use onboard water at a rate of 15 Imp gal/min, so that the 45-gal onboard tank should give occupants three or four minutes to escape, as well as allowing firemen, who might in real life take that time to respond, to connect an external water supply to hydrant points on the aircraft. A typical Save system will weigh about 100 lb, plus the weight of water (about 400 lbs). Results of a test are discussed. I.S.

A88-34582
FUEL-INDUCED ICING - NOW YOU SEE IT, THEN YOU DIDN'T

Flight International (ISSN 0015-3710), vol. 133, April 2, 1988, p. 36-38.

The problem of icing induced by cold fuel in the tanks (cooled at a previous point of departure, during a subsequent high-altitude flight, or from cold soak on the ground) is discussed, with emphasis placed on the findings and recommendations of Soviet research. Clear ice is difficult to see, especially at night or when not expected because of relatively high air temperature, and a relatively thin ice layer may vanish quickly after an accident. It was estimated that fuel-induced ice layers of greater than 15-mm in thickness may form in temperatures up to 10 C. A review of past incidents implicates the fuel-induced icing as a possible cause. I.S.

A88-35694

SAFETY AND FLIGHT ANALYSIS AT AIR FRANCE [LA SECURITE ET L'ANALYSE DES VOLS A AIR FRANCE]

J. GAUTHIER (Air France, Service Securite et Analyse des Vols, Paris) (Societe Francaise de Medecine Aerospatiale, Meeting, Paris, France, Jan. 16, 1987) Medecine Aeronautique et Spatiale, vol. 26, 4th Quarter, 1987, p. 295-301. In French.

A flight analysis for the maintenance of flight safety is discussed which emphasizes the interfaces between man, machine, and environment. An accident prevention cycle is described which consists of the definition of flight standards, their implementation in flight, the analysis of flights, incidents, anomalies, and accidents, and the taking of corrective actions. The flight analysis involves the recording of more than 120 parameters, including the flap position, landing gear position, and engine parameters. The present flight analysis has the advantage of identifying anomalies that have gone previously undetected. The effects of pilot fatigue and pyschological stress are also considered. R.R.

A88-35695

RISKS OF CATASTROPHES IN AERONAUTICS [RISQUES DE CATASTROPHES DANS L'AERONAUTIQUE]

G. BERGOT (Paris, Aeroports, Departement Medical, France) (Societe Francaise de Medecine Aerospatiale, Meeting, Paris, France, Jan. 16, 1987) Medecine Aeronautique et Spatiale, vol. 26, 4th Quarter, 1987, p. 308-311. In French.

Data on aircraft accidents and the classification of victims are discussed. Both the number of aircraft accidents and the number of persons killed have increased between 1982 and 1985. Statistics for 1985 indicate that one death occurred per 80 million passengers, and that 71 percent of the accidents occurred at or in proximity to an airport. Medical strategies for the treatment of the injured are discussed. Accidents in which fire has played a critical role are considered in detail. Accident prevention is explored with respect to the roles played by pilots, aircraft materials, and passengers. R.R.

N88-20281# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.

FLIGHT SIMULATOR EXPERIMENTS CONCERNING TAKE-OFF VISIBILITY MINIMA

M. F. C. VANGOOL 18 Apr. 1986 40 p Sponsored by the Netherlands Dept. of Civil Aviation

(NLR-TR-86050-U; ETN-88-91719) Avail: NTIS HC A03/MF A01

In two sessions on a Boeing 747 flight simulator, the experimental conditions were defined for an investigation directed at the minimum required visual reference to control the aircraft after a failure of the most critical engine at an inconvenient moment during the takeoff run. An investigation was carried out involving a large number of Boeing 747 crews, in which a total of 159 aborted takeoffs were performed in low visibility. Pilot comments and ratings as well as measured pilot-aircraft performance data for these takeoffs are presented. It is concluded that aborted takeoffs can be performed safely in night conditions on runways with 15 or 30 m centerline light spacing with an RVR of as low as 150 m, provided the pilot flying keeps looking outside and the pilot not-flying gives speed calls. ESA

N88-20282# National Transportation Safety Board, Washington, D. C.

AIRCRAFT ACCIDENT REPORT: MIDAIR COLLISION OF CESSNA-340A, N8716K, AND NORTH AMERICAN SNJ-4N, N711SQ, ORLANDO, FLORIDA, MAY 1, 1987

16 Feb. 1988 28 p

(PB88-910402; NTSB/AAR-88/02) Avail: NTIS HC A03/MF A01 CSCL 01C

On May 1, 1987, a Cessna-340A and a SNJ-4 collided in midair about 3,000 ft over Orlando, Florida. The Cessna-340A was level at 3,000 ft operating under instrument flight rules on radar vectors to runway 18R at Orlando International Airport. The SNJ-4 was in descent to 1,500 ft and had completed a turn direct to Orlando Executive Airport when the airplanes collided. Both airplanes were in contact with and were being radar vectored by the Orlando approach control. The Cessna pilot, 2 passengers, and the SNJ-4 pilot were killed. Both airplanes were destroyed. The National Transportation Safety Board determines that the probable cause of the accident was the failure of the Orlando West controller to coordinate the handoff of traffic to the Orlando North controller and the failure of the North controller to maintain radar target identification. Contributing to the accident was the limited capability of the radar system to continually track the targets in proximity to one another and the lack of traffic advisories. Also contributing to the accident was the limitation of the see-and-avoid principle in the circumstances of this accident to serve as a means of collision avoidance. Author

N88-21140# Royal Aircraft Establishment, Farnborough (England).

EQUIPMENT TEST METHODS FOR EXTERNALLY PRODUCED ELECTROMAGNETIC TRANSIENTS

R. A. HOBBS Jul. 1987 36 p

(RAE-TM-FS(F)-457; BR104087; ETN-88-92042) Avail: NTIS HC A03/MF A01

Test methods to simulate the effect of electromagnetic pulse and lightning strike produced transients to aircraft systems are described. ESA

N88-21141 Civil Aviation Authority, London (England).

UK AIRMISS STATISTICS

Nov. 1987 9 p

(REPT-3/87; ISSN-0951-6301; ETN-88-92056) Avail: Civil Aviation Authority, Greville House, 37 Gratton Road, Cheltenham, United Kingdom, 1 pound

Airmiss statistics from 1977 to April 1987 for United Kingdom airspace are presented. ESA

N88-21142 Civil Aviation Authority, London (England).

LAPWINGS AND BIRDSTRIKES. THE BIOLOGY OF THE LAPWING VANELLUS VANELLUS IN RELATION TO THE BIRDSTRIKE HAZARD IT PRESENTS

T. P. MILSOM and J. B. A. ROCHARD Dec. 1987 93 p Sponsored by the United Kingdom Ministry of Defence Prepared in cooperation with the Ministry of Agriculture, Fisheries and Food, London, United Kingdom

(CAA-PAPER-87015; ISBN-0-86-039327-5; ETN-88-92058) Avail: Civil Aviation Authority, Greville House, 37 Gratton Road, Cheltenham, United Kingdom, 7.25 pounds

The ecology and behavior of the lapwing in and around Great Britain were studied. Diurnal and seasonal variations in lapwing-aircraft collisions are discussed. Countermeasures to make aerodromes safe from the lapwing hazard are considered. ESA

N88-21143*# Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.

AN EXPERIMENTAL AND THEORETICAL STUDY OF THE ICE ACCRETION PROCESS DURING ARTIFICIAL AND NATURAL ICING CONDITIONS Final Contractor Report

MARK S. KIRBY and R. JOHN HANSMAN Apr. 1988 136 p

(Contract NAG3-666; NGL-22-009-640)

(NASA-CR-182119; NAS 1.26:182119; DOT/FAA/CT-87/17) Avail: NTIS HC A07/MF A01 CSCL 01C

Real-time measurements of ice growth during artificial and natural icing conditions were conducted using an ultrasonic pulse-echo technique. This technique allows ice thickness to be measured with an accuracy of + or - 0.5 mm; in addition, the ultrasonic signal characteristics may be used to detect the presence of liquid on the ice surface and hence discern wet and dry ice growth behavior. Ice growth was measured on the stagnation line of a cylinder exposed to artificial icing conditions in the NASA Lewis Icing Research Tunnel (IRT), and similarly for a cylinder exposed in flight to natural icing conditions. Ice thickness was observed to increase approximately linearly with exposure time during the initial icing period. The ice accretion rate was found to vary with cloud temperature during wet ice growth, and liquid runback from the stagnation region was inferred. A steady-state energy balance model for the icing surface was used to compare heat transfer characteristics for IRT and natural icing conditions. Ultrasonic measurements of wet and dry ice growth observed in the IRT and in flight were compared with icing regimes predicted by a series of heat transfer coefficients. The heat transfer magnitude was generally inferred to be higher for the IRT than for the natural icing conditions encountered in flight. An apparent variation in the heat transfer magnitude was also observed for flights conducted through different natural icing-cloud formations. Author

N88-21144*# National Aeronautics and Space Administration. Wallops Flight Center, Wallops Island, Va.
INVESTIGATION OF THE MISFUELING OF RECIPROCATING PISTON AIRCRAFT ENGINES
J. HOLLAND SCOTT, JR. Mar. 1988 82 p
(NASA-TP-2803; NAS 1.60:2803) Avail: NTIS HC A05/MF A01 CSCL 01C

The Aircraft Misfueling Detection Project was developed by the Goddard Space Flight Center/Wallops Flight Facility at Wallops Island, Virginia. Its purpose was to investigate the misfueling of reciprocating piston aircraft engines by the inadvertent introduction of jet fuel in lieu of or as a contaminant of aviation gasoline. The final objective was the development of a device(s) that will satisfactorily detect misfueling and provide pilots with sufficient warning to avoid injury, fatality, or equipment damage. Two devices have been developed and successfully tested: one, a small contamination detection kit, for use by the pilot, and a second, more sensitive, modified gas chromatograph for use by the fixed-base operator. The gas chromatograph, in addition to providing excellent quality control of the fixed-base operator's fuel handling, is a very good backup for the detection kit in the event it produces negative results. Design parameters were developed to the extent that they may be applied easily to commercial production by the aircraft industry. Author

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

A88-33048
OPERATIONAL ASPECTS OF JTIDS RELATIVE NAVIGATION
P. A. DOHERTY, C. P. SHEPPARD, and G. L. WRAY (Systems Designers Scientific, Fleet, England) Journal of Navigation (ISSN 0373-4633), vol. 41, Jan. 1988, p. 72-88; Discussion, p. 88, 89. Research supported by the Ministry of Defence Procurement Executive. refs

Joint Tactical Information Distribution System (JTIDS)-based relative navigation operational effectiveness is presently evaluated. One of the most significant factors affecting navigational capabilities within a JTIDS network is the geometry among members of its user community. High navigational accuracy is obtainable when this geometry is of high quality; even when geometry is poor, JTIDS relnav enables a community member with superior navigational capability to improve overall community performance. Fragmented user communities will benefit from the distribution of such position-fixing aids as GPS within the fragments. O.C.

A88-33179
ACCURATE MODELLING OF GLIDESLOPES FOR INSTRUMENT LANDING SYSTEM
M. M. POULOSE, P. R. MAHAPATRA, and N. BALAKRISHNAN (Indian Institute of Science, Bangalore, India) IN: International Conference on Radar, 1st, Nanjing, People's Republic of China, Nov. 4-7, 1986, Record . Beijing, China Academic Publishers, 1986, p. 50-55. refs

Irregularities introduced in electronically defined glideslopes of UHF instrument landing systems by roughness of the terrain around the glideslope antenna has long been a cause for concern from the point of view of flight safety. Various methods based on physical and geometric optics have been applied to model and estimate the glideslope aberration at given locations prior to actual installation. This paper uses advanced ray-theoretic methods for accurate glideslope computation and reports new results. The uniform asymptotic theory (UAT) has been applied to this problem for the first time and results presented. An exhaustive comparative study of various methods and ray order effects is presented. Author

A88-33183
METEOROLOGICAL EFFECTS ON AIR SURVEILLANCE RADARS
BEIDE WANG (PLA, Air Force Research Laboratory, People's Republic of China) IN: International Conference on Radar, 1st, Nanjing, People's Republic of China, Nov. 4-7, 1986, Record . Beijing, China Academic Publishers, 1986, p. 96-101.

Several aspects of meteorological effects on air surveillance radars are examined on the basis of long-term data from several radar stations in China. Particular attention is given to beam distortion caused by atmospheric refraction; the meteorological causes of refraction variation; the generation of radar echoes as natural interference by meteorological targets; and the attenuation of radar waves in the atmosphere. B.J.

A88-33184
AZIMUTH ESTIMATION TECHNIQUES FOR MONOPULSE SSR
ANTONIO DI VITO, GIOACCHINO RANUCCI (Selenia S.p.A., Rome, Italy), GASPARE GALATI (Roma II, Universita, Rome, Italy), and GIOVANNI JACOVITTI (Roma I, Universita, Rome, Italy) IN: International Conference on Radar, 1st, Nanjing, People's Republic of China, Nov. 4-7, 1986, Record . Beijing, China Academic Publishers, 1986, p. 102-109. refs

A new technique for estimating the off-boresight angle in monopulse secondary surveillance radar (SSR) systems is described and evaluated. Apart from its very simple implementation, this technique maintains both the robustness with respect to the phase mismatching (i.e., a typical feature of amplitude-comparison logarithmic receivers) and the nearly-optimum performance for low signal-to-noise-ratio targets near the boresight (typical feature of dual-phase receivers). The proposed technique implements a close approximation of the maximum likelihood estimator (MLE) for coherent beams when the target is near the boresight and of the MLE for noncoherent beams when the target is far from the boresight. Author

A88-33188
THE RESEARCH ON NEAR-FIELD SCATTERING SPECTRUM OF RADAR TARGETS BY SCALED MODELLING
BAOHUI CHEN (Ministry of Astronautics, Shanghai Radio Equipment Research Institute, People's Republic of China) IN: International Conference on Radar, 1st, Nanjing, People's Republic of China, Nov. 4-7, 1986, Record . Beijing, China Academic Publishers, 1986, p. 134-139.

The successful use of millimeter-wave systems in simulation measurements of the near-field scattering characteristics of aircraft models is reported. This approach makes it possible to clearly identify Doppler broadening effects connected with the moving target as well as the jet engine modulation effects. Scale-model results are compared with full-scale results, and it is concluded that the scale-model data are reliable. B.J.

A88-33189

THEORETICAL AND EXPERIMENTAL EVALUATION OF MONOPULSE SSR IN ACTUAL ENVIRONMENT

P. PICCINI (Selenia, S.p.A., Rome, Italy) IN: International Conference on Radar, 1st, Nanjing, People's Republic of China, Nov. 4-7, 1986, Record . Beijing, China Academic Publishers, 1986, p. 140-148. refs

In modern secondary surveillance radar (SSR) the monopulse technique is employed for measurement of the azimuth location of the targets. The two main types of monopulse receivers (amplitude and phase estimation) are briefly described and the trade-off is evaluated. After an introductory discussion on the main causes of performances degradation, a detailed analysis is carried out on the basis of a general mathematical model of the actual phenomenon involved in reply detection and code validation. Author

A88-33227

FALSE TARGET PROBLEMS IN AIR TRAFFIC CONTROL RADAR BEACON SYSTEM

NAMIO MIZUKI and NOBUYUKI KAKU (Electronic Navigation Research Institute, Tokyo, Japan) IN: International Conference on Radar, 1st, Nanjing, People's Republic of China, Nov. 4-7, 1986, Record . Beijing, China Academic Publishers, 1986, p. 412-417. refs

False targets sometimes appear in ATC radar beacon systems due to reflection. Ways to remedy this problem are reviewed, with emphasis on architectural control (AC). It is shown that AC is a useful tool for eliminating false targets. Absorbing materials and cancellation panels have been developed, and evaluation tests have shown their efficiency. B.J.

A88-33246

DATA PROCESSING FOR MULTIPLE MPRF AIRBORNE PD RADARS

YIWEN JIN (Nanjing Research Institute of Electronic Technology, People's Republic of China) IN: International Conference on Radar, 1st, Nanjing, People's Republic of China, Nov. 4-7, 1986, Record . Beijing, China Academic Publishers, 1986, p. 534-539.

The paper examines problems connected with data processing for airborne pulse Doppler radars using medium pulse repetition frequency in a look-down mode. The relationship between multiple PRF parameters and detection performance is examined. Solutions to the data-processing problems are examined. B.J.

A88-33251

PATTERN SHAPING WITH MICROSTRIP ARRAYS FOR MLS APPLICATIONS

V. M. PANDHARIPANDE and B. HARI KUMAR (Osmania University, Hyderabad, India) IN: International Conference on Radar, 1st, Nanjing, People's Republic of China, Nov. 4-7, 1986, Record . Beijing, China Academic Publishers, 1986, p. 565-570.

The paper presents the results on a series fed microstrip patch array designed to obtain a cosec2 theta pattern for the elevation plane of an MLS azimuth antenna. A linear array of length 10 lambda is synthesized to obtain the interelement spacings (non uniform) and the parameters (length and width) of individual rectangular patches. The experimental results on input VSWR and the radiation pattern for the designed series fed printed array are quite satisfactory for microwave landing system applications. Author

A88-33337

ERRORS IN AIRCRAFT HEIGHT INFORMATION TELEMETERED BY SECONDARY SURVEILLANCE RADAR SYSTEMS

D. B. JENKINS, B. A. WYNDHAM, and P. BANKS (Royal Signals and Radar Establishment, Malvern, England) IN: Radar - 87; Proceedings of the International Conference, London, England, Oct. 19-21, 1987 . London and New York, Institution of Electrical Engineers, 1987, p. 200-202.

The errors that emerge in aircraft pressure altitude data telemetered to ground stations via secondary surveillance radar (SSR) links' Mode C are frequently independent of aircraft altimeter function and seem to be generated either during encoding or transmission of radar signals to ground stations. These C-bit (fine-resolution portion of aircraft pressure altitude encoding) errors can yield large errors in calculated aircraft climb and descent rates. Such errors can also generate signal bit patterns that are not employed as Mode C replies. Attention is given to the effect of these errors on the possible application of SSRs to Airborne Alert and Avoidance Systems. O.C.

A88-33342

OPERATION OF MONOPULSE SSR AT DIFFICULT SITES

A. J. MCDEVITT and D. J. SPALDING (Cossor Electronics, Ltd., *Harlow, England*) IN: *Radar - 87; Proceedings of the International* Conference, London, England, Oct. 19-21, 1987 . London and New York, Institution of Electrical Engineers, 1987, p. 237-241.

Monopulse secondary surveillance radar (SSR) performance is assessed in light of experiences gained in over a dozen experimental and operational installations in the UK and abroad. It has been found that, to achieve the full potential of a monopulse SSR system, attention must be given to siting details, as well as to the full spectrum of system signal processing parameters. The siting of an SSR at an established airport is often severely constrained by runway or taxiway obstructions. The effects of reflections, and of ducting in Middle Eastern installations, are noted. O.C.

A88-33654#

RECONTTA - A STATE-OF-THE-ART TELEMETRY TRACKING SYSTEM

STEPHEN G. MORTON (USAF, Flight Test Center, Edwards AFB, CA) IN: ITC/USA/'87; Proceedings of the International Telemetering Conference, San Diego, CA, Oct. 26-29, 1987 . Research Triangle Park, NC, Instrument Society of America, 1987, p. 317-328.

Key features of a Remotely Controllable Telemetry Tracking Antenna (ReConTTA) system which represents the state of the art are presented and discussed. The basic ReConTTA system consists of two equipment groups: the Antenna Group, which operates in the outdoors environment, and the Control Group, which is housed indoors in a controlled environment. Tracking airborne aircraft is accomplished using either local or remote operations. The signal flow and system capabilities are examined. C.D.

A88-33663

LOW COST VERSATILE REMOTELY PILOTED VEHICLE (RPV) DATA LINKS

PAUL RADCLIFFE (Electro-Magnetic Processes, Inc., Chatsworth, CA) IN: ITC/USA/'87; Proceedings of the International Telemetering Conference, San Diego, CA, Oct. 26-29, 1987 . Research Triangle Park, NC, Instrument Society of America, 1987, p. 403-410.

A complete, turnkey, remotely piloted vehicle (RPV) tracking system which uses off-the-shelf hardware and is both versatile and compact is described. The system provides voice and error-protected command signals to the aircraft and simultaneously tracks and receives voice, video, range, and telemetry signals transmitted from the RPV. The voice link serves to aid in the performance testing of developmental prototype RPVs, allowing real-time feedback of position, attitude, and status to and from the observer or passive pilot. The system is composed of both ground-based and airborne equipment which integrates to customer-furnished equipment sensors. In this paper, the ground station, airborne system, and ground station modules are described. C.D.

A88-33687
AN ON-BOARD MULTIBUS ACQUISITION SYSTEM - OPERATIONAL APPLICATIONS
PAR JEAN COSTARD (Avions Marcel Dassault Breguet Aviation, Istres, France) and RENE CRABIE (Electronique Serge Dassault, S.A., Saint-Cloud, France) IN: ITC/USA/'87; Proceedings of the International Telemetering Conference, San Diego, CA, Oct. 26-29, 1987 . Research Triangle Park, NC, Instrument Society of America, 1987, p. 719-728. In French and English.
A self-contained installation for testing flight systems is described which can be placed aboard aircraft. The physical, electrical, and performance characteristics of the installation are reviewed, and its operation is described. A mimic diagram of an operational installation is shown and discussed. The use of the installation in the air and on the ground are addressed. C.D.

A88-33688
FLIGHT TEST SYSTEM (REAL-TIME ANALYSIS, REPORTING, AND DECISION SUPPORT)
EDWARD L. DAVIS and PAUL J. FRIEDMAN (Loral Instrumentation, San Diego, CA) IN: ITC/USA/'87; Proceedings of the International Telemetering Conference, San Diego, CA, Oct. 26-29, 1987 . Research Triangle Park, NC, Instrument Society of America, 1987, p. 729-736.
The architecture and application of a comprehensive integrated flight test system (FTS), the SYSTEM 500, are discussed. The present FTS is designed to speed up the process of platform certification. The use of real-time acquisition and processing, secondary storage, and advanced man-machine interfaces is shown to allow higher confidence in flight safety, and to result in improved quality of maneuvers over a wider envelope range. Standardized file structures make possible interactive correlation between previously recorded results and current incoming data with statistical distribution analysis. R.R.

A88-33692
LORAN - A LOW COST SOLUTION FOR CERTAIN RANGE APPLICATIONS
PHILIP M. MALTBY (Frontier Engineering, Inc., Stillwater, OK) IN: ITC/USA/'87; Proceedings of the International Telemetering Conference, San Diego, CA, Oct. 26-29, 1987 . Research Triangle Park, NC, Instrument Society of America, 1987, p. 793-800. refs
An account is given of the technological bases for an upgrading of the LORAN radio navigation system to serve as a medium-accuracy, very low cost range-instrumentation tool furnishing Time and Space Position Information (TSPI). An account is given of the many applications that suggest themselves for a LORAN TSPI capability, such as vehicle tracking, and multichannel differential tracking. Sources of error in tracking of vehicle positions encompass, in addition to vehicle dynamics, wideband and narrowband RF noise, local signal distortions, and seasonal or diurnal propagation effects. O.C.

A88-33850
ESTIMATION OF THE EFFECT OF NAVIGATION SYSTEM PRECISION AND RELIABILITY ON FLIGHT SAFETY [K OTSENKE VLIIANIIA TOCHNOSTI I NADEZHNOSTI NAVIGATSIONNYKH SISTEM NA BEZOPASNOST' POLETA]
A. A. RESSIN, A. D. TROIANOVSKII, and B. IA. TSIL'KER (Rizhskii Institut Inzhenerov Grazhdanskoi Aviatsii, Riga, Latvian SSR) Priborostroenie (ISSN 0021-3454), vol. 31, March 1988, p. 38-41. In Russian. refs
Approximate expressions are obtained for the probability density of the lateral deviation of aircraft from a given path with and without allowance for the memory of the dead reckoning system (inertial navigation system) and for the possible failure of the radio navigation system. Two kinds of initial distribution of lateral deviation in the case of inertial navigation system are considered: Gaussian and two-sided exponential distributions. The discussion is illustrated by an example. V.L.

A88-34069
CERTAIN DESIGN ASPECTS OF TRUNCATED CORNER REFLECTOR DEPLOYED IN A LOCALIZER ANTENNA SYSTEM
M. C. CHANDRA MOULY, P. S. K. SATYA PRASAD, V. V. RAM PRASAD, and K. UDAYA BHASKAR (VRS Engineering College, Vijayawada, India) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 295-301. refs
The design considerations for a truncated corner reflector deployed in a localizer antenna system are presented. The relation between the spacing of truncation with respect to corner apex and that between source and apex for enhancing the number of images has been derived. Ray tracing has been used. The range of corner angles within which the truncated and conventional reflectors perform alike have been established. I.E.

A88-34074
INTEGRATED INERTIAL REFERENCE SYSTEMS FOR FLIGHT-CONTROL AND NAVIGATION
U. KROGMANN (Bodenseewerk Geraetetechnik GmbH, Ueberlingen, Federal Republic of Germany) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 332-341. refs
To increase reliability and availability, and thus cost-effectiveness, future guidance and control systems can take advantage of integrated inertial reference assemblies. Based on the inertial sensor functions integrated systems can evolve in two steps. An integrated redundant reference system is described first. It integrates the functions needed for flight control and attitude/heading reference in a single box with a minumum number of skewed sensors. Extended requirements for a fully integrated system are analyzed. The inertial reference system for multifunction application capable of meeting these requirements in a double-box configuration with skewed ring laser gyros is then treated. Important signal-processing aspects are dealt with in some detail. I.E.

A88-34075
ERROR ANALYSIS OF A STRAPDOWN INERTIAL NAVIGATION SYSTEM WITH SINGLE AXIS STABILIZATION
SICONG REN, ZIZHENG GUO, and ZONGKE LI (Northwestern Polytechnical University, Xian, People's Republic of China) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 342-349.
A detailed description of the principles, error model, and simulation results of a strapdown inertial navigation system with single axis stabilization are presented. An analytic error model is given. The error propagation characteristic is obtained by means of covariance analysis based on the developed error model. A series iteration technique is adopted for computation. A fighter plane flight trajectory is used for simulating the error covariance propagation. The principle of operation of the system is simpler than that of a pure strapdown system. The system lessens the dynamic range requirement of the gyros. As a result, low-cost gyros can be utilized to achieve the same navigation and guidance missions that would otherwise require high-cost gyros. I.E.

A88-34078
YUMA FLIGHT-TEST VALIDATION OF AN INTEGRATED GPS/INERTIAL NAVIGATION SYSTEM
STEWART P. TEASLEY (Texas Instruments, Inc., Plano) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 367-374.
A system known as global positioning system (GPS) integrated navigation (INAV), under development and test at Texas Instruments, has now progressed from laboratory test to a flight-test

phase on a company-owned aircraft. The results of these flight tests at the GPS test range at the Yuma proving ground are presented. The tightly coupled INAV approach supports the traditional alignment of an inertial set with GPS and, in addition, provides a real-time calibration of the basic inertial sensor errors, compensating for day-to-day drift of the instruments. Effective sensor drift rates are improved by a factor of three. I.E.

A88-34161
LOW-COST DIGITAL RADAR GENERATOR FOR COMPREHENSIVE REALTIME RADAR SIMULATION
GEORGE L. BAIR and ANDREW J. HINSDALE (Merit Technology, Inc., Dallas, TX) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1042-1049.

A novel approach to radar simulation is described. Based on emerging hardware and software technologies, the digital radar generator (DRG) is well suited to many applications including training, engineering analysis, radar prediction, and systems integration. The DRG is capable of simulating all air-to-air, air-to-ground, surveillance/command/control, navigation, an air-to-surface (i.e., ocean surveillance), radar modes including high-resolution coherent ground map modes and inverse synthetic aperture radar (ISAR). Low cost is achieved through the use of innovative radar modeling and multiprocessor hardware/software architectures. I.E.

A88-34167#
SINGLE POINT KEY
STEVEN S. WHITE (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1082-1087.

The single-point keying (SPK) concept provides for the keying of multiple Communications Security (COMSEC) equipment from a single, centrally-located fillport. This concept is being developed to support the draft requirements of the user commands (TAC, MAC, and SAC). O.C.

A88-34170#
FEASIBILITY ANALYSIS OF AN AIR-TO-SATELLITE LASER COMMUNICATIONS LINK
ROBERT J. FELDMANN (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1102-1109.

The laser communications airborne testbed (LCAT) constitutes an advantageous basis for the testing of an air-to-satellite laser communications link with NASA's advanced communications technology satellite (ACTS), since the direct-detection laser portion of the ACTS is suitable for examining the feasibility of an airborne terminal. The characteristics of an LCAT-to-ACTS direct detection communications link are analyzed to provide a measure of the feasibility of developing an airborne laser terminal which will interface directly with the LCAT. Given this connection to the LCAT, the potential for development of an air-to-satellite laser communications terminal for experimentation with the ACTS system is substantially enhanced. O.C.

A88-34171#
MODIFIED/UPGRADED AN/ASC-30 AND THE EHF TEST MODEM/PROCESSOR (ETM/P) (THE AN/ASC-30/U)
JAMES J. FOSHEE and THOMAS E. JOYNER (USAF, Avionics Laboratory, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1110-1113.

The development upgrade modification of the AN/ASC-30 EHF/SHF satellite communications terminal, which has been going on during the past four years for the purpose of providing terminal compatibility with the FLTSAT EHF package (FEP) and MILSTAR satellite system, is discussed. The two major efforts focused on the RF terminal and the modem/processor. The upgrade modification of the RF terminal consisted of design changes to the EHF transmitter, one SHF receiver, and the EHF/SHF antenna. A novel EHF/SHF radome was also developed. With the modem/processor, there was a complete new development which is called the EHF test modem/processor (EMT/P). This ETM/P provides the complex signaling characteristics and signal structures and formats required for operation with the FEP and MILSTAR satellites. I.E.

A88-35371
PILOT ORIENTED AIDS FOR HELICOPTER AUTOMATIC NAP-OF-THE-EARTH FLIGHT
NICHOLAS J. PEKELSMA and RICHARD V. DENTON (TAU Corp., Los Gatos, CA) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 5 p.

An account is given of recently developed tools for the real-time computer generation of both far-field and near-field military helicopter trajectories in nap-of-the-earth (NOE) flight. An evaluation of accumulated experience has established that significant efforts will be required to arrive at a suitable balance of trajectory computations and display technologies with such acceptable handling qualities that a pilot will be comfortable with any automatic NOE computation; attention is given to the case of significant changes in a displayed trajectory. It is noted that such significant trajectory changes can, nevertheless, be rigorously correct from the standpoint of mathematical optimization. O.C.

A88-35372
TERRAIN FOLLOWING/TERRAIN AVOIDANCE/THREAT AVOIDANCE FOR HELICOPTER APPLICATIONS
JEFFREY D. HOFFMAN (Texas Instruments, Inc., Radar Systems Div., McKinney) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 11 p.

The terrain following/terrain avoidance/threat avoidance (TF/TA2) systems presently discussed in the context of military helicopter applications furnish automatic aircraft guidance and control by means of blended digital map data, threat location data, and aircraft sensor data. The result of this blending is a real-time three-dimensional flight path that minimizes altitude and exposure to enemy threats. Attention is given to the Covert Penetration Radar TF/TA2 system, which substantially reduces RF signature and radar on-time by controlling radar in power, space, and time. This system may be installed in any military helicopter. O.C.

A88-35560#
INTEGRATED NAVIGATION/FLIGHT CONTROL FOR FUTURE HIGH PERFORMANCE AIRCRAFT
ROBERT E. EBNER and A. DAVID KLEIN (Litton Systems, Inc., Woodland Hills, CA) IN: Institute of Navigation, Annual Meeting, 43rd, Dayton, OH, June 23-25, 1987, Proceedings . Washington, DC, Institute of Navigation, 1987, p. 147-152. Navy-supported research.

An integrated inertial sensor assembly designed to provide all inertial sensor needs for modern military aircraft is described. Included are flight control and navigation, with reduced avionics cost through the use of redundant skewed inertial navigation sensors. The redundancy management mechanization and the system design features for maximum flight safety are presented. K.K.

A88-36463
AERONAUTICAL CHANNEL CHARACTERIZATION BASED ON MEASUREMENT FLIGHTS
ANDREAS NEUL, JOACHIM HAGENAUER, WOLFGANG PAPKE, FRANK DOLAINSKY, and FRANZ EDBAUER (DFVLR, Institut fuer

Nachrichtentechnik, Oberpfaffenhofen, Federal Republic of Germany) IN: GLOBECOM '87 - Global Telecommunications Conference, Tokyo, Japan, Nov. 15-18, 1987, Conference Record. Volume 3 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1654-1659. refs

The German Aerospace Research Establishment (DFVLR) finished in May 1986 an extensive test program to provide necessary information for the design of a system for aeronautical satellite communications. Over 1000 min of usable test signals were recorded and used as the basis of a detailed statistical evaluation. The theoretical channel model underlying the tests is examined, and the propagation measurement results are presented. I.E.

N88-20287# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.

A METHOD AND MEASURES TO EVALUATE TRACKERS FOR AIR TRAFFIC CONTROL

H. A. P. BLOM 7 Jul. 1986 37 p Sponsored by the Netherlands Dept. of Civil Aviation

(NLR-TR-86072-U; ETN-88-91721) Avail: NTIS HC A03/MF A01

The general setup of the evaluation of a radar tracking algorithm in a civil air traffic control (ATC) system is considered from an operational point of view. Present and potential use of trackdate are taken in account. The result is a method to evaluate trackers for ATC on the basis of live-traffic data, assuming that a sufficiently accurate reconstructed trajectory is available. The evaluation starts with an identification of all moments the pilot or disturbances cause changes in the trajectory and track continuity. The resulting parts of tracks are classified on the basis of this kind of change. For the subclasses quality measures with a distinct operational interpretation are defined. An autocorrelation function for stochastic signals that randomly start and stop continuation is introduced. Both aircraft tracks and tracks originating from other objects or from random origin are taken in account. ESA

N88-20288# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.

FLIGHT SIMULATIONS OF MLS INTERCEPTION PROCEDURES APPLICABLE TO LATERALLY SEGMENTED APPROACH PATHS

L. J. J. ERKELENS and P. J. VANDERGEEST 26 May 1986 15 p Presented at the AIAA Atmospheric Flight Mech. Conference, Williamsburg, Va., 18-20 Aug. 1986 Sponsored by the Netherlands Directorate of Air Traffic Services and Aeronautical Telecommunications

(NLR-MP-86037-U; B8729624; ETN-88-91728) Avail: NTIS HC A03/MF A01

The design and implementation of microwave landing system (MLS) guided interception procedures, applicable to segmented approach paths were studied. Four MLS procedures were proposed for further evaluation. Guidance systems based on closed loop and open loop turn concepts were evaluated as to their capabilities of providing accurate tracking guidance. A simulator investigation was executed to analyze the feasibility of the four proposed interception procedures; turn techniques; and the avionics equipment required for these procedures. The avionics included an experimental navigation display, especially developed to be used with the MLS interception procedures. Test results consist of objective and subjective data. The objective data concern recorded path deviations and statistical data concerning tracking performance and control activity. Subjective data were derived from pilot effort ratings, questionnaire responses, and comments of pilots and air traffic controllers. ESA

N88-21146 Civil Aviation Authority, London (England).

ELECTRONICS AND COMMUNICATIONS IN AIR TRAFFIC CONTROL: THE PRESIDENTIAL ADDRESS

FRANK CHORLEY 1987 29 p Presented at the Institution of Electronic and Radio Engineers' Annual General Meeting, London, United Kingdom, 13 Oct. 1987

(ETN-88-92057) Avail: Civil Aviation Authority, Greville House, 37 Gratton Road, Cheltenham, United Kingdom

The history and development of air traffic control techniques, particularly the rapid growth in the number of aircraft movements during and after World War 2 are reviewed. The methods employed for safe handling of large volumes of civil and military air traffic in crowded air space are discussed. The systems of electronic position identification, guidance, and communications used to support the management task are described together with their necessary performance characteristics. The growth predictions for air traffic movements and the demands which this will make upon the existing system performances are examined, and techniques and systems which might be introduced in the future are considered. ESA

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AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A88-32963

AIRCRAFT MINIMUM TIME-TO-CLIMB MODEL COMPARISON

BION L. PIERSON and SHAW Y. ONG (Iowa State University of Science and Technology, Ames) IN: Optimal control; Proceedings of the Conference on Optimal Control and Variational Calculus, Oberwolfach, Federal Republic of Germany, June 15-21, 1986 . Berlin and New York, Springer-Verlag, 1987, p. 137-146. refs

An attempt is made to find the flight path of a supersonic aircraft for a minimum-time climb from a given initial state to a given final state. Five dynamic models are considered, ranging from the simple energy-state model to the complete point-mass model with five state variables. Comparisons are made between the solutions for these five models with regard to accuracy and computational effort. Numerical results are given for an early representation of the F-4 fighter aircraft. K.K.

A88-32964

AIRCRAFT TRAJECTORY OPTIMIZATION BY CURVATURE CONTROL

RAINER WALDEN (Paderborn, Universitaet-Gesamthochschule, Federal Republic of Germany) IN: Optimal control; Proceedings of the Conference on Optimal Control and Variational Calculus, Oberwolfach, Federal Republic of Germany, June 15-21, 1986 . Berlin and New York, Springer-Verlag, 1987, p. 147-156. refs

The modeling of an aircraft in three-dimensional space over a flat earth is considered. Particular attention is given to a novel point mass model with reduced complexity. The present study is confined to the case of time optimal trajectories. K.K.

A88-32965

OSCILLATORY CRUISE - A PERSPECTIVE

JOHN V. BREAKWELL (Stanford University, CA) IN: Optimal control; Proceedings of the Conference on Optimal Control and Variational Calculus, Oberwolfach, Federal Republic of Germany, June 15-21, 1986 . Berlin and New York, Springer-Verlag, 1987, p. 157-168. refs

The problem of minimum fuel/km is examined using various simplifications, introduced in the last three decades, leading to order reduction. In particular, the second variation about steady cruise, ignoring only the slow change in total weight, reveals two separate physical reasons for the possible advantage of oscillatory cruise. A linear analysis with quadratic payoff (the second variation) and with bounds on thrust variation yields quite good agreement with an exact solution, published recently, for the optimal periodic cruise of a particular airplane. Finally, an explanation is given for the much more substantial percentage saving obtainable by oscillatory maneuvers in the 'endurance' problem: minimum fuel/hour. Author

A88-32968
DIRECT AND INDIRECT APPROACH FOR REAL-TIME OPTIMIZATION OF FLIGHT PATHS
WERNER GRIMM and PETER HILTMANN (DFVLR, Institut fuer Dynamik der Flugsysteme, Wessling, Federal Republic of Germany) IN: Optimal control; Proceedings of the Conference on Optimal Control and Variational Calculus, Oberwolfach, Federal Republic of Germany, June 15-21, 1986 . Berlin and New York, Springer-Verlag, 1987, p. 190-206. refs

Two different numerical approaches for the adaptation of flight path optimization to real-time implementation are presented. Both methods begin with a reduced version of the dynamic model (i.e., variables originally belonging to the state vector are assumed to be directly controllable). The first algorithm is a numerical implementation of the 'direct approach' meaning that the optimal control is approximated via parameter-optimization. The second algorithm is based on the indirect approach meaning that it employs the necessary conditions of variational calculus. While the indirect approach is superior in accuracy, the direct method is shown to be more robust. K.K.

A88-33622* Rice Univ., Houston, Tex.
OPTIMAL PENETRATION LANDING TRAJECTORIES IN THE PRESENCE OF WIND SHEAR
A. MIELE, T. WANG (Rice University, Houston, TX), W. W. MELVIN (Delta Air Lines, Inc., Atlanta, GA), and H. WANG Journal of Optimization Theory and Applications (ISSN 0022-3239), vol. 57, April 1988, p. 1-40. Research supported by the Boeing Commercial Airplane Co. and Air Line Pilots Association. refs
(Contract NAG1-516)

Aircraft penetration landing in the presence of strong-to-severe wind shear is investigated analytically. The optimal-control problem for vertical-plane trajectories is considered, using angle of attack as one control parameter with either (1) a power setting (PS) which remains constant at its preshear value, (2) a PS which increases to its maximum value, or (3) a PS which is controlled (as the second parameter). The problem formulation is explained in detail, and numerical results obtained with the primal sequential gradient-restoration algorithm of Miele and Wang (1986) are presented in extensive tables and graphs. It is found that the touchdown requirements can only be satisfied by optimal trajectories using scheme (1) (but only at low altitudes) or scheme (3); the characteristics of the latter trajectories are explored. T.K.

A88-33739
FOKKER 100 FLIGHT ANALYSIS
JACQUES CLOSTERMANN Interavia (ISSN 0020-5168), vol. 43, March 1988, p. 233-238.

The flight deck of the Fokker 100 107-passenger airliner is dominated by six CRTs on the main instrument panels; the layout and accessibility of cockpit controls follows Airbus principles closely. The aircraft is protected from the pilot's exceeding any part of its envelope by a sophisticated avionic system, as presently demonstrated by a category III automatic landing. Two separate hydraulic systems are used to power the aircraft control surfaces. Graphic data are presented of the F100's weights, payload, and range relationships, and attention is given to the design features and performance of the aircraft's flight controls, fuel system, air conditioning and pressurization system, and electrical system. O.C.

A88-34186
PASSIVE COOLING FOR AVIONICS CAN IMPROVE AIRPLANE EFFICIENCY AND RELIABILITY
CHARLES T. LEONARD (Boeing Commercial Airplane Co., Seattle, WA) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1248-1253.

Passive cooling (no machinery to move coolant) for new-generation avionics is presented as an attractive approach that can produce overall improvements in airplane reliability and reduced costs of operation. Active cooling systems (using machinery to move cooling air) impose airplane penalties in terms of weight, volume occupied by machinery, cost, complexity, reliability, and performance. Tests and analyses demonstrate that passive cooling can produce avionic equipment internal temperatures equivalent to active cooling if thermal design techniques are used early in the design process of the avionics boxes. I.E.

A88-34579
T-45 - TAILHOOK TRAINER
MIKE GAINES Flight International (ISSN 0015-3710), vol. 133, March 12, 1988, p. 20-25.

In 1981, the U.S. Navy selected the Hawk as the carrier deck-landing training aircraft for the VTX-Training System and assigned it the designation T-45 Goshawk. The Hawk's single 12-in-diameter wheel nose gear was replaced by a new twin 16-in-diameter wheel arrangement with a catapult launch-bar and hold-back fitting on the leg. The aircraft was fitted with an arrester hook, which is mounted on parallel beams which, in turn, pick up on modified fuselage frames 30 and 31 on an area with strengthened skin. The command ejection of both pilots can be selected to either cockpit; ejection is through the canopy, after it has been shattered by a miniature detonating cord. Compared with today's U.S. Navy training system using the TA-4J Skyhawk and T-2C Buckeye, the T-45 Goshawks will provide a 48 percent saving in the cost of training each pilot. A cutaway drawing of the first T-45 Goshawk, the BAe T-45A, is included. I.S.

A88-35373
COGNITIVE ENGINEERING APPLIED TO NEW COCKPIT DESIGNS
LORREN STILES, JR. and BRUCE E. HAMILTON (United Technologies Corp., Sikorsky Aircraft Div., Stratford, CT) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 6 p.

The revolutionary growth of systems capability has made available to the crew station designer levels of information processing and automation which have yet to be fully grasped. This, coupled with the customers' desire to utilize aircraft in extremely complex mission scenarios, has made it imperative to apply cognitive engineering to the cockpit. Cognitive engineering, simply stated, is the effective integration of human thought processes with aircraft systems. It is the subset of human factors engineering which concerns itself with the compatibility of the user's mental characteristics with the systems design. This paper will examine the evolution of cockpit requirements specifically for the LHX mission. It will trace the design process from the initial generation of requirements. Man-machine allocation, test and information analysis techniques will be examined to define the design problem in the context of cognitive engineering principles. Finally, the effects of this new approach to design will be discussed from the pilot's perspective. Author

A88-35375
V-22 CREW STATION DESIGN
BRUCE OESTREICH (Boeing Helicopter Co., Philadelphia, PA) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 4 p.

The V-22 tilt-rotor military VTOL aircraft employs as part of its cockpit equipment four multifunction displays and two control displays for operator/aircraft interface. Reliability and maintainability are maximized with a dual-redundant system configuration. In addition, a thust lever is used to optimize the V-22 flight regime. Electroluminescent lighting is employed in conjunction with night vision goggle compatibility and maximized cockpit visibility in all directions. The V-22 is the first aircraft to be made totally dependent on avionics for flight information, with no dedicated gages or instruments for subsystem status information. O.C.

A88-35393
THE DEVELOPMENT AND APPLICATION OF A TILTROTOR FLIGHT SIMULATION
L. W. DOOLEY, D. F. KIMBALL, and D. L. SMITHSON (Bell Helicopter Textron, Inc., Fort Worth, TX) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 14 p. refs

An account is given of the role played by simulation in the design and development of the XV-15 and V-22 tiltrotor aircraft. Attention is given to the software programs, flight simulation hardware, and computing facilities employed in the Generic Tiltrotor computer program employed in the development of the V-22. Simulations were important in the evaluation and refinement of flight control laws, the definition of cockpit displays, the selection of controller configurations, the development of optimal flight techniques for specific tasks, and the determination of external aerodynamic loads during piloted and nonreal-time maneuvers. O.C.

A88-35529
WHIRL FLUTTER OF SWEPT TIP PROPFANS
M. I. YOUNG and C. A. HARPER (Delaware, University, Newark) IN: Recent trends in aeroelasticity, structures, and structural dynamics; Proceedings of the R. L. Bisplinghoff Memorial Symposium, Gainesville, FL, Feb. 6, 7, 1986 . Gainesville, FL, University Presses of Florida, 1987, p. 75-86. refs

Current research on the aeroelastic whirl flutter instability of propfans is reviewed. In particular, attention is given to the aerodynamic sweep of the blade tips, which provides greater efficiency at high subsonic speeds; the investigation of pusher and tractor configurations; and the examination of the effect of the counterrotating dual propeller design on system stability. It is emphasized that considerable analytical and experimental effort is required in the future to fully exploit the performance-economic potential of advanced turbofan engines employing swept tip propfans while successfully avoiding whirl flutter. V.L.

A88-35535
AEROELASTICITY OF VERY LIGHT AIRCRAFT
ILAN KROO (Stanford University, CA) IN: Recent trends in aeroelasticity, structures, and structural dynamics; Proceedings of the R. L. Bisplinghoff Memorial Symposium, Gainesville, FL, Feb. 6, 7, 1986 . Gainesville, FL, University Presses of Florida, 1987, p. 187-202. refs

The design of aircraft with exceptionally lightweight structures is strongly influenced by aeroelastic considerations. This paper addresses some of the problems which have been encountered by this unusual class of low speed aircraft, some of the methods by which they may be analyzed, and some of the ways in which potential aeroelastic difficulties have been turned to advantage. Author

A88-35544
STRUCTURAL TAILORING FOR AIRCRAFT PERFORMANCE
T. A. WEISSHAAR (Purdue University, West Lafayette, IN) IN: Recent trends in aeroelasticity, structures, and structural dynamics; Proceedings of the R. L. Bisplinghoff Memorial Symposium, Gainesville, FL, Feb. 6, 7, 1986 . Gainesville, FL, University Presses of Florida, 1987, p. 336-352. refs

The importance of aeroelastic tailoring at the conceptual design phase is demonstrated with reference to two case studies. One example is the X-29A research aircraft, which has been recently flown, while the other example is an oblique wing that is still in an evolutionary stage. It is shown that aeroelastic optimization using advanced composite materials can lead to substantial improvements in the aeroelastic stability of unconventional aircraft. V.L.

A88-36254
CONSTRUCTION AND ANALYSIS OF A SIMPLIFIED NON-LINEAR GROUND RESONANCE MODEL
M. D. JANOWSKI and B. H. TONGUE (Georgia Institute of Technology, Atlanta) Journal of Sound and Vibration (ISSN 0022-460X), vol. 122, April 22, 1988, p. 233-241. Army-supported research. refs
(Contract NSF MSM-84-51186)

It has long been recognized by the rotary wing aircraft community that an instability known as ground resonance can occur which can threaten both the integrity and performance of an aircraft. Although the behavior of linear rotorcraft models have been well established, only recently has the behavior of a vehicle with non-linear characteristics been studied. A simplified physical model is developed in the present analysis which exhibits many of the same response characteristics as the non-linear model of a helicopter. A parametric study of this model is undertaken to see how parametric changes affect the steady state response of the system. Through the use of the model, it is shown that the limit cycle behavior of a non-linear ground resonance model behaves in a manner similar to that of a rotating shaft with a setscrew or key. Author

A88-36264*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
IN-FLIGHT FLOW VISUALIZATION OF F-106B LEADING-EDGE VORTEX USING THE VAPOR-SCREEN TECHNIQUE
J. E. LAMAR, R. A. BRUCE, J. D. PRIDE, JR., R. H. SMITH, P. W. BROWN (NASA, Langley Research Center, Hampton, VA) et al. Journal of Aircraft (ISSN 0021-8669), vol. 25, Feb. 1988, p. 113-120. Previously cited in issue 14, p. 1985, Accession no. A86-32118. refs

A88-36268#
POTENTIAL APPLICATION OF ADVANCED PROPULSION SYSTEMS TO CIVIL AIRCRAFT
ALAN BLYTHE (British Aerospace, PLC, Civil Aircraft Div., Hatfield, England) (ICAS, Congress, 15th, London, England, Sept. 7-12, 1986, Proceedings. Volume 2, p. 1111-1118) Journal of Aircraft (ISSN 0021-8669), vol. 25, Feb. 1988, p. 141-146. Previously cited in issue 24, p. 3542, Accession no. A86-49093.

N88-20291*# Houston Univ., Tex.
THE DESIGN OF AIRCRAFT USING THE DECISION SUPPORT PROBLEM TECHNIQUE
FARROKH MISTREE, STERGIOS MARINOPOULOS, DAVID M. JACKSON, and JON A. SHUPE Apr. 1988 236 p
(Contract NAS1-18117)
(NASA-CR-4134; NAS 1.26:4134) Avail: NTIS HC A11/MF A01 CSCL 01C

The Decision Support Problem Technique for unified design, manufacturing and maintenance is being developed at the Systems Design Laboratory at the University of Houston. This involves the development of a domain-independent method (and the associated software) that can be used to process domain-dependent information and thereby provide support for human judgment. In a computer assisted environment, this support is provided in the form of optimal solutions to Decision Support Problems. Author

N88-20292# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, Ohio.
AN INVESTIGATION OF CLASSICAL DYNAMIC SCALING TECHNIQUES APPLIED TO AN OLEO-PNEUMATIC LANDING GEAR STRUT Final Report, Oct. 1983 - Jul. 1985
ARCHIE B. CLARK, III Feb. 1987 157 p
(AD-A187664; AFWAL-TR-86-3058) Avail: NTIS HC A08/MF A01 CSCL 01C

A program was conducted to investigate the technical feasibility and practicality of using dynamic scale modeling techniques to design, fabricate, and test a scale model of an aircraft landing gear strut and tire. Dynamic scaling laws were developed and used to design a one-third model of an A-37 Nose Landing Gear (NLG) strut and tire. The A-37 NLG strut and the model gear were tested under dynamically similar conditions of weight, speed, and forcing function on a circular track, Dynamic Test Machine at the Mobility Development Laboratory, Wright-Patterson AFB, OH. Comparison of time history data, recorded during each phase of testing, indicated good correlation of the dynamic response of the model landing gear, in relation to the scaling laws and the A-37 NLG dynamic response. Presented in the report is the development and analytical verification of the scaling laws, test data and comparisons, conclusions, and recommendations. GRA

N88-20293# Aeronautical Research Labs., Melbourne (Australia).
CRACK DISTRIBUTION AND GROWTH RATES FOR CRITICAL FASTENER HOLES IN MIRAGE WING RH79
S. BOWLES 18 Sep. 1987 42 p
(AD-A189080; ARL-MAT-TM-396; DODA-AR-004-560) Avail: NTIS HC A03/MF A01 CSCL 01C

Results of fractographic inspection of fatigue cracks found in the fastener holes (excepting hole 1 and SLAN rivet holes) in the inboard end of the lower flange of RH79 wing-spar, as a result of fatigue testing for 5600 hours, are presented. The largest crack found was only 2.18 mm deep and occurred in hole 10 in the rearward flange of the spar. Holes 1 to 4 remained crack-free as a result of the refurbishment procedures. GRA

N88-20294# Army Aviation Systems Command, St. Louis, Mo.
AVSCOM'S MODIFICATIONS TO TELEDYNE SYSTEMS COMPANY'S AIR-TO-AIR FIRE CONTROL SYSTEM SIMULATION MODEL
DANIEL J. BREYER Nov. 1987 31 p
(AD-A189136; USAAVSCOM-TM-87-F-3) Avail: NTIS HC A03/MF A01 CSCL 19E

This report has been written to document the changes made to Teledyne Systems Company's (TSC) Attack Helicopter Air-to-Air (ATA) Fire Control System Simulation model (AIRTOAIR). The AIRTOAIR Simulation was used as a tool by TSC to assess the effectiveness of several mechanizations of fire control equations. These equations were being formulated with the intent of becoming a product improvement to the existing attack helicopters, the AH-1S COBRA and the AH-64 APACHE. The model simulates a one-on-one, non-dueling, close-in combat scenario using the automatic cannon. Since it is a fire control system representation, all of the sensors that feed information to the fire control computer (FCC) are modelled. The changes to AIRTOAIR are discussed at length and the coding required for each change is also provided. Applications of the changes to specific projects are briefly discussed when appropriate. GRA

N88-20295# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
HOW TO GENERATE EQUAL PROBABILITY DESIGN LOAD CONDITIONS
R. NOBACK 5 Dec. 1985 22 p
(Contract NIVR-1995)
(NLR-TR-86060-U; B8729597; ETN-88-91720) Avail: NTIS HC A03/MF A01

A method for the generation of design load conditions based on the design loads obtained with the power spectral density method and especially with the design envelope criterion is proposed. The generated design load conditions all have the same probability of occurrence. An example with only two loads is shown. The steps that have to be carried out to generate equal probability design load conditions for N loads are outlined. ESA

N88-20296*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A CORRELATION STUDY OF X-29A AIRCRAFT AND ASSOCIATED ANALYTICAL DEVELOPMENT Ph.D. Thesis. Final Contract Report
ALI AHMADI, KAJAL GUPTA, and PAUL FORTIN (Kansas Univ. Center for Research, Inc., Lawrence.) Mar. 1988 282 p
(Contract NCC2-313)
(NASA-TM-89735; NAS 1.15:89735) Avail: NTIS HC A13/MF A01 CSCL 01C

Results of the contractor structural and aerodynamic analysis of the X-29A aircraft are verified. A brief history and potential advantages of the X-29A aircraft are discussed. The NASA developed computer package, STARS (STructures, Aerodynamics, and Related Systems), which is used in verifying contractor results is discussed. Enhancements of the STARS package are described, particularly the incorporation of the FASTEX computer program under STARS, and the development of a complete computer graphics system. A comparative study of free vibration and aerodynamic analysis of the X-29A aircraft is given. This study has shown that the natural frequencies and modeshapes determined analytically by STARS and the contractor compare relatively well with experimentally determined data. Also included in the study is the formulation and development of the higher-order plane-stress finite dynamic triangular element. Author

N88-20297*# National Aeronautics and Space Administration, Washington, D.C.
PROCEDURE FOR DETECTION AND IDENTIFICATION OF A HELICOPTER
HANS SIEBECKER Apr. 1988 9 p Transl. into ENGLISH from Verfahren Zur Detektion und Identifizierung Eines Hubschraubers, Federal Republic of Germany, Patent No. 2851205 Transl. by SCITRAN, Inc., Santa Barbara, Calif. Original document prepared for Eltro GmbH, Corporation for Radiation Technology
(Contract NASW-4307)
(NASA-TT-20234; NAS 1.77:20234) Avail: NTIS HC A02/MF A01 CSCL 01C

A procedure is described for detecting and identifying a helicopter based on its characteristic energy radiation in the visible and heat emitting range, as well as in the sonic range. This procedure uses a passive IR identification sensor. The procedure is discussed using illustrations and examples. Author

N88-20298# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany). Unternehmensgruppe Hubschrauber und Flugzeuge.
AEROELASTIC MODELS IN AIRCRAFT DESIGN [AEROELASTISCHE MODELLE IN DER FLUGZEUGENTWICKLUNG]
H. HOENLINGER and O. SENSBURG Jun. 1986 10 p In GERMAN
(MBB/LKE-294/S/PUB/249; ETN-88-91439) Avail: NTIS HC A02/MF A01

The use of aeroelastic model tests in aircraft design is outlined. Aeroelastic models are economical for the development and testing of novel active-control technologies and measuring methods for aircraft vibration tests. The linearized dynamic calculation model of a flying elastic aircraft was realized in a wind tunnel using aeroelastic models. The validity domain of an aeroelastic model was substantially extended in a cryogenic wind tunnel. ESA

N88-20299# Bristol Univ. (England). Dept. of Aerospace Engineering.
AIR-JET SPOILER B.E. Thesis
K. N. WOLSTENCROFT and A. E. J. WOOD Jun. 1987 46 p
(BU-364; ETN-88-91903) Avail: NTIS HC A03/MF A01

The aerodynamic characteristics of a slender jet of air issuing transversely from a flat plate into the passing airflow was studied in anticipation of the use of such a jet to replace a conventional spoiler. The effects of air-jet momentum, mainstream velocity, and efflux angle of the jet on the separation bubble were investigated. Comparisons were made with the flow pattern of fluid passing over a simple fence. Two-dimensional and three-dimensional flow were created. Average Reynolds number was 193,500. The pressure distribution along the plate was determined at the centerline and at one position beyond the edge of the slot. The pressure variation on the centerline is consistent with the observed flow. A limited range of pressure variations beyond the slot edge is obtained. The two principal configurations adopted show characteristics similar to a fence. However, the net force over the whole plate is virtually zero and so the effect of the separation bubble was assessed. An air-jet angled upstream, instead of being normal to the plate, causes greater flow separation and is more effective. ESA

N88-20300# Fraunhofer-Inst. fuer Betriebsfestigkeit, Darmstadt (West Germany).
STANDARDIZED ENVIRONMENTAL FATIGUE SEQUENCE FOR THE EVALUATION OF COMPOSITE COMPONENTS IN COMBAT AIRCRAFT (ENSTAFF = ENVIRONMENTAL FALSTAFF)
J. J. GERHARZ, comp., D. SCHUETZ, J. W. BERGMANN, J. B. DEJONGE, J. N. WEBB, and R. T. POTTER (Royal Aircraft Establishment, Farnborough, England) 1987 79 p Sponsored by BMFT, Bonn, Fed. Republic of Germany
(LBF-FB-179; IABG-B-TF-2194; NLR-TR-87053-U; RAE-TR-87048; ISSN-0721-5320; ETN-88-91936) Avail: NTIS HC A05/MF A01
An environmental fatigue loading standard was developed. It represents the mechanical loading and the environmental service conditions expected for wing root area structure of fighter aircraft. The standard, called ENSTAFF, utilizes the mechanical loading sequence FALSTAFF and connects defined temperatures to each peak and trough load on the basis of flight missions. It also includes rules for moisture conditioning and moisture control to account for the water picked up by the plastic matrix primarily during ground storage. The load and evironment sequence of ENSTAFF is presented in a form ready for application. ESA

N88-20301*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
AIRCRAFT FLIGHT FLUTTER TESTING AT THE NASA AMES-DRYDEN FLIGHT RESEARCH FACILITY
MICHAEL W. KEHOE May 1988 17 p Presented at the AIAA 4th Flight Test Conference, San Diego, Calif., 18-20 May 1988
(NASA-TM-100417; H-1445; NAS 1.15:100417) Avail: NTIS HC A03/MF A01 CSCL 01C
Many parameter identification techniques have been used at the NASA Ames Research Center, Dryden Research Facility at Edwards Air Force Base to determine the aeroelastic stability of new and modified research vehicles in flight. This paper presents a summary of each technique used with emphasis on fast Fourier transform methods. Experiences gained from application of these techniques to various flight test programs are discussed. Also presented are data-smoothing techniques used for test data distorted by noise. Data are presented for various aircraft to demonstrate the accuracy of each parameter identification technique discussed. Author

N88-21147# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany). Unternehmensgruppe Hubschrauber und Flugzeuge.
THE COOLING OF ELECTRONIC EQUIPMENT IN FIGHTER AIRCRAFT [KUEHLUNG VON ELEKTRONISCHEN GERAETEN IN KAMPFFLUGZEUGEN]
WERNER SENONER 23 Jul. 1986 49 p In GERMAN
(MBB/LKE-312/S/PUB/258; ETN-88-91441) Avail: NTIS HC A03/MF A01
Cooling systems for avionics purposes are discussed. The design and test requirements for the continuous and intermittent operation of equipment, and the sensitivity of avionics to cooling air temperature are discussed. Climatic conditions in aircraft and avionics are given. The heat dissipation of typical modules and avionics systems is explained. Examples of cooling systems design are presented. ESA

N88-21148# Bristol Univ. (England). Dept. of Aerospace Engineering.
INVESTIGATION INTO THE EFFECTS OF FLAP END MODIFICATIONS ON THE PERFORMANCE OF A WING WITH A SINGLE SLOTTED FLAP B.E. Thesis
J. A. GREEN and D. A. WIRDNAM Jun. 1987 54 p
(BU-357; ETN-88-91897) Avail: NTIS HC A04/MF A01
Aerodynamic balance measurements were employed with probe wake traverses, tuft grid pictures, wool tuft probe investigations, and surface oil film tests to study the possible aerodynamic improvements available by the addition of flap end devices to a wing with a single slotted flap. Flat end plates, winglet style flaplets, flap extensions, and variable span slotted flaps were tested at a constant dynamic pressure of 550 N/m sq (corresponding to a Reynolds number of 600,000 and a tunnel speed of 30 m/sec). To simulate take off conditions the flow visualization was performed at a wing incidence of 8 deg with a flap angle of 19 deg. Balance measurements were taken over a complete incidence range of 0 to 20 deg. The most effective modification, based on an A340 Airbus winglet, improves lift/drag ratio (used as a measure of aerodynamic efficiency) by 2.4 percent at an incidence of 10 deg. ESA

N88-21149# Bristol Univ. (England). Dept. of Aerospace Engineering.
AN INVESTIGATION INTO THE EFFECT OF CANARD LOCATION ON THE AERODYNAMICS OF THE CLOSE-COUPLED CANARD CONFIGURATION B.E. Thesis
I. MARSH and R. K. J. PRATT Jun. 1987 58 p
(BU-361; ETN-88-91901) Avail: NTIS HC A04/MF A01
The aerodynamic interaction of a 50 deg swept back, truncated delta wing and a swept back close-coupled canard was investigated. The all-moving canard had an area of 13.5 percent of the wing area, and its relative position with the wing could be varied from -10 to +20 percent of the wing root chord longitudinally and between 0 and 20 percent normally with respect to the leading edge of the wing. Force measurements were taken for the wing and canard individually in each configuration at a wind speed of 40 m/sec. Results show that aerodynamic interference decreases with increasing longitudinal separation, but the effect of increased normal separation is inconclusive. The total lift of the configurations is only found to be enhanced at very high angles of attack. It must be noted, however, that any effects are small, with the wing C sub L only varying by 5 over the range of positions. ESA

N88-21150# Bristol Univ. (England). Dept. of Aerospace Engineering.
AN INVESTIGATION OF THE SPRAY PRODUCED BY A YAWED WHEEL, INCLUDING MEASUREMENT OF IMPACT FORCES B.E. Thesis
R. J. SEMMENS and R. M. F. VAUGHAN Jun. 1987 38 p
(BU-363; ETN-88-91902) Avail: NTIS HC A03/MF A01
The effects of yaw (up to 20 deg) on the spray plumes caused by a wheel running on a flooded runway were studied to produce a correction procedure for estimating spray impact forces from pressure data. Spray was generated at various conditions with a 2000 mm diameter model pneumatic tire, and pressure measurements were made with an intensity probe and an impact-force measuring device. As expected, wheel yaw causes a number of definite asymmetrical effects on the spray plumes. A general correlation between intensity probe data and direct force measurements is obtained, though it is not well defined. Spray pressures of up to 35 psi are recorded at the maximum velocity of 28 m/sec. ESA

N88-21151*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, Calif.
DEVELOPMENT OF A REAL-TIME AEROPERFORMANCE ANALYSIS TECHNIQUE FOR THE X-29A ADVANCED TECHNOLOGY DEMONSTRATOR
R. J. RAY, J. W. HICKS, and R. I. ALEXANDER May 1988 18 p Prepared for presentation at the 4th Flight Test Conference, San Diego, Calif., 18-20 May 1988
(NASA-TM-100432; H-1471; NAS 1.15:100432) Avail: NTIS HC A03/MF A01 CSCL 01C
The X-29A advanced technology demonstrator has shown the practicality and advantages of the capability to compute and display, in real time, aeroperformance flight results. This capability includes the calculation of the in-flight measured drag polar, lift curve, and aircraft specific excess power. From these elements many other types of aeroperformance measurements can be computed and analyzed. The technique can be used to give an immediate postmaneuver assessment of data quality and maneuver technique, thus increasing the productivity of a flight program. A key element of this new method was the concurrent development of a real-time

in-flight net thrust algorithm, based on the simplified gross thrust method. This net thrust algorithm allows for the direct calculation of total aircraft drag. Author

N88-21152*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, Calif.
OPERATIONAL VIEWPOINT OF THE X-29A DIGITAL FLIGHT CONTROL SYSTEM
VINCE CHACON and DAVID MCBRIDE May 1988 11 p Presented at the ISA Aerospace Industries/Test Measurement Divisions 34th International Instrumentation Symposium, Albuquerque, N. Mex., 2-5 May 1988
(NASA-TM-100434; H-1467; NAS 1.15:100434) Avail: NTIS HC A03/MF A01 CSCL 01C

In the past few years many flight control systems have been implemented as full-authority, full-time digital systems. The digital design has allowed flight control systems to make use of many enhanced elements that are generally considered too complex to implement in an analog system. Examples of these elements are redundant information exchanged between channels to allow for continued operation after multiple failures and multiple variable gain schedules to optimize control of the aircraft throughout its flight envelope and in all flight modes. The introduction of the digital system for flight control also created the problem of obtaining information from the system in an understandable and useful format. This paper presents how the X-29A was dealt with during its operations at NASA Ames-Dryden Flight Research Facility. A brief description of the X-29A control system, a discussion of the tools developed to aid in daily operations, and the troubleshooting of the aircraft are included. Author

N88-21153*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
DEVELOPMENT AND FLIGHT TEST OF AN EXPERIMENTAL MANEUVER AUTOPILOT FOR A HIGHLY MANEUVERABLE AIRCRAFT
EUGENE L. DUKE, FRANK P. JONES, and RALPH B. RONCOLI Sep. 1986 61 p
(NASA-TP-2618; H-1258; NAS 1.60:2618) Avail: NTIS HC A04/MF A01 CSCL 01C

This report presents the development of an experimental flight test maneuver autopilot (FTMAP) for a highly maneuverable aircraft. The essence of this technique is the application of an autopilot to provide precise control during required flight test maneuvers. This newly developed flight test technique is being applied at the Dryden Flight Research Facility of NASA Ames Research Center. The FTMAP is designed to increase the quantity and quality of data obtained in test flight. The technique was developed and demonstrated on the highly maneuverable aircraft technology (HiMAT) vehicle. This report describes the HiMAT vehicle systems, maneuver requirements, FTMAP development process, and flight results. Author

N88-21154# Technische Hogeschool, Delft (Netherlands). Vakgroep Constructies, Sterkte en Trillingen.
COMPUTER AIDED DESIGN OF AIRCRAFT STRUCTURES [COMPUTERGESTEUND ONTWERPEN VAN VLIEGTUEGKONSTRUKTIES]
T. J. VANBATEN, J. W. GUNNINK, R. R. HORDIJK, R. P. NOTENBOOM, and A. ROTHWELL 13 Jan. 1987 28 p In DUTCH
(ETN-88-91353) Avail: NTIS HC A03/MF A01

The application of computer aided design (CAD) for aircraft structures is outlined, with a view to the education of students. The global optimization of an airfoil construction, the optimization of panels, the distances between ribs and the skin thicknesses, and the application of the finite element method are discussed. The design of an airfoil panel using the drawing system MEDUSA, is explained. Exercises for students are presented. ESA

N88-21155# Royal Aircraft Establishment, Farnborough (England).
RECOMMENDED TEST SPECIFICATION FOR THE ELECTROMAGNETIC COMPATIBILITY OF AIRCRAFT EQUIPMENT
N. J. CARTER Nov. 1985 103 p
(RAE-TM-FS(F)-510; BR99101; ETN-88-92043; AD-A188867)
Avail: NTIS HC A06/MF A01

Test limits and test methods for measurement and determination of the electromagnetic interference characteristics (emission and susceptibility) of the electrical, electronic, and electromechanical equipment to be procured for use in military aircraft are specified. Tests specific to the performance of transmitting and/or receiving equipment are not included. ESA

N88-21156# Royal Aircraft Establishment, Farnborough (England).
A FLIGHT TEST INVESTIGATION INTO FLOW SEPARATION AND STRUCTURAL RESPONSE FOR A TRANSPORT AIRCRAFT AT BUFFET ONSET
S. L. BUCKINGHAM Jan. 1987 79 p
(RAE-TR-87006; RAE-FS(B)-256; BR104348; ETN-88-92044)
Avail: NTIS HC A05/MF A01

Flight measurements of structural accelerations and strains were made in a VC-10 aircraft at buffet onset. Tuft photography was used to identify the different separations which occur at conditions along the buffet boundary. Wind tunnel oil-flow studies, and pressure measurements were compared with the results. Strengths and weaknesses of these methods of buffet prediction are identified. Digital spectral analysis of accelerations and strains proves to be a powerful analysis technique, and reveals the extreme complexity of the structural response. Ten or more structural modes, at frequencies to beyond 20 Hz, are excited. The characteristics and relative importance of the modes depends on flight condition. It is possible to identify changes in response with changes in the location of the separations. However, the complexity of the response, together with limitations in the test aircraft's instrumentation system and the absence of unsteady pressure measurements, preclude a detailed study of the interaction between excitation and response. ESA

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AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A88-32799
INTEGRATED AVIONICS
Aerospace Engineering (ISSN 0736-2536), vol. 8, April 1988, p. 8-14.

Advances in avionics made due to the introduction of electronic flight instrument systems are discussed. The avionics systems in the cockpits of the Beech Starship and the Gulfstream IV are described.The feasibility of using electronic voice synthesis systems in cockpits is addressed. C.D.

A88-33076*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
AN IN-FLIGHT DATA SYSTEM FOR CHORDWISE TURBULENCE MEASUREMENTS DURING ACOUSTIC DISTURBANCES
RAYMOND S. CALLOWAY and JEFFERY J. MASSIE (NASA, Langley Research Center, Hampton, VA) IN: International Instrumentation Symposium, 33rd, Las Vegas, NV, May 3-8, 1987, Proceedings . Research Triangle Park, NC, Instrument Society of America, 1987, p. 409-419.

An in-flight data system for chordwise turbulence measurements has been developed by NASA to investigate laminar flow stability in the presence of acoustic disturbances. Flight tests were performed with an OV-1B turboprop with a JT-15D engine in order to establish the feasibility of utilizing natural laminar flow (NLF) nacelles to reduce drag and to determine the extent of NLF over a range of controlled acoustic frequencies. The data system consisted of PCM and FM data acquisition subsystems, dual wide-band magnetic flight recorders, and acoustic generating and measuring subsystems. R.R.

A88-33306
AIRBORNE SOLID STATE PHASED ARRAYS - A SYSTEM ENGINEERING PERSPECTIVE
R. LOGAN (Texas Instruments, Inc., Dallas) IN: Radar - 87; Proceedings of the International Conference, London, England, Oct. 19-21, 1987 . London and New York, Institution of Electrical Engineers, 1987, p. 26-31. refs

The system engineering perspectives of the parameters relevant to airborne solid state phased arrays for the 1990s are examined. Two options for an electronically scanned array (ESA) are described, and the characteristics of array/element types are given. An active ESA module is discussed, including its reliability, cost, and cooling, and its parameter values are presented. C.D.

A88-33357
DIGITAL GENERATION OF WIDEBAND FM WAVEFORMS FOR RADAR ALTIMETERS
H. D. GRIFFITHS (University College, London, England) and W. J. BRADFORD (SERC, Rutherford Appleton Laboratory, Didcot, England) IN: Radar - 87; Proceedings of the International Conference, London, England, Oct. 19-21, 1987 . London and New York, Institution of Electrical Engineers, 1987, p. 325-329. refs
(Contract ESA-6079/84/NL/GM(SC))

A method of generating highly linear frequency-modulated continuous wave radar pulses with time-bandwidth products well in excess of those achievable with SAW devices is described and demonstrated. The range sidelobe level, the quantized nature of the waveform, and the component phase errors of the system are examined. The hardware is described, and test and performance results are summarized. The size and power consumption of the system is discussed. C.D.

A88-33384
A MILLIMETER-WAVE LOW-RANGE RADAR ALTIMETER FOR HELICOPTER APPLICATIONS - EXPERIMENTAL RESULTS
M. LANGE, J. DETLEFSEN, M. BOCKMAIR, and U. TRAMPNAU (Muenchen, Technische Universitaet, Munich, Federal Republic of Germany) IN: Radar - 87; Proceedings of the International Conference, London, England, Oct. 19-21, 1987 . London and New York, Institution of Electrical Engineers, 1987, p. 525-529.

This paper describes a 35-GHz FM-CW low-range radar altimeter with extremely high resolution developed for helicopter applications. The altimeter uses full digital data processing of the beat signal in conjunction with a spectrum-analysis-type data evaluation. The results of tests indicate that the altimeter can support autorotation landings carried out on the basis of information on altitude and obstacle-free ground. A block diagram of the altimeter radar system is presented together with the altimeter response curves during the tests. I.S.

A88-34037
INTEGRATED TERRAIN ACCESS/RETRIEVAL SYSTEM (ITARS) ROBUST DEMONSTRATION SYSTEM
W. K. LAU, S. A. BERNSTEEN (Merit Technology, Inc., Dallas, TX), and B. T. FINE (Hughes Aircraft Co., El Segundo, CA) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 66-72.

The ITARS integrated terrain access/retrieval system, a large-scale digital data storage system being developed by Hughes Aircraft Company, is described. A simulation system has been developed to demonstrate the capabilities of ITARS. The author describes the simulation system configuration and ITARS's user algorithms, system performance and future growth possibilities. I.E.

A88-34038
RADAR SYSTEMS ANALYSIS USING DTED DATA
GEORGE L. BAIR and DONALD A. JOHNSTON (Merit Technology Inc., Dallas, TX) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 73-79.

The Defense Mapping Agency's (DMA) Digital Terrain Elevation Data (DTED) provides a comprehensive topographic database that can be used for a variety of applications. This database is useful both as a truth model for the terrain surface and as a sensory input of onboard terrain databases for fusion with other sensors. The authors examine the use of Level 1 DTED data for modeling terrain following radar and its effects on the flight path. In addition, the utility of DTED as an aid to radar is demonstrated. I.E.

A88-34039
A COVERT RADAR SCAN CONTROL ALGORITHM
KURT KJELD CHRISTENSEN (Texas Instruments, Inc., Dallas) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 80-87.

When the future ground track of an aircraft is known and a digital elevation map of the corresponding terrain is available, the average power emitted from a terrain-following radar can be greatly reduced. The scan pattern can be very irregular and the radar antenna can be hidden for a relatively large percentage of time. Such reductions in periodic radar emissions can greatly enhance the survivability of aircraft in hostile territory. The author briefly describes such a map-based covert penetration system, and describes the development of an intelligent radar scan control algorithm for that system. Several prototypes of the algoithm, writtin in Lisp/Prolog and in Fortran, are described, and the algorithm itself is detailed. I.E.

A88-34041
COCKPIT AVIONICS-CHARTING THE COURSE FOR MISSION SUCCESS
GERALD O. BURNHAM, STEPHEN A. SMITH, and KENNETH L. DAVIS (Texas Instruments, Inc., New Program Development Div., Dallas) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 97-100.

Recent advances in digital mapping technology, coupled with the increasing availability of accurate terrain elevation and feature data, have spawned a wide variety of display types and operational capabilities. The authors discuss the options available to the avionics system integrator and the tradeoffs necessary to insure maximum benefit with minimum pilot workload. I.E.

A88-34044
FLIGHT TESTING OF A FIBRE OPTIC DATABUS
R. BOGENBERGER and W. SCHNEIDER (Messerschmitt-Boelkow-Blohm GmbH, Munich, Federal Republic of Germany) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 112-119. refs

A fiber-optic data bus is implemented and tested in a Tornado aircraft. The concept and structure of this data bus and of the monitor equipment are discussed. The system tests prove the airworthiness of the selected and laboratory tested components, as well as the reliability of the fiber-optic data transmission in severe environments. For this purpose the light levels are monitored during flight and transmission errors are counted. Components, bus, and monitor structure are described and test results are reported. I.E.

A88-34048#

A HIGH SPEED FIBER OPTIC DATA BUS FOR AVIONICS APPLICATIONS

W. J. BERMINGHAM, E. A. ALFONSI, and W. A. ROSEN (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 137-142. refs

A 60-Mb/s 64-station fiber-optic data bus suitable for avionics applications has been designed and constructed. The system uses a token-passing logical ring implemented on a physical transmissive star topology. The token-passing protocol is based on the SAE AE-9B linear token-passing protocol draft. The optical transceivers use a commercial LED/PIN photodiode. The bus interface unit implements the protocol function by use of a 16-bit microprocessow, while message buffering and encoding/decoding are performed in high-speed logic. The nominal maximum message length was set at 256 16-bit words. Ongoing work is described that involves increasing the speed to 100 Mb/s. The technical issues involved in militarizing the system are also discussed. I.E.

A88-34050

INTERFACING A HSDB TO A PI-BUS: STUDY THROUGH IMPLEMENTATION

STEVEN S. SCHNETZLER, MIKE G. MADDEN, and THOMAS A. MCDERMOTT (Lockheed-Georgia Co., Marietta, GA) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 151-155.

The requirements for high-speed, distributed-control data distributions in avionic systems has produced many new bus specifications. Two of these are the high-speed data bus (HSDB) and the parallel interface bus (PI-bus). The design of an integrated rack functional equivalent system is described. A comparison of the HSDB and the PI-bus is made along with a description of various mapping alternatives that are to be tested. I.E.

A88-34051

DESIGN OF A PASSIVE STAR-COUPLED FIBER OPTIC HIGH SPEED DATA BUS FOR MILITARY AIRCRAFT

R. W. UHLHORN (Harris Corp., Government Aerospace Systems Div., Melbourne, FL) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 158-164. Research supported by Harris Corp. refs

The details of a design study to define the physical-medium-dependent components for a 64-terminal serial high-speed data bus that meets the environmental requirements for a military avionics platform are presented. The components must be either be qualified or be suitable for qualification testing. Variables associated with the transmitter, connector, optical fiber and cable, and access coupler are included. The effects of optical fiber size, encoding and decoding techniques, and various optical receiver design options are considered to illustrate the link margins that can be achieved. The resulting intertransmission dynamic range and required receiver operating range for a prototype system are used to develop a suitable optical receiver for the data bus. Experimental results are presented to support the study conclusions. I.E.

A88-34052

TRADEOFFS IN AVIONIC SIGNAL PROCESSING CONFIGURATION

KENNETH E. WILLIAMS (Texas Instruments, Inc., Dallas) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 165-168.

A number of the tradeoffs required in configuring a comprehensive avionic signal processor are discussed. The advantages of processor centralization for economy of backup and system availability are indicated, along with the complications caused by the unique processing requirements of various sensors. Alternative solutions and their implications are briefly discussed. Also addressed are such factors as number of sensors served by each processor, distribution of modules by type in typical processor designs, and physical limitations. I.E.

A88-34061

THE CMU (COCKPIT MOCK-UP)-A DESIGN TOOL FOR DISPLAY AND CONTROL CONCEPTS FOR FUTURE HELICOPTERS

WOLFGANG SCHUMACHER and MANFRED STARKE (Elektronik-System-Gesellschaft mbH, Munich, Federal Republic of Germany) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 225-232.

The CMU, realized in close cooperation with the user, is a full-size model cockpit of a future light transport helicopter with modern operating and display features such as a centralized control system, multifunction displays etc. Necessary simulation models are information for guidance, navigation and system status. Thus the test personnel are part of the CMU closed-loop simulation. The CMU is described in respect of its tasks, construction, functions and results, which are obtained by tests with pilots and engineers. I.E.

A88-34062

THREE-DIMENSIONAL STEREOGRAPHIC DISPLAYS

ALAN L. BRIDGES (Lockheed-Georgia Co., Advanced Electronics Div., Marietta, GA) and JOHN M. REISING (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 233-240. refs

The authors review current research, development, and evaluation of easily modifiable three-dimensional (3-D) stereographic pictorial display systems being used at the advanced cockpit display laboratory (ACDL), Lockheed-Georgia Company and at the flight dynamics laboratory, Wright-Patterson AFB. These developments include 3-D variable- and planar-perspective pictorial display formats. Electrooptical shuttering systems, e.g., active and passive liquid-crystal shutters, stereographic display systems, and high-performance computer graphics workstations being used to generate stereo pairs, are demonstrated. I.E.

A88-34065

BIG PICTURE: A SOLUTION TO THE PROBLEM OF SITUATION AWARENESS

PHILIP A. KING (McDonnell Aircraft Co., Saint Louis, MO) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 261-265.
(Contract F33615-85-C-1702)

The problem of presenting integrated data to the pilot of a tactical fighter in a manner designed to improve pilot situation awareness is examined. A solution to this problem is Big Picture, an advanced display concept that makes use of a single, large-area, color display. This display has a surface area of approximately 300 sq in, so that it occupies the entire instrument panel of a fighter cockpit. A simulator that incorporates Big Picture is described. The benefits provided by Big Picture are discussed, including fused data, pictorial formats, and flexible displays. Finally, a brief discussion of present display technology is provided. This includes the problems that have to be solved to produce flightworthy large-area display hardware. I.E.

A88-34073

AN AVIONICS EXPERT SYSTEM FOR GROUND THREAT ASSESSMENT

HENRIK LIND and RICHARD STENERSON (Boeing Military Airplane Co., Seattle, WA) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 326-331.

A prototype avionics threat assessement system consisting of an interactive threat editor, a ground threat situation assessor, and a graphical user interface has been designed as a first step toward building an embedded situation assessor for flight systems. The interactive threat editor provides a menu system to create the threat knowledge base. The editor generates both the data structure displays and the code needed by the situation assessor. The situation assessor uses a blackboard inferencing environment to form threat hypotheses. These hypotheses drive the user interface to create area sensitive displays that can be interrogated to determine the nature of the threats. The threat hypotheses developed are also readily available for input to other candidate embedded avionics expert systems; particularly, the mission planner and the crew station information manager. I.E.

A88-34076
MULTIPROCESSOR IMPLEMENTATIONS OF REAL-TIME MULTI-SENSOR INTEGRATION AVIONICS
CHRISTOPHER BOWMAN and GLEASON SNASHALL (VERAC, Inc., San Diego, CA) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 350-358. refs

The general multiple-target-tracking, fusion-tree framework, useful in formulating alternative approaches, is defined. The role of multisensor integration in advanced avionics concepts is then described along with a sample future tree solution. Parallel implementation approaches to multisensor integration are presented. A massively parallel distributed processing architecture called an artificial neural system is described because of its potential to efficiently solve problems for which a solution methodology is not available, e.g., asset management. I.E.

A88-34079
A PROTOTYPE STRAPDOWN IRU WITH PASSIVE FIBER OPTIC GYROS
HARRY L. GUBBINS (Lear Siegler, Inc., Instrument and Avionics Systems Div., Grand Rapids, MI) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 376-382. refs

The theory of operation and the development status of a passive fiber-optic gyro are presented. This optical rate sensor (ORS) concept is a hybrid, in that it incorporates LSI-built integrated optics devices in conjunction with a multiturn fiber optic ring. A design of a strapdown inertial reference unit (IRU) prototype intended for integration with a modern production strapdown IMU for future flight test evaluation is described. The hardware system described has performance suitable for military applications, including flight stabilization, midcourse guidance, attitude and heading reference, and short-term unaided navigation. I.E.

A88-34080
ACCURACIES FOR DIGITAL MULTIPLE OUTPUT AIR DATA SYSTEMS FOR ANGLE OF ATTACK, PITOT AND STATIC PRESSURE MEASUREMENTS
FLOYD W. HAGEN and RICHARD V. DELEO (Rosemount, Inc., Eden Prairie, MN) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 383-390.

Two types of air data sensors, identified as Models 857C and 857E, are analyzed. The sensors have no moving parts for high reliability and are fully deiced and anti-iced for use on operational aircraft. Each sensor has one static pressure and one pitot pressure output. A system analysis shows significant improvement in angle-of-attack accuracy when digital transducers and circuitry replace analog systems. Predicted system errors are shown to agree with experimentally determined errors obtained from a wind-tunnel calibration of the new digital system. Pitot pressure, static pressure, and angle-of-attack sensing accuracies and reproducibility were determined from wind- tunnel tests on production sensors for two multiple-output sensor designs. I.E.

A88-34081
FUTURE TRENDS IN AIR DATA-CADC OR ADSU?
RICHARD A. DE VERTEUIL (GEC Avionics, Ltd., Rochester, England) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 391-395.

The author reviews the needs and abilities of current air data systems. He focuses on the central air data computer (CADC) and on air data sensor units (ADSUs). The author notes the merits of both systems, and argues against discarding the CADC in favor of the ADSU, which is a decentralized system. I.E.

A88-34098
SYSTEM DESIGN AND AVIONICS INTEGRATION OF A TAKEOFF PERFORMANCE MONITOR
STEVEN F. BALDWIN (E-Systems, Inc., Greenville, TX) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 538-543.

The system design and development of a prototype takeoff performance monitor (TOPM) and its avionics integration into a Falcon 10 jet aircraft are described. The design maximizes the use of color graphics for quick and discernible interpretation by the flight crew for the computations of weight and balance, takeoff performance requirements, and to display real-time takeoff acceleration. An Intel 310 computer is integrated with the antiskid system, the air data computer, and the color radar indicator. All necessary weight, balance, and performance charts were taken from the Falcon 10 flight manual and digitized for increased speed and accuracy. An FAA supplemental type certificate has been issued for the Falcon 10 that incorporates the TOPM, which has a patent pending. I.E.

A88-34099#
A LOW ALTITUDE WARNING SYSTEM FOR PREVENTION OF CONTROLLED FLIGHT INTO TERRAIN
DIANE SHAFFER SHAH and BOB LOMBARDI (USAF, Flight Technology Div., Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 544-551.

A Low Altitude Warning System (LAWS) has been developed for use on a twin-engined subsonic fighter aircraft in order to prevent 'controlled flights into terrain', which are characterized as accidents in which either a pilot's attention is diverted or the pilot becomes disoriented. Attention is presently given to the system's configuration and its test results, as well as areas requiring further development. The design philosophy of the LAWS algorithm is that the pilot should not depend on the system for terrain avoidance, but that if a warning is sounded, the pilot may be assured that an aircraft-to-ground-clearance error has been committed. O.C.

A88-34108
OPTICAL DIAGNOSTIC PROCESSOR FOR FLIGHT CONTROL
ALASTAIR D. MCAULAY (Wright State University, Dayton, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 610-615. refs

An optical diagnostic processor is proposed that diagnoses fault situations arising in flight within nanoseconds. Optics permits much faster operation than would be possible with electronics. Input signals are transmitted to the processor via optical fibers from sensors in the aircraft. The output may be used to override controls to avoid catastrophic situations and minimize damage. The processor has application in pilot training, combat situations, and aircraft testing. It operates in coordination with numerical and symbolic processors. The equations implemented in the diagnostic processor are based on Bayes' theorem. A training method for developing the knowledge base is suggested. An optical implementation using spatial light modulators is described. The limitations of the approach and the status for constructing such systems are discussed. I.E.

A88-34192

STANDARD AIR-VEHICLE EQUIPMENT (SAVE)-BRINGING TRANSPORT AIRCRAFT AVIONICS ONE STEP CLOSER TO THE TWENTY FIRST CENTURY

BENJAMIN FELDGAJER (Lockheed-Georgia Co., Marietta) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1289-1295.

The author addresses the issue of standardized avionics and suggests three characteristics of such systems: (1) modular architecture with standardized interfacing; (2) unified diagnostics for high fault tolerance; and (3) simplified logistic support (i.e., one- and two-level maintenance). Design guidelines are presented for smart built-in test, and for the fault data recorder, the protocol configuration adapter, the autothrottle computer, and the fuel interface unit. Directions in which this work may proceed are noted. I.E.

A88-34863* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

AN EVALUATION OF A REAL-TIME FAULT DIAGNOSIS EXPERT SYSTEM FOR AIRCRAFT APPLICATIONS

PAUL C. SCHUTTE, KATHY H. ABBOTT, MICHAEL T. PALMER, and WENDELL R. RICKS (NASA, Langley Research Center, Hampton, VA) IN: IEEE Conference on Decision and Control, 26th, Los Angeles, CA, Dec. 9-11, 1987, Proceedings. Volume 3 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1941-1947. refs

A fault monitoring and diagnosis expert system called Faultfinder was conceived and developed to detect and diagnose in-flight failures in an aircraft. Faultfinder is an automated intelligent aid whose purpose is to assist the flight crew in fault monitoring, fault diagnosis, and recovery planning. The present implementation of this concept performs monitoring and diagnosis for a generic aircraft's propulsion and hydraulic subsystems. This implementation is capable of detecting and diagnosing failures of known and unknown (i.e., unforseeable) type in a real-time environment. Faultfinder uses both rule-based and model-based reasoning strategies which operate on causal, temporal, and qualitative information. A preliminary evaluation is made of the diagnostic concepts implemented in Faultfinder. The evaluation used actual aircraft accident and incident cases which were simulated to assess the effectiveness of Faultfinder in detecting and diagnosing failures. Results of this evaluation, together with the description of the current Faultfinder implementation, are presented. I.E.

A88-35380

COMMON MODULE IMPLEMENTATION FOR AN AVIONIC DIGITAL MAP

JOHN C. WAHTERA, JIM A. GRACIA, and PAUL E. FARLEY (Harris Corp., Melbourne, FL) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 11 p. refs

The modular implementation alternatives investigated for next-generation avionics' digital moving map subsystem uses the Pave Pillar architecture as the baseline from which the common modules for the U.S. Army's LHX, USAF ATF, and Navy Advanced Tactical Aircraft will be developed. Three common module conceptual implementations for the moving map are discussed: the vector processor module set, the array processor module set, and the postprocessor module set. Custom-designed, state-of-the-art postprocessors are found to offer substantial size, weight, and power advantages over the two other alternatives. O.C.

A88-35381

INTEGRATED COMMUNICATION, NAVIGATION, IDENTIFICATION (CNI) FOR FUTURE ARMY AIRCRAFT

MICHAEL DZUGAN, JR. (U.S. Army, Avionics Research and Development Activity, Fort Monmouth, NJ) and PETER C. CAMANA (TRW, Inc., Military Electronics and Avionics Div., San Diego, CA) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 5 p. refs

Communication, Navigation and Identification (CNI) devices have proliferated on Army aircraft over the last two decades. When first introduced, CNI devices for the most part gave the aviator an advantage over adversaries but were not commonly considered mission critical. In today's sophisticated electronic battlefield the most modern CNI avionics is often essential for aircraft survivability and mission success. Unfortunately these CNI devices are using ever increasing proportions of valuable space and weight allotments. This is one of the reasons that avionics, in general, has become a major contributor to development costs of new aircraft. This paper will address the Army's plans for using an integrated CNI approach for future avionic suites. Advantages and possible trouble areas for this approach will be discussed. Advantages include savings in size, weight and life cycle costs. Also expected are significant improvements in Reliability, Availability and Maintainability (RAM). The opportunity an integrated CNI approach provides for a tri-service standardized common modules program will also be discussed. Author

A88-35390

INSTRUMENTATION OF ADVANCED AVIONICS SUITES USING REAL TIME DATA COMPRESSION TECHNIQUES

THOMAS SQUIRES and BRUCE RIGGINS (Boeing Military Airplane Co., Wichita, KS) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 9 p. refs

Advanced avionics architectures will be incorporated into future aircraft designs employing computational systems far more complex than current systems. In order to provide instrumentation support during the design, development, and test of these avionics, a number of technical issues must be addressed. The purpose of this paper is to address these issues and define an approach for developing advanced avionics instrumentation. Typically, a data system must have at a minimum, the same communications capabilities as the system under test. For example, in advanced avionics architectures, fiber-optic and elecrical data buses will communicate at data rates from 1 to 1000 megabits/second. Instrumentation and analysis systems will have to collect, correlate, and compress the data in order to integrate and validate the avionics system designs. Real time data compression will be required to reduce the storage device requirements and simplify the data analysis process. Author

A88-35467

ADVANCED HEAD-UP DISPLAY (HUD) SYMBOLOGY - AIDING UNUSUAL ATTITUDE RECOVERY

JOHN P. ZENYUH, JOHN M. REISING, JAMES E. MCCLAIN (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH), DIANA J. BARBATO, and DAVID C. HARTSOCK (Midwest Systems Research, Inc., Dayton, OH) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2 . Santa Monica, CA, Human Factors Society, 1987, p. 1067-1071. refs

The head-up displays (HUD's) of today's fighter aircraft present numerous symbology formats to the pilot which are essential for successful performance of a variety of flight tasks from navigation to weapons delivery. One common element in all of these formats is the pitch ladder, designed to provide the pilot with aircraft attitude even in the absence of external visual cues. Unlike the head down attitude director indicator (ADI), the HUD pitch ladder's intent is to aid the pilot in recovering from an unusual attitude while staying head-up. The purpose of this research was to compare the relative effectiveness of two changes to current pitch ladder symbology designed to enhance the pilot's ability to recover from unusual attitudes -- the use of angled pitch bars versus standard straight pitch bars, and multicolor versus the standard monochromatic symbology. The results showed that, in extreme unusual attitudes, the use of both the angled pitch bars and color contributed to better flight performance. In the non-extreme attitudes, however, where the horizon line is always visible, the standard symbology was sufficient for recovery. Author

A88-35468
PICTORIAL FORMAT DISPLAYS FOR TWO-SEAT FIGHTER-ATTACK AIRCRAFT
ROBIN L. MARTIN and THOMAS C. WAY (Boeing Military Airplane Co., Seattle, WA) IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2 . Santa Monica, CA, Human Factors Society, 1987, p. 1072-1076. (Contract F33657-83-C-3618)

Use of pictorial displays was explored as one solution to the complexity of modern aircraft and missions. A simulator crew-in-the-loop study was conducted to evaluate the utility and crew acceptance of pictorial format displays for two-seat fighter-attack aircraft, to determine whether utility and crew acceptance were affected by application for color, and to recommend format changes based on the results. Pictorial formats were developed in both color and monochrome for the Head-Up Display and tactical, situation, and system status displays. Sixteen operational two-man aircrews learned the formats and flew them in mission simulation. Opinion, workload, and performance data were collected. The crews clearly supportd the concept of pictorial formats, preferred the color version, and provided critiques of specific formats. Author

A88-35469
AN ASSESSMENT OF DISPLAY FORMATS FOR CREW ALERTING AND GUIDANCE
LINDA LALUMIERE-GRUBBS, BARRY L. BERSON (Lockheed-California Co., Burbank), GEORGE P. BOUCEK, JR., CHARLES ANDERSON (Boeing Commercial Airplane Co., Seattle, WA), LELAND G. SUMMERS (Douglas Aircraft Co., Long Beach, CA) et al. IN: Human Factors Society, Annual Meeting, 31st, New York, NY, Oct. 19-23, 1987, Proceedings. Volume 2 . Santa Monica, CA, Human Factors Society, 1987, p. 1077-1081. refs

This paper describes studies conducted to assess the relative effectiveness of selected display formats for an aircraft alerting system designed for communicating time-critical information to commercial airline pilots. In these experiments, the effects of the format type, format complexity, and format symbology on the response time and the number of errors were assessed using a part-task simulation. The results indicate that the response to symbolic formats without alphanumerics was faster and more accurate than the response to symbolic formats with alphanumerics or alphanumeric only formats. I.S.

A88-35551
INSTITUTE OF NAVIGATION, ANNUAL MEETING, 43RD, DAYTON, OH, JUNE 23-25, 1987, PROCEEDINGS
Meeting supported by the Institute of Navigation, Bell Aerospace Textron, Honeywell, Inc., et al. Washington, DC, Institute of Navigation, 1987, 191 p. For individual items see A88-35552 to A88-35560, A88-35562.

The conference presents papers on future navigation needs; autonomous navigation, radio, and integrated navigation; and systems integration. Particular attention is given to simplified GPS integrity checking with multiple satelites, impact upon GPS user segment of GPS conversion to the WGS-84 earth model, airborne transfer alignment, and SAR motion compensation. Other topics include an overview of the IISA/ABICS flight test program, integrated navigation/flight control for future high performance aircraft, integrated CNI for future army aircraft; and integration, test, and evaluation of inertially aided avionics. K.K.

A88-35552#
INTERNATIONAL FUTURE NAVIGATION NEEDS - OPTIONS AND CONCERNS
ROLF JOHANNESSEN (STC Technology, Ltd., Harlow, England) IN: Institute of Navigation, Annual Meeting, 43rd, Dayton, OH, June 23-25, 1987, Proceedings . Washington, DC, Institute of Navigation, 1987, p. 7-12. refs

The paper examines likely needs which can be foreseen from civil users of navigation systems, be they aviation, marine or land. Differences between users in the USA and in EUROPE are considered. The need for full international discussion is stressed as a pre-requisite for trust in the system. It is also argued that the USA has as much to gain from such discussion as has the rest of the world. The paper concentrates on GPS which is seen as a considerable advance on earlier navigation systems. Nevertheless, the international community has several anxieties. Selective availability is likely to hurt US users as much as those in Europe and the integrity issue is an area where international discussion and cooperation is considered to be particularly valuable. Author

A88-35553#
VIBRATION-INDUCED DRIFT IN THE HEMISPHERICAL RESONATOR GYRO
DAVID D. LYNCH (General Motors Corp., Delco Systems Operations, Goleta, CA) IN: Institute of Navigation, Annual Meeting, 43rd, Dayton, OH, June 23-25, 1987, Proceedings . Washington, DC, Institute of Navigation, 1987, p. 34-37.

The mechanisms in the HRG that lead to drift sensitivity to externally applied vibration are discussed. They are shown to result in modest vibration sensitivities that occur only at frequencies above those of the usual aircraft vibration environment. The HRG is shown to be suitable for use in severe vibration environments. Author

A88-35554#
USE OF A THREE-AXIS MONOLITHIC RING LASER GYRO AND DIGITAL SIGNAL PROCESSOR IN AN INERTIAL SENSOR ELEMENT
DONALD J. WEBER (Singer Co., Kearfott Guidance and Navigation Div., Little Falls, NJ) IN: Institute of Navigation, Annual Meeting, 43rd, Dayton, OH, June 23-25, 1987, Proceedings . Washington, DC, Institute of Navigation, 1987, p. 38-43.

The paper presents a configuration based on a 24-cm path length triple laser gyro (Trilag), three miniature single-axis force rebalance accelerometers, and a digital signal processor. Its use as a stand-alone inertial subsystem or as an integral part of a full inertial navigation system is considered and performance data are presented. Associated development involving down-sized Trilag gyros for tactical missile or sensor stabilization applications is also reviewed. K.K.

A88-35555#
PERFORMANCE OF HIGH-ACCURACY RING-LASER GYROS FOR CRUISE APPLICATIONS
LUDD A. TROZPEK and ROBERT G. CHRISTIANSEN (Rockwell International Corp., Autonetics Marine Systems Div., Anaheim, CA) IN: Institute of Navigation, Annual Meeting, 43rd, Dayton, OH, June 23-25, 1987, Proceedings . Washington, DC, Institute of Navigation, 1987, p. 51-55. USAF-supported research.

The paper describes 38-cm square dithered ring-laser gyros that perform ten percent better than the advanced cruise missile high-accuracy velocity and position specification. These gyros also meet the high accuracy requirements for the advance tactical fighter for velocity error and come within twenty percent of meeting the position requirement assuming a 3-minute gyro compass alignment. This projected system performance was achieved by minimizing bias white noise in the gyro design and fabrication and by modeling the very repeatable temperature sensitivity. Author

A88-35559#
OVERVIEW OF THE IISA/ABICS FLIGHT TEST PROGRAM
CARLOS A. BEDOYA (McDonnell Aircraft Co., Saint Louis, MO) and JOHN M. PERDZOK (USAF, Wright Aeronautical Laboratory, Wright-Patterson AFB, OH) IN: Institute of Navigation, Annual Meeting, 43rd, Dayton, OH, June 23-25, 1987, Proceedings . Washington, DC, Institute of Navigation, 1987, p. 134-146. refs

The paper presents an overview of the following programs: Multifunction Inertial Reference Assembly, Integrated Inertial Sensor Assembly (IISA), Integrated Inertial Reference Assembly, Multifunction Flight Control Reference System (MFCRS), and Ada Based Integrated Control System. Particular attention is given to the flight test results and lessons learned during the MFCRS program and the incorporation of the U.S. Navy IISA advanced development model hardware into the Ada Based Integrated Controls Phase III Program. The goals of the ABICS program are discussed. K.K.

A88-35562#
A MODERN TOWER OF BABEL - INTEGRATION, TEST, AND EVALUATION OF INERTIALLY AIDED AVIONICS
NORMAN WALTON and STEVEN ZISKIND (Boeing Military Airplane Co., Seattle, WA) IN: Institute of Navigation, Annual Meeting, 43rd, Dayton, OH, June 23-25, 1987, Proceedings . Washington, DC, Institute of Navigation, 1987, p. 172-177.

Important considerations for the integration of inertially supported avionics are outlined. Attention is given to the following specific applications of inertial systems: (1) flight control, (2) SAR motion compensation, (3) IR sensor stabilization, and (4) coordinate frame alignment among sensors and transfer of data between different vehicles having similar sensor suites. Case studies are used to illustrate the problems which can arise when insufficient attention is paid to critical details of the integration task. K.K.

A88-36292
EVALUATION OF LASER TECHNOLOGIES FOR ON-AIRCRAFT WIND SHEAR DETECTION
STEPHEN E. MOODY (Spectra Technology, Inc., Bellevue, WA) IN: Laser radar II; Proceedings of the Meeting, Orlando, FL, May 19, 20, 1987 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1987, p. 124-131. Research supported by Spectra Technology, Inc. refs

Lidar has been established as a viable method for wind-shear detection, even in conditions of moderately heavy precipitation. The use of 10 microns as the detection wavelength improves detection in fog and clouds, while the use of a 2-micron detection wavelength offers a performance advantage in very clear air. The requisite eye-safe 2-micron solid state laser technology, however, is insufficiently developed for near-term use. In the immediate future, CO2 lasers appear to be well suited to wind shear detection. O.C.

A88-36380
FLIGHT TEST RESULTS OF THE KS-147A LOROP CAMERA IN THE RF-5E
ROBERT L. WALKE (Northrop Corp., Aircraft Div., Hawthorne, CA) and OBERT OSTREM (Recon/Optical, Inc., Barrington, IL) IN: Airborne reconnaissance XI; Proceedings of the Meeting, San Diego, CA, Aug. 17, 18, 1987 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1988, p. 51-59. refs

The RF-5E tactical reconnaissance aircraft incorporates the KS-147A Long Range Oblique Photography camera, whose design features encompass a 66-inch focal length, closed-loop autofocus, a gyrostabilized scan head, and a passive isolation mount. A self-contained thermal system stabilizes temperature-sensitive optics. Incorporation of this system has required the modification of the camera bay lower door with side-pointing windows, as well as the use of a new cockpit forward control panel and oblique sights. Attention is presently given to laboratory and flight test activities associated with the new system, including verification of the in-flight photo-resolution requirement of 70 line pairs/mm. O.C.

A88-36384
RIU - SPELLS COMMAND AND CONTROL FOR F-16(R)
W. FISHELL and C. FLOYD (Fairchild Communications and Electronics Co., Germantown, MD) IN: Airborne reconnaissance XI; Proceedings of the Meeting, San Diego, CA, Aug. 17, 18, 1987 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1988, p. 91-94.

As part of the USAF Advanced Tactical Air Reconnaissance System (ATARS), a pod-mounted sensor suite has been equipped with a Reconnaissance Interface Unit (RIU) to furnish command, control, and interfacing functions in the case of an F-16R platform aircraft. An existing AN/ASQ-172 was modified to include all required features in a single RIU, at whose heart is a single embedded microprocessor. Numerous and diverse system interface functions are performed by the RIU for ATARS; these encompass image motion compensation, sensor mode selection, clock and exposure setting determination, annotation data input, and the control of sensor doors, turret, and power. O.C.

N88-20304*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
THE DESIGN AND USE OF A TEMPERATURE-COMPENSATED HOT-FILM ANEMOMETER SYSTEM FOR BOUNDARY-LAYER FLOW TRANSITION DETECTION ON SUPERSONIC AIRCRAFT
HARRY R. CHILES May 1988 14 p Presented at the Aerospace Industries/Test Measurement Symposium, Albuquerque, N. Mex., 2-5 May 1988
(NASA-TM-100421; H-1451; NAS 1.15:100421) Avail: NTIS HC A03/MF A01 CSCL 01D

An airborne temperature-compensated hot-film anemometer system has been designed, fabricated, and used to obtain in-flight airfoil boundary-layer flow transition data by the NASA Ames-Dryden Flight Research Facility. Salient features of the anemometer include near constant sensitivity over the full flight envelope, installation without coaxial wiring, low-noise outputs, and self-contained signal conditioning with dynamic and steady-state outputs. The small size, low-power dissipation, and modular design make the anemometer suitable for use in modern high-performance research aircraft. Design of the temperature-compensated hot-film anemometer and its use for flow transition detection on a laminar flow flight research project are described. Also presented are data gathered in flight which is representative of the temperature-compensated hot-film anemometer operation at subsonic, transonic, and supersonic flight conditions. Author

N88-21158# Analytic Sciences Corp., Fairborn, Ohio.
ADVANCED AVIONICS SYSTEM ANALYSIS. MODULAR AVIONICS COST BENEFIT STUDY FORMULATION Final Report, Sep. 1983 - Jan. 1986
WILLIAM L. BEDZYK, DONALD R. CZECH, THOMAS J. DICKMAN, FRANK S. GRUBER, and JOHN F. MYERS Feb. 1987 77 p
(Contract F33615-83-C-1053)
(AD-A189019; TASC-J-5043; AFWAL-TR-87-1138) Avail: NTIS HC A05/MF A01 CSCL 09A

This is a technical baseline for a cost benefit analysis of optional features of an advanced modular avionics architecture for the mid-1990s. It provides an outline of a projected life cycle cost for alternate configurations for future avionics (including cost for implementation and supportability). 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.

A88-32800
CHANGE THE AIR FLOW - REDUCE THE FUEL FLOW

JAMES H. BRAHNEY Aerospace Engineering (ISSN 0736-2536), vol. 8, April 1988, p. 26-29.

Research is described which has shown that a movable nozzle wall is a viable and efficient means of effectively controlling the flow capacity of a radial turbine for rotorcraft. The best performing configuration includes straight nozzle sidewalls and a converging vaneless space. Similar performance results are obtained with either a movable hub wall or a shroud wall. A flexible metal wiper is an effective method for controlling leakage flow around the nozzle vanes. C.D.

A88-34085

AIRCRAFT NO-BREAK ELECTRICAL POWER TRANSFER

JOE BREIT (Sundstrand Corp., Sundstrand Aviation Electric Power, Rockford, IL) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 424-432.

Momentary power interruptions to electrical loads can occur during load transfers from ground to aircraft generator, auxiliary power unit to aircraft generator, etc.; these interruptions vary from 50 milliseconds maximum (MIL-STD-704) to 200 milliseconds maximum (CA-DO-160) in duration, and can affect digital computers, avionics, and communications systems. It is accordingly necessary to incorporate a no-break power feature. The basic steps in a typical transfer from ground or auxiliary power unit to aircraft power are described, together with the steps in a no-break transfer system, with attention to the operational features of each component involved. The need for energy storage circuits on sensitive equipment is eliminated. O.C.

A88-34087

CONCEPTUAL DESIGN OF AN ADVANCED AIRCRAFT ELECTRICAL SYSTEM (AAES)

WILLIAM R. OWENS, WILLIAM R. DUNCUMB, RONALD W. DOERFLER, ANDREA R. JANG (Sundstrand Corp., Rockford, IL), and ROBERT G. ZUEHLKE (McDonnell Douglas Corp., Saint Louis, MO) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 441-455.

A fault-tolerant aircraft electrical power system study has been conducted which addressed the number and rating of generators, cross-shafting, distribution architecture for both ac and dc feeders, load management system architecture and control, reliability aspects, and system parameter ranking. O.C.

A88-34088

DISTRIBUTED POWER PROCESSING CONCEPTS USING ON-CARD POWER CONVERSION FOR AVIONIC EQUIPMENT

C. P. HENZE (Unisys Corp., Saint Paul, MN) and H. C. MARTIN (Unisys Corp., Salt Lake City, UT) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 456-461.

A distributed power processing system that is suitable for VHSIC applications using on-card power conversion is described. A software-driven digital control system is discussed to address basic control issues and to increase the testability and the reliability of the distributed power processing system is described. Miniaturization issues are addressed. I.E.

A88-34089

DIGITAL CONTROLLER FOR A CYCLOCONVERTER LINK BRUSHLESS DC MOTOR PUMP DRIVE

STEPHEN F. GORMAN, JIMMIE J. CATHEY (Kentucky, University, Lexington), and JOSEPH A. WEIMER (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 462-469. refs

(Contract F33615-81-C-2011)

The design is presented of a multiple microprocessor-based discrete-time controller for a permanent-magnet brushless dc motor suitable for driving an aircraft fuel pump where the motor is fed from a variable-voltage, variable-frequency source through a midpoint cycloconverter link under synchronous envelope control. Subsequent buildup of a testbed model of the system and the formulation of a computer simulation are described. The computer model is used to make a comparison study of theoretically predicted and laboratory measured performance of the testbed drive while operated from a constant-voltage, constant-frequency source. Also, results of steady-state operation from a variable-voltage, variable-frequency source are given. I.E.

A88-34218

SOFTWARE DESIGN FOR THE FAULT TOLERANT ELECTRICAL POWER SYSTEM

JOHN H. ENTHOVEN, FREDERICK D. N. GOULD, CATHY P. HO, and TODD E. NEWELL (Boeing Military Airplane Co., Seattle, WA) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1475-1482.

(Contract F33615-85-C-2504)

A fault-tolerant electrical power system (FTEPS) being developed under Air Force contract F33615-85-C-2504 is described. The FTEPS design incorporates sufficient levels of redundancy and integration to provide, ultrahigh reliable electric power for flight-critical loads on a future fighter aircraft. The authors describe the software design for the FTEPS program, and the design issues that arose during software development. Primarily, they include the distributed processing control functions, MIL-STD-1553B data bus control, timing analysis, user interface, data management, processing efficiency, software transportability, adaptability, development, and problems associated with using Ada high-order language. I.E.

A88-34219

DESIGNING A FAULT TOLERANT ELECTRICAL POWER SYSTEM

MARK W. DIGE, PATRICK J. LEONG, and DAVID L. SOMMER (Boeing Military Airplane Co., Seattle, WA) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1483-1490.

A fault-tolerant electrical power system (FTEPS) has been designed in a way that incorporates levels of redundancy and integration sufficient to satisfy the reliable, ultrahigh electric power requirements of a future fighter aircraft. The FTEPS, which incorporates solid-state power controllers and digital processors to enhance fault tolerance and integration with other air vehicle systems, employs four split parallel generators of 60 kVA each; two generators are driven by each of the fighter's two engines through clutch-connected, airframe-mounted accessory drives. O.C.

A88-34581

RB.211 BIG FAN BROADENS APPEAL

GRAHAM WARWICK Flight International (ISSN 0015-3710), vol. 133, April 2, 1988, p. 22-27.

This year, the latest RB.211-524G turbofan was certificated at 58,000-lb thrust for the Boeing 747-400, and is believed to be capable of growth to 63,000-lb thrust. This article describes the general features of the RB.211 engine, together with special features of the RB.211-524G model. The RB.211 is considered to be the simplest engine in its class, which can be disassembled easily. It is also considered easily maintainable. The major new features of the 524G engine include a wide-chord fan (that eliminates the snubbers used previously to stabilize the blades), long-duct nacelle, and digital fuel control. A cutaway drawing of the RB.211-524G is included. I.S.

A88-34612#
EMERGING TECHNOLOGIES FOR LIFE-CYCLE MANAGEMENT OF TURBINE ENGINE COMPONENTS
A. K. KOUL, J.-P. IMMARIGEON, and W. WALLACE (National Aeronautical Establishment, Structure and Materials Laboratory, Ottawa, Canada) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 34, March 1988, p. 27-37. DND-supported research. refs

This paper reviews ongoing developments in gas turbine engine component lifing technologies. Novel NDI inspection techniques for microdamage detection in turbine engine components based on SANS, positron annihilation spectroscopy, and neutron diffraction are described. The limitations of these techniques have yet to be established, and much research and development work will be required before they can be commercialized. An emerging lifting procedure for low-cycle fatigue life-limited parts, based on defect tolerance and the application of fracture mechanics principles, is also outlined. The potential impact of these technologies on component life-cycle management and the cost of ownership of turbine engines is discussed. Author

A88-35505*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
DETERMINATION OF COMPRESSOR IN-STALL CHARACTERISTICS FROM ENGINE SURGE TRANSIENTS
CARL F. LORENZO, FRANCIS P. CHIARAMONTE, and CHARLES M. MEHALIC (NASA, Lewis Research Center, Cleveland, OH) Journal of Propulsion and Power (ISSN 0748-4658), vol. 4, Mar.-Apr. 1988, p. 133-143. Previously cited in issue 17, p. 2432, Accession no. A84-36959. refs

A88-35506#
FLOW VISUALIZATION STUDY OF TIP LEAKAGE FLOWS ACROSS CANTILEVERED STATOR BLADES
NATHAN G. ADAMS (Garrett Turbine Engine Co., Phoenix, AZ) and H. KENT HEPWORTH (Northern Arizona University, Flagstaff, AZ) Journal of Propulsion and Power (ISSN 0748-4658), vol. 4, Mar.-Apr. 1988, p. 144-151. Previously cited in issue 18, p. 2620, Accession no. A85-39620. refs

A88-35527
A SURVEY OF CURRENT PROBLEMS IN TURBOMACHINE AEROELASTICITY
F. SISTO (Stevens Institute of Technology, Hoboken, NJ) IN: Recent trends in aeroelasticity, structures, and structural dynamics; Proceedings of the R. L. Bisplinghoff Memorial Symposium, Gainesville, FL, Feb. 6, 7, 1986 . Gainesville, FL, University Presses of Florida, 1987, p. 48-62. refs

The history of turbomachine aeroelasticity is briefly reviewed, and current problems in this field are discussed. In particular, attention is given to the phenomena of rotating stall and stall flutter in axial turbomachines; system modes and mistuning; and compressibility effects. The usefulness of the finite element method in the structural description of blades, vanes, and disks is emphasized. Attention is also given to damping effects and applications of mechanical dampers of special high-damping materials, such as chromium-based stainless steels, composites, and laminates. V.L.

A88-35528* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EXPERIMENTAL CLASSICAL FLUTTER RESULTS OF A COMPOSITE ADVANCED TURBOPROP MODEL
O. MEHMED and K. R. V. KAZA (NASA, Lewis Research Center, Cleveland, OH) IN: Resent trends in aeroelasticity, structures, and structural dynamics; Proceedings of the R. L. Bisplinghoff Memorial Symposium, Gainesville, FL, Feb. 6, 7, 1986 . Gainesville, FL, University Presses of Florida, 1987, p. 62-74. Previously announced in STAR as N86-29271.

Experimental results are presented that show the effects of blade pitch angle and number of blades on classical flutter of a composite advanced turboprop (propfan) model. An increase in the number of blades on the rotor or the blade pitch angle is destablizing which shows an aerodynamic coupling or cascade effect between blades. The flutter came in suddenly and all blades vibrated at the same frequency but at different amplitudes and with a common predominant phase angle between consecutive blades. This further indicates aerodynamic coupling between blades. The flutter frequency was between the first two blade normal modes, signifying an aerodynamic coupling between the normal modes. Flutter was observed at all blade pitch angles from small to large angles-of-attack of the blades. A strong blade response occurred, for four blades at the two-per-revolution (2P) frequency, when the rotor speed was near the crossing of the flutter mode frequency and the 2P order line. This is because the damping is low near the flutter condition and the interblade phase angle of the flutter mode and the 2P response are the same. Author

A88-35530* Princeton Univ., N. J.
RECENT DEVELOPMENTS IN FLUTTER SUPPRESSION TECHNIQUES FOR TURBOMACHINERY ROTORS
O. O. BENDIKSEN (Princeton University, NJ) IN: Recent trends in aeroelasticity, structures, and structural dynamics; Proceedings of the R. L. Bisplinghoff Memorial Symposium, Gainesville, FL, Feb. 6, 7, 1986 . Gainesville, FL, University Presses of Florida, 1987, p. 87-100. refs
(Contract NAG3-308)

Recent research on passive flutter control techniques for rotors and cascades is reviewed. The proposed methods include the use of periodicity-breaking inperfections, aeroelastic tailoring, dry friction damping, and mode shape control. Numerical results are presented to illustrate the effectiveness of each method in controlling various types of flutter, and to evaluate the feasibility of incorporating the techniques in current and future technology rotors. Mistuning may be the only feasible approach for existing engines, but aeroelastic tailoring offers promising advantages for future engines. Author

A88-36711#
OPTIMAL CONTROL OF SUPERSONIC INLET/ENGINE COMBINATION
JIAHN-BO YARNG and YAN-SHEN GUAN (Northwestern Polytechnical University, Xian, People's Republic of China) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 11, Mar.-Apr. 1988, p. 137-145. refs

This paper applies the techniques of modern optimal control theory to the design of a control system for a two-input, two-output inlet/engine combination. The mathematical model of the integrated combination is formulated using an idea of flow matching of the inlet and the engine. The control problem is approached as a stochastic linear quadratic regulator problem. The state estimator is designed by a recursive eigenvalue-eigenvector method for a linear time-in-variant state equation. The results of a digital simulation for a NASA 48 cm inlet/J85 engine combination show that this design method is satisfactory. Author

A88-36744*# Sverdrup Technology, Inc., Middleburg Heights, Ohio.
STAEBL/GENERAL COMPOSITES WITH HYGROTHERMAL EFFECTS (STAEBL/GENCOM)
R. RUBINSTEIN (Sverdrup Technology, Inc., Middleburg Heights, OH) ASME, Transactions, Journal of Engineering for Gas Turbines and Power (ISSN 0022-0825), vol. 110, April 1988, p. 301-305. NASA-supported research. Previously announced in STAR as N88-13754.
(ASME PAPER 87-GT-77)

A computer code has been developed to perform structural optimization of turbine blades made from angle ply fiber composite laminates. Design variables available for optimization include geometric parameters such as blade thickness disribution and root chord, and composite material parameters such as ply angles and numbers of plies of each constituent material. Design constraints include resonance margins, forced response margins, maximum stress, and maximum ply combined stress. A general description of this code is given. Design optimization studies for typical blades are presented. Author

A88-36745*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
ADVANCED COMPOSITE TURBOPROPS - MODELING, STRUCTURAL, AND DYNAMIC ANALYSES
R. A. AIELLO and S. CHI (NASA, Lewis Research Center, Cleveland, OH) ASME, Transactions, Journal of Engineering for Gas Turbines and Power (ISSN 0022-0825), vol. 110, April 1988, p. 306-311. refs
(ASME PAPER 87-GT-78)
This paper presents a structural and dynamic analysis of a scaled-down wind tunnel model propfan blade made from fiber composites. This blade is one of a series of propfan blades that have been tested at the NASA Lewis Research Center wind tunnel facilities. The blade is highly swept and twisted and of the spar/shell construction. Due to the complexity of the blade geometry and its high performance, it is subjected to much higher loads and tends to be much less stable than conventional blades. The structural and dynamic analyses of the blade were performed using the NASA-Lewis COBSTRAN computer code. COBSTRAN is designed to generate the mesh and calculate the anisotropic material properties for composite blade analysis. Comparison of analytical and experimental mode shapes and frequencies are shown, verifying the model development and analysis techniques used. The methodologies and programs developed for this analysis are directly applicable to other propfan blades. Author

A88-36750#
VIBRATION AMPLITUDES OF MISTUNED BLADES
D. AFOLABI (Purdue University, Indianapolis, IN) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 110, April 1988, p. 251-257. refs
Due to the mistuning effect, the nominally identical blades on a rotor are forced to vibrate with greatly unequal amplitudes under certain circumstances. It is, therefore, desireable to have the capability of predicting the highest responding blades so that such blades may be instrumented during engine tests. However, the predictions of various investigators in this regard are apparently inconsistent. Usually, the inconsistency is attributed to differences in mathematical models. By using modal analysis, it is shown that the various results are really not in conflict, but merely reflect the local and contrasting features in the global characteristics of a typical bladed disk. Good agreement is obtained when the results of this study, which is based on a model with structural coupling, are compared with those of other investigators utilizing models with aerodynamic and structural coupling. It is concluded that if the primary resonance being excited is not in a 'crossover' zone, the highest responding blades are most likely to be those with extreme mistuning. Author

N88-20305# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
ENGINE FLOW SIMULATION FOR WIND TUNNEL TESTING AT NLR
W. B. DEWOLF 9 Feb. 1987 28 p Presented at the Symposium on Developments in Aircraft Propulsion, Haarlem, The Netherlands, 18 Mar. 1987
(NLR-MP-87011-U; B8729623; ETN-88-91737) Avail: NTIS HC A03/MF A01
Techniques for turbofan engine simulation like the blown nacelle and the turbo powered simulator are reviewed. Propeller model test techniques are discussed. ESA

N88-20306*# Hamilton Standard, Windsor Locks, Conn.
LARGE-SCALE ADVANCED PROP-FAN (LAP) Final Report
C. L. DEGEORGE 1988 255 p Original contains color illustrations
(Contract NAS3-23051)
(NASA-CR-182112; NAS 1.26:182112) Avail: NTIS HC A12/MF A01 CSCL 21E
In recent years, considerable attention has been directed toward improving aircraft fuel efficiency. Analytical studies and research with wind tunnel models have demonstrated that the high inherent efficiency of low speed turboprop propulsion systems may now be extended to the Mach .8 flight regime of today's commercial airliners. This can be accomplished with a propeller, employing a large number of thin highly swept blades. The term Prop-Fan has been coined to describe such a propulsion system. In 1983 the NASA-Lewis Research Center contracted with Hamilton Standard to design, build and test a near full scale Prop-Fan, designated the Large Scale Advanced Prop-Fan (LAP). This report provides a detailed description of the LAP program. The assumptions and analytical procedures used in the design of Prop-Fan system components are discussed in detail. The manufacturing techniques used in the fabrication of the Prop-Fan are presented. Each of the tests run during the course of the program are also discussed and the major conclusions derived from them stated. Author

N88-20307*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, Calif.
EXHAUST-GAS PRESSURE AND TEMPERATURE SURVEY OF F404-GE-400 TURBOFAN ENGINE
JAMES T. WALTON and FRANK W. BURCHAM, JR. Dec. 1986 32 p
(NASA-TM-88273; H-1375; NAS 1.15:88273) Avail: NTIS HC A03/MF A01 CSCL 21E
An exhaust-gas pressure and temperature survey of the General Electric F404-GE-400 turbofan engine was conducted in the altitude test facility of the NASA Lewis Propulsion System Laboratory. Traversals by a survey rake were made across the exhaust-nozzle exit to measure the pitot pressure and total temperature. Tests were performed at Mach 0.87 and a 24,000-ft altitude and at Mach 0.30 and a 30,000-ft altitude with various power settings from intermediate to maximum afterburning. Data yielded smooth pressure and temperature profiles with maximum jet temperatures approximately 1.4 in. inside the nozzle edge and maximum jet temperatures from 1 to 3 in. inside the edge. A low-pressure region located exactly at engine center was noted. The maximum temperature encountered was 3800 R. Author

N88-21159*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
PERFORMANCE IMPROVEMENTS OF AN F-15 AIRPLANE WITH AN INTEGRATED ENGINE-FLIGHT CONTROL SYSTEM
LAWRENCE P. MYERS and KEVIN R. WALSH May 1988 12 p Presented at the AIAA 4th Flight Test Conference, San Diego, Calif., 18-20 May 1988
(NASA-TM-100431; H-1470; NAS 1.15:100431) Avail: NTIS HC A03/MF A01 CSCL 21E
An integrated flight and propulsion control system has been developed and flight demonstrated on the NASA Ames-Dryden F-15 research aircraft. The highly integrated digital control (HIDEC) system provides additional engine thrust by increasing engine pressure ratio (EPR) at intermediate and afterburning power. The amount of EPR uptrim is modulated based on airplane maneuver requirements, flight conditions, and engine information. Engine thrust was increased as much as 10.5 percent at subsonic flight conditions by uptrimming EPR. The additional thrust significantly improved aircraft performance. Rate of climb was increased 14 percent at 40,000 ft and the time to climb from 10,000 to 40,000 ft was reduced 13 percent. A 14 and 24 percent increase in acceleration was obtained at intermediate and maximum power, respectively. The HIDEC logic performed fault free. No engine anomalies were encountered for EPR increases up to 12 percent and for angles of attack and sideslip of 32 and 11 degrees, respectively. Author

N88-21161*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NNEPEQ: CHEMICAL EQUILIBRIUM VERSION OF THE NAVY/NASA ENGINE PROGRAM
LAURENCE H. FISHBACH and SANFORD GORDON (Gordon, Sanford, Cleveland, Ohio) 1988 10 p Proposed for presentation at the 1988 International Gas Turbine and Aerospace Congress,

Amsterdam, Netherlands, 5-9 Jun. 1988; sponsored by ASME
(NASA-TM-100851; E-4050; NAS 1.15:100851) Avail: NTIS HC A02/MF A01 CSCL 21E

The Navy NASA Engine Program, NNEP, currently is in use at a large number of government agencies, commercial companies and universities. This computer code has bee used extensively to calculate the design and off-design (matched) performance of a broad range of turbine engines, ranging from subsonic turboprops to variable cycle engines for supersonic transports. Recently, there has been increased interest in applications for which NNEP was not capable of simulating, namely, high Mach applications, alternate fuels including cryogenics, and cycles such as the gas generator air-turbo-rocker (ATR). In addition, there is interest in cycles employing ejectors such as for military fighters. New engine component models had to be created for incorporation into NNEP, and it was found necessary to include chemical dissociation effects of high temperature gases. The incorporation of these extended capabilities into NNEP is discussed and some of the effects of these changes are illustrated. Author

N88-21162*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

EFFECT OF SPATIAL INLET TEMPERATURE AND PRESSURE DISTORTION ON TURBOFAN ENGINE STABILITY

CHARLES M. MEHALIC 1988 19 p Proposed for presentation at the 24th Joint Propulsion Conference, Boston, Mass., 11-13 Jul. 1988; sponsored by AIAA, ASEE, ASME and SAE
(NASA-TM-100850; E-4047; NAS 1.15:100850; AIAA-88-3016) Avail: NTIS HC A03/MF A01 CSCL 21E

The effects of circumferential and radial inlet temperature distortion, circumferential pressure distortion, and combined temperature and pressure distortion on the stability of an advanced turbofan engine were investigated experimentally at simulated altitude conditions. With circumferential and radial inlet temperature distortion, a flow instability generated by the fan operating near stall caused the high-pressure compressor to surge at, or near, the same time as the fan. The effect of combined distortion was dependent on the relative location of the high-temperature and low-pressure regions; high-pressure compressor stalls occurred when the regions coincided, and fan stalls occurred with the regions separated. Author

N88-21163*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

A MICROPROCESSOR-BASED REAL-TIME SIMULATOR OF A TURBOFAN ENGINE

JONATHAN S. LITT (Army Aviation Research and Development Command, Cleveland, Ohio.), JOHN C. DELAAT, and WALTER C. MERRILL 1988 16 p Presented at the 19th Annual Pittsburgh Conference on Modeling and Simulation, Pittsburgh, Pa., 5-6 May 1988; sponsored by ISA and IEEE
(NASA-TM-100889; E-4124; NAS 1.15:100889; AVSCOM-TR-88-C-011) Avail: NTIS HC A03/MF A01 CSCL 21E

A real-time digital simulator of a Pratt and Whitney F 100 engine is discussed. This self-contained unit can operate in an open-loop stand-alone mode or as part of a closed-loop control system. It can also be used in control system design and development. It accepts five analog control inputs and its sixteen outputs are returned as analog signals. Author

08

AIRCRAFT STABILITY AND CONTROL

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

A88-34015

MOTION OF A LIFTING BODY WITH AN EXTERNALLY SUSPENDED LOAD [DVIZHENIE NESUSHCHEGO TELA S GRUZOM NA VNESHNEI PODVESKE]

A. M. VOLODKO and A. IA. SEROV Akademiia Nauk SSSR, Izvestiia, Mekhanika Tverdogo Tela (ISSN 0572-3299), Jan.-Feb. 1988, p. 12-15. In Russian.

The problem considered here concerns the motion, in the atmosphere, of a system of rigid bodies consisting of the principal lifting body (helicopter) and a supported body (load) connected by means of a two-link suspension system (external suspension). Equations are obtained which describe the motion of the system. Results of a computer simulation for a specific example show that the dynamics of the relative motion of the supported body significantly affects the motion of the system. V.L.

A88-34077

FLIGHT PATH PLANNING UNDER UNCERTAINTY FOR ROBOTIC AIR VEHICLES

A. C.-C. MENG (Texas Instruments, Inc., Artificial Intelligence Laboratory, Dallas) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 359-366. refs

A path planning solution for autonomous air vehicles maneuvering in a large three-dimensional space is presented. The free-space model is based on the geometrical property of the obstacles known as a Voronoi Diagram. By interpreting the diagram into a spatially-oriented graph representing the skeleton of the free space, the find-path problem is solved by a path search on the graph. For the navigation-under-uncertainty problem, the proximity property is imposed on the edges of the graph and maintain the snapshot of the world that is safe at time t with instantaneous uncertainty r is maintained. Therefore, the vehicle always travels along an edge path proven to be collision-free. The system has been implemented and the performance is reported. I.E.

A88-34094*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

FLYING QUALITIES RESEARCH CHALLENGES

STEVEN M. SLIWA (NASA, Langley Research Center, Hampton, VA) and FRANK L. GEORGE (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 504-506. refs

Traditional flying qualities requirements for airplane dynamics are based on airplane modal response characteristics derived from linear small-perturbation analysis. These requirements are supported by a large experimental data base. The challenge to the flying qualities community is to demonstrate how flying qualities, the control system and aircraft configuration are still closely linked. This is evident in the definition of flying qualities and, as far as pilots are concerned, that flying qualities are still the measure of overall design success. I.E.

A88-34095* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

UPDATE 8501: A NEW SPECIFICATION FOR ROTORCRAFT HANDLING QUALITIES

DAVID L. KEY, CHRIS L. BLANKEN (NASA, Ames Research Center; U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA), and ROGER H. HOH (Systems Technology, Inc., Hawthorne, CA) (National Aerospace and Electronics Conference, 39th, Dayton, OH, May 18-22, 1987) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 507-522. refs

MIL-H-8501B is a mission-oriented rotorcraft handling-qualities specification which prescribes the desired vehicle command response as a function of the mission task and the usable visual cues. It covers failures and flight envelopes, like MIL-F-8785C, but adds a novel concept in compliance testing in the form of a set of flight demonstration maneuvers. The proponents of this proposed specification including the authors, recognize that there are still many topics that are inadequately covered by it; they argue that it is nonetheless a significant improvement and should be adopted. I.E.

A88-34096

AN EXAMPLE OF PRELIMINARY LONGITUDINAL FLYING QUALITIES DESIGN USING A FREQUENCY MATCHING METHOD

THOMAS A. GENTRY (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) and L. R. PUJARA (Wright State University, Dayton, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 523-529. refs

A preliminary longitudinal flying qualities design is presented using the YF-16 CCV airframe. The design is performed using a frequency matching method that chooses the coefficients of a controller with user-specified order. The method chooses the coefficients to match most closely a desired closed-loop frequency response. The design goal is to attain nominal values of short-period natural frequency and damping ratio within the respective ranges allowed by MIL-F-8785C and to minimize the equivalent time delay. I.E.

A88-34100

FOUR-DIMENSIONAL TRAJECTORY OPTIMIZATION WITH RISK MINIMIZATION FOR REAL TIME MISSION REPLANNING

JOHN R. MOORE and JOHN L. VIAN (Boeing Military Airplane Co., Wichita, KS) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 552-558. refs

Four-dimensional trajectory optimization techniques are developed that may be incorporated into an integrated vehicle management system (IVMS) for military aircraft. A discussion of trajectory generation requirements is presented along with an overview of the key functional areas of an IVMS. Vertical and lateral trajectory generation algorithms are independently developed using similar techniques based on singular perturbation theory. The standard vertical problem, using the direct operating costs of time and fuel, is expanded to include cost due to risk while in threat areas. A novel algorithm for lateral trajectory generation is developed which optimizes with respect to time, fuel, risk, and final position. In each case, reduced-order models along with appropriate assumptions permit static rather than dynamic optimization to better support real-time applications. I.E.

A88-34102* Boeing Military Airplane Development, Seattle, Wash.

METHODS FOR EVALUATING INTEGRATED AIRFRAME/PROPULSION CONTROL SYSTEM ARCHITECTURES

GERALD C. COHEN, CHARLES W. LEE (Boeing Military Airplane Co.,Seattle, WA), and DANIEL L. PALUMBO (NASA, Langley Research Center, Hampton, VA) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 569-575. refs (Contract NAS1-18099)

Methodology, analysis, and detailed design of integrated control system architectures suitable for high-performance aircraft of the 1990s are presented. A methodology, with supporting analytical tools, has been developed to provide system designers with the capability to specify candidate architectures and accurately predict their reliability and performance in the early stages of design development. The authors address the methodology and supporting tools. I.E.

A88-34106

NOTES ON 'THE ELECTRIC CONTROL OF LARGE AEROPLANES'

KEN THOMPSON (Lockheed-Georgia Co., Marietta) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 595-601. refs

The modern flight control system has become heavily electrical involving electric fly-by-wire input systems with multiple digital computers and redundant electrical systems. The hydraulic actuator is the last major nonelectrical element. In-depth analyses have been performed on the all-electric airplane concept, in which all the aircraft secondary power is generated electrically and the pneumatic and hydraulic systems are eliminated. The all-electric airplane offers many potential benefits including billions of dollars in life-cycle cost savings. I.E.

A88-34107

DEVELOPMENT OF AN ADVANCED PRIMARY FLIGHT CONTROL ELECTROMECHANICAL ACTUATOR

GRAHAM BRADBURY (Sundstrand Corp., Sundstrand Aviation Mechanical, Rockford, IL) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 602-607.

The world's first primary flight control electromechanical actuator (EMA) has been demonstrated aboard a C-141 USAF transport aircraft, where it effected the movements of the left-hand aileron. The two primary requirements for the EMA test program were that there be minimal impact on the existing aircraft interface, and that the design should employ technology from existing programs. Attention is given to actuator design features and installation details. Samarium-cobalt permanent magnet rotors are used. Compatibility with existing aircraft power supplies was demonstrated. O.C.

A88-34109#

QFT DIGITAL FLIGHT CONTROL DESIGN AS APPLIED TO THE AFTI/F-16

D. L. SCHNEIDER, I. M. HOROWITZ, and C. H. HOUPIS (USAF, Institute of Technology, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 616-623. refs

The authors develop and apply quantitative feedback theory in the discrete domain by employing the w' bilinear transformation. The application is to the AFTI/F-16 aircraft with three outputs: pitch rate (q), roll rate (p), and yaw rate (r) and driven with six inputs: two flaperons, two horizontal tails, vertical canard pair, and rudder. An approximate analog simulation replaces the w'-domain compensators with continuous ones, and gives satisfactory results. I.E.

A88-34111#

ACCURATE FLYING QUALITIES PREDICTION DURING LANDING USING LOOP SEPARATION PARAMETER

JAMES J. MARTZ (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) and DANIEL J. BIEZAD (USAF, Institute of Technology, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 634-641. refs

Loop separation parameter (LSP) is a method used to evaluate the flying qualities of landing aircraft. It combines classical root locus and frequency-response methods with simple and intuitive pilot models to predict expected pilot ratings for aircraft in the landing phase. The LSP method is applied as a predictive tool to both fighter-type and large aircraft configurations that are independent of the original database. The large aircraft are representative of transport, bomber, and highly augmented space shuttle configurations. Good correlation between LSP predicted and actual pilot ratings for landing is shown. In addition, insightful modifications to the original method lead to improved correlation for all aircraft configurations. Recommendations include the consideration of LSP for the flying qualities handbook. I.E.

A88-34112#

PARAMETER-ADAPTIVE MODEL-FOLLOWING FOR IN-FLIGHT SIMULATION

LUIS A. PINEIRO (USAF, Wright-Patterson AFB, OH) and DANIEL J. BIEZAD (USAF, Institute of Technology, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 642-650. refs

It is shown that the use of parameter-adaptive control techniques can be a highly effective way of maintaining a specified level of tracking performance by compensating for plant parameter variations. This offers the potential for increased fidelity for in-flight simulations. The effectiveness of the adaptive controller is demonstrated by designing a digital fast-sampling tracker controller in an explicit model-following configuration. The performance of the resulting system is excellent and demonstrates the relative advantages of adaptive controllers for in-flight simulation. I.E.

A88-34113

DESIGN OF ADAPTIVE DIRECT DIGITAL FLIGHT-MODE CONTROL SYSTEMS INCORPORATING RECURSIVE STEP-RESPONSE MATRIX IDENTIFIERS FOR HIGH-PERFORMANCE AIRCRAFT WITH NOISY SENSORS

B. PORTER and A. MANGANAS (Salford, University, England) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 651-657. refs

(Contract AF-AFOSR-85-0208)

It is shown that, by incorporating fast online recursive identifiers to provide updated step-response matrices for inclusion in digital proportional-integral derivative control laws, highly effective adaptive digital set-point tracking controllers can be readily designed for multivariable plants with noisy sensors. The effectiveness of such an adaptive controller is illustrated by the design of an adaptive direct digital flight-mode control system for the F-16 aircraft with noisy sensors. I.E.

A88-34117#

MULTIVARIABLE PI AND PID DIGITAL CONTROL LAW DESIGNS FOR A HIGH PERFORMANCE AIRCRAFT

ERIC K. MYERS (USAF, Operational Test and Evaluation Center, Kirtland AFB, NM), STUART N. SHELDON, and JOHN J. D'AZZO (USAF, Institute of Technology, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 677-683. refs

Multivariable output feedback digital control laws are designed for a high-performance aircraft in both the landing and normal configurations. Lateral aircraft dynamics are presented in state-space form for the design procedure. Responses of a proportional plus integral (PI) controller requiring inner loop compensation are compared to responses of a proportional plus integral plus derivative (PID) controller implementing only output feedback. The design encompasses control surface actuator dynamics, control surface deflection and rate limits, sensor dynamics, sensor noise, and computational time delay. Both PI and PID controllers provide comparable, robust designs; however, the PID controller is more sensitive to noise. I.E.

A88-34118#

A SUBSONIC ANALYSIS OF DIGITAL DATCOM USING SEVERAL FORWARD SWEPT WING CONFIGURATIONS

WILLIAM B. BLAKE (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) and DANIEL G. SHARPES (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 686-693. refs

Digital Datcom is evaluated as a tool for predicting the subsonic aerodynamic characteristics of forward-swept-wing aircraft. Comparisons are made with wing-alone and wing-body wind tunnel data as well as three complete configurations: two generic (one being sweptback) and the X-29. Good agreement between tested and predicted longitudinal and lateral-directional stability derivatives is noted but the zero-lift pitching moment is not well estimated for the X-29. Control derivative estimates match test data well, except for aileron-induced yawing moment. I.E.

A88-34862

COOPERATIVE RULE-BASED SYSTEMS FOR AIRCRAFT CONTROL

ROBERT F. STENGEL (Princeton University, NJ) and BRENDA L. BELKIN IN: IEEE Conference on Decision and Control, 26th, Los Angeles, CA, Dec. 9-11, 1987, Proceedings. Volume 3 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1934-1940. Navy-supported research. refs

(Contract DAAG29-84-K-0048)

The application of artificial-intelligence theory in the flight domain of a military aircraft is considered. Nine rule-based systems were implemented to demonstrate complex system cooperation in combat-aircraft operations. The organization of tasks within each rule-based system is described, and details of knowledge-base development and implementation are given. An interactive simulation testbed was developed to provide a realistic view of intersystem cooperation and pilot-system interaction. Single-processor emulations demonstrate cooperation of parallel rule-based systems. Software tools developed to aid in fast prototyping of rule-based systems are described. Search effort metrics were used to quantify and compare light- and heavy-workload phases of a combat mission. I.E.

A88-34871

EIGENSTRUCTURE ASSIGNMENT AND ITS APPLICATIONS TO THE DESIGN OF FLIGHT CONTROL SYSTEMS

GENG ZHENG (Nanjing Aeronautical Institute, People's Republic of China) IN: IEEE Conference on Decision and Control, 26th, Los Angeles, CA, Dec. 9-11, 1987, Proceedings. Volume 3 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 2037-2041.

Problems concerned with eigenstructure assignment of state feedback system have been studied. An important result regarding freedom in assigning a closed-loop system eigenstructure is given, and two novel algorithms assigning an eigenstructure with complex conjugate eigenvalues and/or with eigenvalues are presented. A practical flight-control-system example is presented. I.E.

A88-34915

AIRCRAFT FORE AND AFT MODAL SUPPRESSION SYSTEMS

C. B. TRAN, T. J. GOSLIN, J. K. HO, and A. CHAKRAVARTY (Boeing Commercial Airplane Co., Seattle, WA) IN: IEEE Conference on Decision and Control, 26th, Los Angeles, CA, Dec. 9-11, 1987, Proceedings. Volume 3 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 2337-2340.

The authors address the design procedure for a modal suppression system that can control fore and aft body oscillation of an aircraft in the presence of turbulence. Power spectral density (PSD) plots are shown comparing the performance of the airplane with the modal suppression system on and off. Substantial benefits are derived in terms of ride quality improvement when this modal suppression system is used in place of a conventional yaw damper. I.E.

A88-35367

ASSESSMENT OF DIGITAL FLIGHT-CONTROL TECHNOLOGY FOR ADVANCED COMBAT ROTORCRAFT

MARK B. TISCHLER (U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 17 p. refs

Single-pilot, nap-of-the-earth flight requirements for advanced military rotorcraft render digital flight control systems (DFCSs) critical to the mission success of advanced combat rotorcraft. DFCSs must be of high-bandwidth, full-authority, high-gain, multimode, multiply-redundant type; attention must accordingly be given to the bridging of the gap between current technology and that required by next-generation combat helicopters. It is stressed that frequency-domain analysis and design methods are essential for practical implementation of such DFCSs; both approximate and exact methods are presently demonstrated. O.C.

A88-35369

EFFECT OF HYSTERESIS ON THE PERFORMANCE OF A HIGHLY AUGMENTED FLIGHT CONTROL SYSTEM

DONALD G. CALDWELL and BRIAN J. WOOD (McDonnell Douglas Helicopter Co., Mesa, AZ) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 4 p.

This paper demonstrates the effect of hysteresis on the performance of a highly augmented fly-by-wire helicopter control system and shows that hysteresis need not be a problem with lower levels of augmentation. A describing function analysis demonstrates that the highly augmented system is more sensitive to hysteresis effects than the conventional rate command system because of its added integrations. These nonlinearities can become the limiting factor in attainable automatic hover hold precision. A linear compensation technique for nonlinearities is described and its effect on control system performance is demonstrated. Author

A88-35370

APPLICATION OF FREQUENCY AND TIME DOMAIN COST FUNCTIONALS TO ACTIVE VIBRATION CONTROL OF AN OH-6 HELICOPTER IN FORWARD FLIGHT

D. P. SCHRAGE, K. P. NYGREN, and M. E. WASIKOWSKI (Georgia Institute of Technology, Atlanta) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 8 p. Army-sponsored research. refs

Helicopter rotor vibration problems are presently addressed by means of active feedback control techniques. These have been demonstrated on a free flight-trimmed, coupled rotor-body OH-6 model simulation in forward flight with the dynamic systems coupler, or 'DYSCO', program. Optimal regulator algorithms are formulated in both the frequency and time domain, using the higher harmonic and individual blade control, respectively. The various control schemes are compared, and their effectiveness is discussed with a view to implementational recommendations. O.C.

A88-35377* Stanford Univ., Calif.

IMPLEMENTATION AND FLIGHT-TEST OF A MULTI-MODE ROTORCRAFT FLIGHT-CONTROL SYSTEM FOR SINGLE-PILOT USE IN POOR VISIBILITY

WILLIAM S. HINDSON (Stanford University, CA) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 22 p. refs
(Contract NCC2-106)

A flight investigation was conducted to evaluate a multi-mode flight control system designed according to the most recent recommendations for handling qualities criteria for new military helicopters. The modes and capabilities that were included in the system are those considered necessary to permit divided-attention (single-pilot) lowspeed and hover operations near the ground in poor visibility conditions. Design features included mode-selection and mode-blending logic, the use of an automatic position-hold mode that employed precision measurements of aircraft position, and a hover display which permitted manually-controlled hover flight tasks in simulated instrument conditions. Pilot evaluations of the system were conducted using a multi-segment evaluation task. Pilot comments concerning the use of the system are provided, and flight-test data are presented to show system performance. Author

A88-35378

AN EVALUATION OF A 4-AXIS DISPLACEMENT SIDE-ARM CONTROLLER IN A VARIABLE STABILITY HELICOPTER

M. SINCLAIR and M. MORGAN (National Aeronautical Establishment, Ottawa, Canada) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 5 p. refs

Results are presented from an evaluation of a four function, deflection side-stick controller in the NAE In-Flight Simulator. The new controller was assessed within various control system environments ranging from a primative direct drive control to several highly augmented command control modes. Pilot assessments and handling qualities ratings are presented and areas for improvement in the controller design are discussed. Author

A88-35379

IMPLEMENTATION OF FLY-BY-WIRE/FLY-BY-LIGHT EXPERIMENTAL FLIGHT CONTROL SYSTEM IN HELICOPTERS

JEFFREY T. BAKKEN (Honeywell, Inc., Military Avionics Div., Minneapolis, MN) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 13 p.

Three programs are currently evaluating and demonstrating the low-workload control laws, fly-by-wire/fly-by-light digital control systems, advanced redundancy management, and functional integration of navigation data with flight controls, of experimental military helicopters. It is found in the course of these programs that optical interconnection systems furnish improved system survivability, although substantial work remains to be done on optical position transducers. Tripple-channel digital flight control system architectures are noted to provide minimum weight in conjunction with adequate flight safety. O.C.

A88-35382

PERIODIC MODEL-FOLLOWING FOR THE CONTROL-CONFIGURED HELICOPTER

ROBERT M. MCKILLIP, JR. (Princeton University, NJ) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 13 p. refs

A technique for designing flight control systems for rotorcraft that allows inclusion of the periodic terms in the rotor dynamics equations is described. The method is based upon an extension of optimal control theory, and permits incorporation of desired response behavior in terms of a dynamic model of the ideal closed-loop system. It is shown that the procedure is numerically simple, requiring at most two integration passes through the linearized dynamics equations, representing two rotor cycles. Sample calculations are presented for a simplified two-bladed helicopter, indicating the various trends with choice of response model structure. Finally, implementation issues concerning the resulting periodic feedback structures are discussed. Author

A88-35389* Army Aviation Systems Command, Moffett Field, Calif.

PRELIMINARY RESULTS OF A FLIGHT INVESTIGATION OF ROTORCRAFT CONTROL AND DISPLAY LAWS FOR HOVER

MICHELLE M. ESHOW (U.S. Army, Aeroflightdynamics Directorate, Moffett Field, CA), EDWIN W. AIKEN (NASA, Ames Research Center, Moffett Field, CA), and WILLIAM S. HINDSON (Stanford University, CA) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 20 p. refs

A flight experiment designed to evaluate the effects of compatible versus incompatible display and control system response characteristics, and to evaluate a candidate display law design methodology, is described. The experiment was conducted on the NASA/Army CH-47B variable-stability helicopter using its model-following control system and a color, panel-mounted display. Three control response types representative of modern highly augmented rotorcraft and three corresponding sets of display dynamics were considered for three hover and low-speed tasks performed in simulated instrument conditions. Preliminary results based on pilot handling qualities ratings and comments indicate that performance and workload can be significantly affected by certain control and display combinations and that the display design methodology shows promise for improving the handling qualities of rotorcraft operating in conditions of low visibility. Author

A88-35391

X-WING FLY-BY-WIRE FLIGHT CONTROL SYSTEM TEST

EDWARD A. FREDERICKS, WILLARD J. HARRIS, and DOUGLAS C. SHIDLER (United Technologies Corp., Sikorsky Aircraft Div., Stratford, CT) . IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 6 p.

Complex fly-by-wire vehicle management systems present a challenge not only to the designers but also to the test engineering community. The challenge is to develop the test methodology, design the test facility, perform the testing, track the overall effort, process the test results and assist in the development and implementation of configuration management and quality control. An example of such a challenge is the current RSRA/X-Wing system being developed by Sikorsky Aircraft. This paper provides an overview of the airborne vehicle management system, a description of the test facility, the scope of testing including the test methodology, a look at the needs for configuration management and a summary of key observations that are pertinent to the validation test process. Author

A88-35392

QUALIFICATION TESTING OF AH64 FLY BY WIRE BACK UP CONTROL SYSTEM (BUCS)

S. S. OSDER (McDonnell Douglas Helicopter Co., Culver City, CA) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 10 p.

The AH64 Helicopter's Fly By Wire Back Up Control System was qualified using a combination of tests performed on the aircraft and in a closed loop validation facility. The Back Up Fly By Wire System concept is described and the test procedures used to qualify that system are reviewed. Some key technical issues relating to the control logic used to monitor system health and to detect the conditions requiring automatic Back Up Control engagement are discussed. Author

A88-35394

FLIGHT INVESTIGATION OF THE TRADEOFF BETWEEN AUGMENTATION AND DISPLAYS FOR NOE FLIGHT IN LOW VISIBILITY

ROGER H. HOH (Systems Technology, Inc., Hawthorne, CA), STEWART W. BAILLIE, and J. MURRAY MORGAN (National Aeronautical Establishment, Flight Research Laboratory, Ottawa, Canada) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 14 p. refs

Nap-of-the-earth environment helicopter operations will require the use of pilot vision aids. Attention is presently given to the interaction of such cockpit displays with aircraft handling qualities, as in the cases of visual cueing for low speed and hover, and the use of enhanced stabilization to compensate for the loss of essential cues. The present flight test experiments were conducted with a conventional helicopter and a variable stability helicopter, as well as electronically fogged lenses and night vision goggles with daylight training filters. Fine-grained cue texture is found to be more important than cues for large discrete objects, and even than field-of-view. O.C.

A88-35546* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

CONSTRAINED OPTIMIZATION TECHNIQUES FOR ACTIVE CONTROL OF AEROELASTIC RESPONSE

VIVEKANANDA MUKHOPADHYAY (NASA, Langley Research Center; George Washington University, Hampton, VA) IN: Recent trends in aeroelasticity, structures, and structural dynamics; Proceedings of the R. L. Bisplinghoff Memorial Symposium, Gainesville, FL, Feb. 6, 7, 1986 . Gainesville, FL, University Presses of Florida, 1987, p. 371-383. refs

Active control of aeroelastic response is a complex problem in which the designer usually tries to satisfy many design criteria which are often conflicting in nature. To further complicate the design problem, the state space equations describing this type of control problem are usually of high order, involving a large number of states to represent the flexible structure and unsteady aerodynamics. Control laws based on the standard Linear - Quadratic - Gaussian method are of the same high order as the aeroelastic plant and may be difficult to implement in the flight computer. To overcome this disadvantage a new approach was developed for designing low-order optimized robust control laws. In this approach, a nonlinear programming algorithm is used to search for the values of control law design variables that minimize a performance index while satisfying several inequality constraints that describe the design criteria on the stability robustness and responses. The method is applied to a gust load alleviation problem and a stability robustness improvement problem of a drone aircraft. Author

A88-36275#

ACTIVE CONTROL OF ASYMMETRIC FORCES AT HIGH INCIDENCE

YONGNIAN YANG, XINZHI YU, JIANYING LI, and ZONGDONG WANG (Northwestern Polytechnical University, Xian, People's Republic of China) Journal of Aircraft (ISSN 0021-8669), vol. 25, Feb. 1988, p. 190-192. refs

An active control system using a rotating nosecone for axisymmetric missile and aircraft airframes operating at high angle of attack, which may be subjected to strong asymmetric forces due to vortex wake asymmetry, was wind tunnel tested to ascertain the effectiveness of microcomputer control of the asymmetric force-alleviating nosecone spin rate in various flight conditions. It is found that the active control programs developed can automatically limit the side force on the model to its minimum magnitude. O.C.

A88-36713#

ADAPTIVE FILTERING OF BIODYNAMIC STICK FEEDTHROUGH IN MANIPULATION TASKS ON BOARD MOVING PLATFORMS

M. VELGER, A. GRUNWALD, and S. MERHAV (Technion - Israel Institute of Technology, Haifa) (Guidance, Navigation and Control Conference, Williamsburg, VA, Aug. 18-20, 1986, Technical Papers, p. 848-858) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 11, Mar.-Apr. 1988, p. 153-158. Previously cited in issue 23, p. 3411, Accession no. A86-47495. refs
(Contract F33615-82-C-0520)

A88-36714#
IDENTIFICATION OF PILOT DYNAMICS IN A SYSTEM WITH A CHOICE OF FEEDBACK STRUCTURES
NORIHIRO GOTO (Kyushu University, Fukuoka, Japan) and TAKUMI MATSUO (Japan Air Lines Co., Ltd., Tokyo) (Guidance, Navigation and Control Conference, Williamsburg, VA, Aug. 18-20, 1986, Technical Papers, p. 859-866) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 11, Mar.-Apr. 1988, p. 159-166. Research supported by Kyushu University. Previously cited in issue 23, p. 3411, Accession no. A86-47496. refs

N88-20308*# Boeing Commercial Airplane Co., Seattle, Wash.
INTEGRATED AUTOPILOT/AUTOTHROTTLE BASED ON A TOTAL ENERGY CONTROL CONCEPT: DESIGN AND EVALUATION OF ADDITIONAL AUTOPILOT MODES
KEVIN R. BRUCE NASA Apr. 1988 111 p
(Contract NAS1-16300)
(NASA-CR-4131; NAS 1.26:4131) Avail: NTIS HC A06/MF A01 CSCL 01C

An integrated autopilot/autothrottle system was designed using a total energy control design philosophy. This design ensures that the system can differentiate between maneuvers requiring a change in thrust to accomplish a net energy change, and those maneuvers which only require elevator control to redistribute energy. The system design, the development of the system, and a summary of simulation results are defined. Author

N88-21164# Instituto Nacional de Tecnica Aeroespacial, Esteban Terradas, Torrejon de Ardoz (Spain). Dept. de Estructuras y Materiales Estructurales.
SCALE MODEL DEVELOPMENT FOR AEROELASTICITY STUDIES [DESARROLLO DE MODELOS A ESCALA PARA ESTUDIOS AEROELASTICOS]
RAFAEL GONZALOUGARTE 1987 10 p In SPANISH; ENGLISH summary
(ETN-88-91887) Avail: NTIS HC A02/MF A01

Scale models were developed for aeroelastic research, including external stores and flutter active supression areas. The specific design of a C-101 wing model is detailed. The design is based on the application of similitude laws. The list of mass distribution required in the different segments is given. Drawings are presented. ESA

N88-21165# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung Flugversuchstechnik.
INVESTIGATIONS ON HIGHER HARMONIC BLADE PITCH CONTROL AT HELICOPTERS Ph.D. Thesis - Technische Univ., Brunswick, Fed. Republic of Germany
GERT LEHMANN Sep. 1987 155 p In GERMAN; ENGLISH summary
(DFVLR-FB-87-36; ISSN-0171-1342; ETN-88-91920) Avail: NTIS HC A08/MF A01; DFVLR, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, 51.50 Deutsche marks

An analytical linear model which describes vibration generation in the harmonics of helicopter rotor blade passage frequency in the low and moderate speed region are derived. For calculation of optimal control inputs for vibration reduction, different approaches are discussed. A vectorized quality criterion is used to show the control effectiveness and the couplings. The concept, hardware, and testing of a higher harmonic control system at a model rotor are described. 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.

A88-33056*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
VISUAL DISPLAY AND ALARM SYSTEM FOR WIND TUNNEL STATIC AND DYNAMIC LOADS
RICHARD D. HANLY (NASA, Ames Research Center, Moffett Field, CA) and JAMES T. FOGARTY (Raman Aeronautics, Inc., Palo Alto, CA) IN: International Instrumentation Symposium, 33rd, Las Vegas, NV, May 3-8, 1987, Proceedings . Research Triangle Park, NC, Instrument Society of America, 1987, p. 79-84. Previously announced in STAR as N87-20298.

A wind tunnel balance monitor and alarm system developed at NASA Ames Research Center will produce several beneficial results. The costs of wind tunnel delays because of inadvertent balance damage and the costs of balance repair or replacement can be greatly reduced or eliminated with better real-time information on the balance static and dynamic loading. The wind tunnel itself will have enhanced utility with the elimination of overly cautious limits on test conditions. The microprocessor-based system features automatic scaling and 16 multicolored LED bargraphs to indicate both static and dynamic components of the signals from eight individual channels. Five individually programmable alarm levels are available with relay closures for internal or external visual and audible warning devices and other functions such as automatic activation of external recording devices, model positioning mechanism, or tunnel shutdown. Author

A88-33058*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FLOATING FRAME GROUNDING SYSTEM
T. J. FORSYTH (NASA, Ames Research Center, Moffett Field, CA) IN: International Instrumentation Symposium, 33rd, Las Vegas, NV, May 3-8, 1987, Proceedings . Research Triangle Park, NC, Instrument Society of America, 1987, p. 95-103. refs

The development of a floating frame grounding system (FFGS) for the 40- by 80-foot low speed wind tunnel facility at the NASA Ames Research Center National Full Scale Aerodynamics Complex is addresssed. When electrical faults are detected, the FFGS ensures a ground path for the fault current. In addition, the FFGS alerts the tunnel operator when a mechanical foul occurs. K.K.

A88-33064*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FAN BLADE ANGLE SYSTEM FOR THE NATIONAL FULL-SCALE AERODYNAMIC COMPLEX
REGINALD F. KING (NASA, Ames Research Center, Moffett Field, CA) IN: International Instrumentation Symposium, 33rd, Las Vegas, NV, May 3-8, 1987, Proceedings . Research Triangle Park, NC, Instrument Society of America, 1987, p. 155-165.

An adjustable, fan-blade-angle-positioning system for use in a wind tunnel was designed and fabricated to control the airflow from rotating fans in the National Full-scale Aerodynamic Complex (NFAC) at Ames Research Center. The NFAC consists of two test sections, a 40- by 80-ft test section with a top airspeed rating of 300 knots and an 80- by 120-ft test section with a top airspeed rating of 110 knots. Author

A88-33065*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A DISTRIBUTED DATA ACQUISITION SYSTEM FOR AERONAUTICS TEST FACILITIES
DENNIS L. FRONEK, ROBERT N. SETTER, PHILIP Z. BLUMENTHAL, and ROBERT R. SMALLEY (NASA, Lewis Research Center, Cleveland, OH) IN: International Instrumentation

Symposium, 33rd, Las Vegas, NV, May 3-8, 1987, Proceedings . Research Triangle Park, NC, Instrument Society of America, 1987, p. 167-172. Previously announced in STAR as N87-16851.

The NASA Lewis Research Center is in the process of installing a new data acquisition and display system. This new system will provide small and medium sized aeronautics test facilities with a state-of-the-art real-time data acquisition and display system. The new data system will provide for the acquisition of signals from a variety of instrumentation sources. They include analog measurements of temperatures, pressures, and other steady state voltage inputs; frequency inputs to measure speed and flow; discrete I/O for significant events, and modular instrument systems such as multiplexed pressure modules or electronic instrumentation with a IEEE 488 interface. The data system is designed to acquire data, convert it to engineering units, compute test dependent performance calculations, limit check selected channels or calculations, and display the information in alphanumeric or graphical form with a cycle time of one second for the alphanumeric data. This paper describes the system configuration, its salient features, and the expected impact on testing. Author

A88-33066*# Sterling Federal Systems, Inc., Palo Alto, Calif.
DESIGN TECHNIQUES FOR DEVELOPING A COMPUTERIZED INSTRUMENTATION TEST PLAN
S. KAY BURNETT (Sterling Federal Systems, Inc., Palo Alto, CA), THEODORE J. FORSYTH, and EVERETT E. MAYNARD (NASA, Ames Research Center, Moffett Field, CA) IN: International Instrumentation Symposium, 33rd, Las Vegas, NV, May 3-8, 1987, Proceedings . Research Triangle Park, NC, Instrument Society of America, 1987, p. 173-186. refs

The development of a computerized instrumentation test plan (ITP) for the NASA/Ames Research Center National Full Scale Aerodynamics Complex (NFAC) is discussed. The objective of the ITP program was to aid the instrumentation engineer in documenting the configuration and calibration of data acquisition systems for a given test at any of four low speed wind tunnel facilities (Outdoor Aerodynamic Research Facility, 7 x 10, 40 x 80, and 80 x 120) at the NFAC. It is noted that automation of the ITP has decreased errors, engineering hours, and setup time while adding a higher level of consistency and traceability. K.K.

A88-33072
REAL TIME COMPUTER AIDED TESTING (CAT) - CONCEPTS AND TECHNIQUES
C. SCHIANO (Grumman Corp., Woodbury, NY) IN: International Instrumentation Symposium, 33rd, Las Vegas, NV, May 3-8, 1987, Proceedings . Research Triangle Park, NC, Instrument Society of America, 1987, p. 337-344.

The various requirements for CAT systems, data acquisition and transmission schemes, and various hardware/software data processing system architectures are discussed. An automated test system supporting vehicle and avionics flight testing is described as well as a test instrumentation system for developmental engine testing for the USAF; a computer centralization/modization program system for the U.S. Navy; and an automated data reduction system for research, development, and production testing for an engine manufacturer. The benefits of this type of testing are a reduction in the test cycle and a reduction in test articles. K.K.

A88-33689*# Teledyne Controls, Los Angeles, Calif.
DACS II - A DISTRIBUTED THERMAL/MECHANICAL LOADS DATA ACQUISITION AND CONTROL SYSTEM
BEHZAD ZAMANZADEH, WILLIAM F. TROVER (Teledyne Controls, Los Angeles, CA), and KARL F. ANDERSON (NASA, Flight Research Center, Edwards, CA) IN: ITC/USA/'87; Proceedings of the International Telemetering Conference, San Diego, CA, Oct. 26-29, 1987 . Research Triangle Park, NC, Instrument Society of America, 1987, p. 737-752.

A distributed data acquisition and control system has been developed for the NASA Flight Loads Research Facility. The DACS II system is composed of seven computer systems and four array processors configured as a main computer system, three satellite computer systems, and 13 analog input/output systems interconnected through three independent data networks. Up to three independent heating and loading tests can be run concurrently on different test articles or the entire system can be used on a single large test such as a full scale hypersonic aircraft. Thermal tests can include up to 512 independent adaptive closed loop control channels. The control system can apply up to 20 MW of heating to a test specimen while simultaneously applying independent mechanical loads. Each thermal control loop is capable of heating a structure at rates of up to 150 F per second over a temperature range of -300 to +2500 F. Up to 64 independent mechanical load profiles can be commanded along with thermal control. Up to 1280 analog inputs monitor temperature, load, displacement and strain on the test specimens with real time data displayed on up to 15 terminals as color plots and tabular data displays. System setup and operation is accomplished with interactive menu-driver displays with extensive facilities to assist the users in all phases of system operation. Author

A88-33693
DIGITAL TELEMETRY SYSTEMS FOR GAS TURBINE DEVELOPMENT
PETER RUSSHARD (Rolls-Royce, PLC, Derby, England) IN: ITC/USA/'87; Proceedings of the International Telemetering Conference, San Diego, CA, Oct. 26-29, 1987 . Research Triangle Park, NC, Instrument Society of America, 1987, p. 819-828.

The progressive development and application of three high simultaneous-channel-capacity digital telemetry systems in everyday use which enable a variety of parameters to be measured within the high 'g' environment of gas turbine rotors is described. Each of the three systems utilizes 'on-line' control facilities enhancing the overall capabilities by providing further selections, data validation, and calibration facilities. In the battery powered system, a 'sleep' mode is provided which extends the useful life of the batteries. K.K.

A88-34055
LABORATORY FACILITY FOR F-15E AVIONICS SYSTEMS INTEGRATION TESTING
MARK B. SMITH and GREGORY T. BOCHANTIN (McDonnell Douglas Corp., Saint Louis, MO) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 180-182. USAF-supported research.

A dedicated avionics integration laboratory facility at McDonnell Aircraft Company in St. Louis, Missouri is described. The facility consists of a closed laboratory area with forced cooling air, all necessary power, multiplex bus interconnections, discrete signal interfaces, and voice communication lines to other avionic lab areas. The major element of the facility is the avionic system integration bench (ASIB). The ASIB consists of two components; the central computer integration bench, and the controls and displays integration bench. The ASIB, with dedicated aircraft equipment installed, is the nucleus for all integration tests. The combinations of benches, systems, and software provides a flexible and capable integration tool. I.E.

A88-34064
CONTROL OF RASTER POSITIONAL MOVEMENT IN HIGH RESOLUTION MULTICOLOR PROJECTORS
JEFFREY A. ROSS (Systems Research Laboratories, Inc., Dayton, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 255-260.

Control of raster positional movement in high resolution multicolor projectors is a major design objective to meet performance requirements in flight simulation applications. These projectors are used to display highly detailed computer-generated images with specific application to flight simulation training scenarios. Simulator expense and high demand necessitates minimizing projector maintenance and providing long periods of uninterrupted flight simulation. The major source of undesired raster positional movement in raster scan and raster/calligraphic scan projectors are identified. In addition, a circuit application that effectively controls the error source is presented. I.E.

A88-35278

THREE-DIMENSIONAL STEREOGRAPHIC PICTORIAL VISUAL INTERFACES AND DISPLAY SYSTEMS IN FLIGHT SIMULATION

ALAN L. BRIDGES (Lockheed-Georgia Co., Marietta, GA) and JOHN M. REISING (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: True three-dimensional imaging techniques and display technologies; Proceedings of the Meeting, Los Angeles, CA, Jan. 15, 16, 1987 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1987, p. 102-111. refs

A development status evaluation is presented for easily modifiable three-dimensional stereographic pictorial display systems being used in a proprietary advanced cockpit display laboratory. The research being conducted by the laboratory encompasses the analysis and development of true three-dimensional pictorial formats representing the entire three-dimensional flight profile, as in the cases of terrain following/avoidance and air-to-air/air-to-surface weapons delivery. Stereo pairs are being generated by electrooptical shuttering systems, stereographic display systems, and high-performance pseudothree-dimensional computer graphics workstations. O.C.

A88-35280

THE MAINTENANCE OF THREE-DIMENSIONAL SCENE DATABASES USING THE ANALYTICAL IMAGERY MATCHING SYSTEM (AIMS)

STANFORD T. HOVEY (Autometric, Inc., Falls Church, VA) IN: True three-dimensional imaging techniques and display technologies; Proceedings of the Meeting, Los Angeles, CA, Jan. 15, 16, 1987 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1987, p. 138-145.

An account is given of a modular Analytical Image Matching System (AIMS) that allows digital three-dimensional terrain feature data to be derived from cartographic and imagery sources by a combination of automatic and man-machine techniques. AIMS facilitates the superposition of scenes of feature information in three dimensions over imagery for updating, and in turn, real-time operator interaction between a monoscopic digital imagery display, a digital map display, a stereoscopic digital imagery display, and automatically detected feature changes for the transfer of three-dimensional data from one coordinate system's frame-of-reference to another, for updating the scene-simulation database. O.C.

A88-36273#

INFLUENCE OF SUPPORT OSCILLATION IN DYNAMIC STABILITY TESTS

MARTIN E. BEYERS (National Aeronautical Establishment, Unsteady Aerodynamics Dept., Ottawa, Canada) Journal of Aircraft (ISSN 0021-8669), vol. 25, Feb. 1988, p. 178-183. Previously cited in issue 08, p. 1053, Accession no. A87-22506. refs

A88-36488

A MICROPROCESSOR BASED SYSTEM FOR WIND TUNNEL MEASUREMENTS

C. RAVIKUMAR, N. BALAKRISHNAN, and V. S. HOLLA (Indian Institute of Science, Bangalore, India) IN: ICIASF '87 - International Congress on Instrumentation in Aerospace Simulation Facilities, 12th, Williamsburg, VA, June 22-25, 1987, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 54-68. Research supported by the Aeronautical Research and Development Board. refs

A 16-bit-microprocessor-based system has been designed and developed for automatic flow-field pressure survey and force measurements in a low-speed wind tunnel. The instrumentation subsystems that are required for the above measurements and the software are described. The software was designed to provide friendly and reconfigurable integrated instrumentation, and to ensure real-time data acquisition, online pre-processing, and storage of the data on a floppy disk. Software for presenting the data in color graphics using a microcomputer is also described. I.E.

A88-36519* Madison Magnetics, Inc., Wis.

MAGNETIC SUSPENSION AND BALANCE SYSTEM (MSBS) ADVANCED STUDY.I - SYSTEM DESIGN

ROGER W. BOOM, MOSTAFA K. ABDELSALAM, YEHIA M. EYSSA, and GLEN E. MCINTOSH (Madison Magnetics, Inc., WI) IN: ICIASF '87 - International Congress on Instrumentation in Aerospace Simulation Facilities, 12th, Williamsburg, VA, June 22-25, 1987, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 295-307. refs
(Contract NAS1-17931)

A magnetic suspension and balance system is designed to support models of aircraft or other objects in wind tunnels by means of magnetic forces. Major design improvements have been achieved, resulting in reductions of the system size, weight, and cost. These improvements are due to: (1) the use of holmium in the model core to increase its magnetic moment, (2) the use of a powerful new permanent magnet material in the model wings, (3) a new arrangement for the roll coils, and (4) the use of a nonmetallic structure to eliminate eddy current losses. The conceptual design of the holmium core superconductive solenoid and of the new permanent magnet wing assembly is described in detail. The discussion includes comparisons of the pole strengths for different model core magnets, the design of a superconducting solenoid and cryostat, and the analysis of model wing magnetic requirements. B.J.

A88-36522* Old Dominion Univ., Norfolk, Va.

DIGITAL CONTROL OF WIND TUNNEL MAGNETIC SUSPENSION AND BALANCE SYSTEMS

COLIN P. BRITCHER (Old Dominion University, Norfolk, VA), MICHAEL J. GOODYER, JONATHAN ESKINS, DAVID PARKER, and ROBERT J. HALFORD (Southampton, University, England) IN: ICIASF '87 - International Congress on Instrumentation in Aerospace Simulation Facilities, 12th, Williamsburg, VA, June 22-25, 1987, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 334-342. SERC-supported research. refs
(Contract NAS1-17993-24; NAG1-716; NSG-7523)

Digital controllers are being developed for wind tunnel magnetic suspension and balance systems, which in turn permit wind tunnel testing of aircraft models free from support interference. Hardware and software features of two existing digital control systems are reviewed. Some aspects of model position sensing and system calibration are also discussed. I.E.

A88-36531

B-1B CENTRALIZED TEST PROGRAM SET (TPS) INTEGRATION FACILITY (CTIF) - CONCEPT AND STATUS REPORT

DAVE FRANKE (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH), B. L. POE (Rockwell International Corp., Columbus, OH), K. H. LEDFORD (Emerson Electric Co., Columbus, OH), and CRAIG STOLDT (GT&T Industries, Westgate Village, CA) IN: AUTOTESTCON '87; Proceedings of the International Automatic Testing Conference, San Francisco, CA, Nov. 3-5, 1987 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 11-22.

The B-1B CTIF was conceived and instituted to reduce B-1B program organic support costs and to consolidate TPS development and integration efforts for approximately 1400 depot units under test at a single site using the US Air Force Modular Automatic Test Equipment (MATE) concept and the Emerson Electric Company (EEC) depot automatic test system for avionics (DATSA). This concept of TPS integration will bring under one facility approximately 20 individual contractors, all with separate B-1B contracts, 22 B-1B DATSA test stations, two DATSA program development stations (PDS), six B-1B intermediate automatic test equipment (IATE), and various compiler supporting systems. The authors discuss all of the functions of CTIF, where it was designed, its organization, overall requirements, training program, facilities and support, and its current status. I.E.

A88-36554
NEW CONCEPTS IN THE AUTOMATED TESTING OF HYDROMECHANICAL JET ENGINE FUEL CONTROLS
CHARLES R. HALL, JR. and KEVIN L. JOZWIAK (Allied-Signal Aerospace Co., Bendix Energy Controls Div., South Bend, IN) IN: AUTOTESTCON '87; Proceedings of the International Automatic Testing Conference, San Francisco, CA, Nov. 3-5, 1987 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 213-216.

The topics discussed by the authors center around integrating not only the test equipment hardware and software, but also the testing process in general. Expanding the concept of a unit under test to encompass the test equipment itself results in reusable executive software. In addition, it provides a consistent application code that can be used for engine control testing as well as for test-system calibration and maintenance. The use of the Ada programming language for application code is also discussed. I.E.

A88-36557
MAINTENANCE SUPPORT EQUIPMENT FOR MULTI-NATIONAL COLLABORATIVE PROGRAMMES
G. MILLOY (RAF, London, England) IN: AUTOTESTCON '87; Proceedings of the International Automatic Testing Conference, San Francisco, CA, Nov. 3-5, 1987 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 227-232.

The author addresses the problems associated with provision of maintenance support facilities for multinational projects. The rising costs associated with introducing technologically state-of-the-art weapon systems has meant that it becomes increasingly attractive to share the development costs of such projects among several partner governments. The author examines the maintenance support problems that arise because the test equipment and other aspects of the maintenance environment must address the needs of different nations' armed forces from the outset. I.E.

N88-20310# Bristol Univ. (England). Dept. of Aerospace Engineering.
A WIND TUNNEL MODEL WITH DYNAMIC CONTROL B.E. Thesis
A. ANDERSON and P. HANNAH Jun. 1987 42 p
(BU-352; ETN-88-91892) Avail: NTIS HC A03/MF A01

The use of a wind tunnel model for demonstrating how active control can augment stability of an unstable configuration is evaluated. A deliberately unstable delta wing with canard combination was tested. Interactive programs in two microcomputers are used to implement a pitch rate feedback controller with variable gains and motion display. A computer simulation package helps to compare flight test results with theoretical responses. Adequate performance of the system is achieved with similarities in frequency response and damping ratios, although more sensitive actuation of control surfaces and a reduction in friction in the model suspension would improve the reality of response when concentrating on the short period mode. ESA

N88-20311# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Large Testing Facilities Dept.
ACTIVITIES REPORT OF THE LARGE TESTING FACILITIES DEPARTMENT Annual Report, 1986
Sep. 1987 34 p Original contains color illustrations
(ETN-88-91982) Avail: NTIS HC A03/MF A01

Airbus A320 tests; preparatory testing for the Airbus A340; a balance for testing the motorized A320; store separation tests under fighters; flow survey in a fighter air intake; effects of protuberances from the surface of Ariane 4 on the aerodynamic coefficients of the launch vehicle; upgrading of the wind tunnel for Hermes tests; and breakage of a wind tunnel fan blade are discussed. ESA

N88-21167# Bristol Univ. (England). Dept. of Aerospace Engineering.
DETERMINATION OF CANOPY LOADS FOR A LIGHT AIRCRAFT BY WIND TUNNEL TESTING AND COMPUTER MODELLING B.E. Thesis
T. W. CHAPMAN and T. H. A. LAM Jun. 1987 56 p
(BU-353; ETN-88-91893) Avail: NTIS HC A04/MF A01

The airflow over the canopy of the ARV Super 2 was investigated to determine the resulting loads. Wind tunnel tests used a powered model, whereas computer modeling was only for unpowered flight cases with inviscid flow. Results for the entire range of flight conditions, including power setting are presented. The two methods are compared for both pressure distributions and force coefficients on the canopy. Normal force is seen to be the greatest force acting, overshadowing both side and longitudinal forces. Normal force increases rapidly with velocity and g loading, and also with power setting. The greatest canopy loads occur therefore, at the maximum velocity, power setting, and g loading. The results are applicable to all single-engined, high wing light aircraft. ESA

N88-21168# Imperial Coll. of Science and Technology, London (England). Dept. of Aeronautics.
THE 30 X 30 INCH WIND TUNNEL
A. D. CUTLER and P. BRADSHAW Jun. 1987 15 p
(IC-AERO-87-01; ISSN-0308-7247; ETN-88-91914) Avail: NTIS HC A03/MF A01

A 30 x 30 in. (0.76 x 0.76 m) blower tunnel was improved. The flow in the working section is of good quality, with a free-stream turbulence level of 0.2 percent and total-pressure variations of less than 2 percent over the cross section. These appear to be the best figures obtainable from a blower tunnel with a contraction ratio of only 4:1. Calibration details and advice for operators of this and similar tunnels are included. ESA

N88-21169*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
DEVELOPMENT OF AN INTEGRATED SET OF RESEARCH FACILITIES FOR THE SUPPORT OF RESEARCH FLIGHT TEST
ARCHIE L. MOORE and CONSTANCE D. HARNEY May 1988 17 p Presented at the AIAA 4th Flight Test Conference, San Diego, Calif., 18-20 May 1988
(NASA-TM-100427; H-1458; NAS 1.15:100427; AIAA-88-2095) Avail: NTIS HC A03/MF A01 CSCL 14B

The Ames-Dryden Flight Research Facility (DFRF) serves as the site for high-risk flight research on many one-of-a-kind test vehicles like the X-29A advanced technology demonstrator, F-16 advanced fighter technology integration (AFTI), AFTI F-111 mission adaptive wing, and F-18 high-alpha research vehicle (HARV). Ames-Dryden is on a section of the historic Muroc Range. The facility is oriented toward the testing of high-performance aircraft, as shown by its part in the development of the X-series aircraft. Given the cost of research flight tests and the complexity of today's systems-driven aircraft, an integrated set of ground support experimental facilities is a necessity. In support of the research flight test of highly advanced test beds, the DFRF is developing a network of facilities to expedite the acquisition and distribution of flight research data to the researcher. The network consists of an array of experimental ground-based facilities and systems as nodes and the necessary telecommunications paths to pass research data and information between these facilities. This paper presents the status of the current network, an overview of current developments, and a prospectus on future major enhancements. Author

N88-21171# Technische Univ., Berlin (West Germany). Inst. fuer Luft und Raumfahrt.
DESIGN OF A SOUND NECK IN CONNECTION WITH THE MODEL-SUPPORT SYSTEM OF A TRANSONIC WIND TUNNEL TEST SECTION [GESTALTUNG DES SCHALLHALSES IN VERBINDUNG MIT DEM MODELL-SUPPORT-SYSTEM EINER TRANSSONIK WINDKANAL-MESSTRECKE]
H.-G. LUXA and U. GANZER Sep. 1987 74 p In GERMAN
(Contract DFG-GA-123/26-1)
(ILR-MITT-186(1987); ETN-88-91446) Avail: NTIS HC A04/MF A01

A wind tunnel concept whereby the support sting as central compression body is connected to the second constriction (neck), was investigated with a view to the reduction of the effects of perturbations in the support arrangement on the model flow. The sound neck configuration consists of a fixed-geometry sting profile and variable wind tunnel walls. The efficiency of this arrangement was verified. The production of perturbations by the profile body, and their suppression by the sound necking at the sting are demonstrated. ESA

N88-21174 British Aerospace Aircraft Group, Preston (England).
DETAILS OF LOW SPEED INTAKE TEST FACILITY AT THE WARTON (UNITED KINGDOM) 2.7M X 2.1M WIND TUNNEL
30 Jan. 1986 7 p
(AXM-127; ETN-88-91071) Avail: British Aerospace PLC, Military Aircraft Division, Warton Aerodrome, Preston PR4 1AX, United Kingdom

An intake/suction rig was designed in order to assess: (1) Inlet internal performance and engine face flow quality by simultaneous measurement of pressure recovery, time variant distortion, swirl and turbulence, for the full range of flight conditions from static/ground running to low speed, and particularly the critical subsonic high incidence and sideslip combinations; (2) Inlet duct performance and flow quality by using an appropriate bellmouth; (3) Intake performance including simulation of the duct, heat exchanger and ejector, with comprehensive diagnostic instrumentation; and (4) Air data system performance. The rig consists of a twin compressed air powered ejector to power the two inlets; a strut mounted keelplate which can be easily adapted to carry various models (typically at 1/5th scale); a comprehensive, 152 mm dia, A/P rake. The 2.7 m x 2.1 m wind tunnel, using this rig, gives speeds from 0 to 45 m/sec and a full range of alpha (-10 to +70 deg) and beta (-15 to +15 deg) to cover all flight conditions in one facility. ESA

N88-21176# Royal Air Force Coll., Cranwell (England). Dept. of Transport Technology.
DESIGN OF A SUPERSONIC WIND TUNNEL M.S. Thesis
COLIN WILLIAM HAMILTON 1987 135 p
(ETN-88-92078) Avail: NTIS HC A07/MF A01

The possibility of using an existing high pressure air supply to drive a supersonic wind tunnel was verified, and a tunnel was designed. Comparison of the direct drive and induced flow tunnels shows that an induced flow design is significantly larger and, therefore, more suitable for the demonstration use intended. After considering wind tunnel features including nozzle geometry, working section layout, injector box design, diffuser performance, and boundary layer effects, the design of an induced flow wind tunnel evolved. The design consists of a supersonic demonstration tunnel operating at Mach 1.6 with a working section which has a cross-section of 1.875 by 0.8 in. ESA

N88-21177*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
THE NASA INTEGRATED TEST FACILITY AND ITS IMPACT ON FLIGHT RESEARCH
D. A. MACKALL, M. D. PICKETT, L. J. SCHILLING, and C. A. WAGNER May 1988 16 p Presented at the 4th Flight Test Conference, San Diego, Calif., 18-20 May 1988
(NASA-TM-100418; H-1446; NAS 1.15:100418) Avail: NTIS HC A03/MF A01 CSCL 14B

The Integrated Test Facility (ITF), being built at NASA Ames-Dryden Flight Research Facility, will provide new test capabilities for emerging research aircraft. An overview of the ITF and the challenges being addressed by this unique facility are outlined. The current ITF capabilities, being developed with the X-29 Forward Swept Wing Program, are discussed along with future ITF activities. Author

N88-21178# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
F-16 SIMULATOR FOR MAN-IN-THE-LOOP TESTING OF AIRCRAFT CONTROL SYSTEMS (SIMTACS) M.S. Thesis
MARK W. KASSAN Dec. 1987 176 p
(AD-A189675; AFIT/GE/ENG/87D-30) Avail: NTIS HC A09/MF A01 CSCL 01D

The focus of this project is the development of a real-time flight simulator for man-in-the-loop evaluation of flight control system designs. The F-16A is the simulated aircraft and a simplified F-16 digital flight control system is used. The simulations model nonlinear aerodynamic data over most of flight envelope and nonlinear inertially cross-coupled aircraft dynamics. The simulator is implemented on two Electronic Associates, Inc. SIMSTAR hybrid computer systems and an initial cockpit is designed for human pilot interactions. The simulated aircraft dynamic behavior is validated using AFTI/F-16 closed-loop time responses provided by the Air Force Flight Dynamics Laboratory. The real-time, man-in-the-loop simulator is designed using the SIMSTAR computer systems. Currently, the simulator performance is limited in the speed of response. This temporary lack of speed is the result of the computational limitations of the current digital processors of the SIMSTAR computer systems. These limitations can be removed with hardware upgrades. GRA

N88-21351# Joint Publications Research Service, Arlington, Va.
CHINA CONSTRUCTING HIGH-ALTITUDE TEST CELL
DAXIANG LIU and HANZHONG ZHOU *In its* JPRS Report: Science and Technology. China p 1-5 29 Oct. 1987 Transl. into ENGLISH from Guoji Hangkong (Beijing, Peoples Republic of China), no. 6, Jun. 1987 p 20-21, 56
Avail: NTIS HC A06/MF A01

A high altitude test cell is being constructed in China with continuous air supply. In an effort to develop China's aviation industry, considerable design and preparation work had been done before a decision was reached to begin construction. The tuning and testing equipment and system performance began in 1980; the results showed that design requirements were met. Initially, the test cell was used to conduct tests of direct engine exhaust into the atmosphere. In particular, the high altitude performance tests of a certain engine in a uniform flow field and its certification test in a distorted flow field were successfully completed. Now the second phase of the construction has begun, and the entire facility is expected to be completed and ready for service shortly. Author

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ASTRONAUTICS

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

N88-20344*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, Calif.
DEVELOPMENT OF AN INTERACTIVE REAL-TIME GRAPHICS SYSTEM FOR THE DISPLAY OF VEHICLE SPACE POSITIONING
ROBERT COMPERINI and DONALD C. RHEA May 1988 15 p Prepared for presentation at the 4th Flight Test Conference, San

Diego, Calif., 18-20 May 1988
(Contract NAS2-12591)
(NASA-TM-100429; H-1460; NAS 1.15:100429; AIAA-88-2167)
Avail: NTIS HC A03/MF A01 CSCL 09F

Outlined is a new approach taken by the NASA Western Aeronautical Test Range to display real-time space positioning data using computer-generated images that produce a graphic representation of an area map integrated with the research flight test aircraft track. This display system supports research flight test requirements of research projects such as the advanced fighter technology integration (AFTI) F-16, F-18 high alpha research vehicle (HARV), AFTI F-111 mission adaptive wing (MAW), F-15, and X-29A forward-swept wing. This paper will discuss the requirements, system configuration and capability, and future system applications. Author

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CHEMISTRY AND MATERIALS

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

A88-32825
USE OF TIME-OF-FLIGHT C-SCANNING FOR ASSESSMENT OF IMPACT DAMAGE IN COMPOSITES
T. E. PREUSS and G. CLARK (Defence Science and Technology Organisation, Aeronautical Research Laboratories, Melbourne, Australia) Composites (ISSN 0010-4361), vol. 19, March 1988, p. 145-148. refs

A time-of-flight ultrasonic C-scanning technique for the detection, sizing, and characterization of defects in carbon fiber composite structures is presented with emphasis on aerospace applications. An implementation of the method is described, and it is shown that the method is capable of providing a detailed display of the layer-by-layer structure of impact damage in composite materials. The system is currently used to monitor damage growth in laboratory tests on aircraft and skin laminates. V.L.

A88-32979
DEVELOPMENT OF RAPID CURE ADHESIVE FOR NAVAL AIRCRAFT FIELD REPAIR APPLICATIONS
R. SCOTT RIEFLER and WARREN D. STEINMETZ (American Cyanamid Co., Havre de Grace, MD) IN: International SAMPE Technical Conference, 19th, Crystal City, VA, Oct. 13-15, 1987, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1987, p. 24-35. Research supported by the Grumman Aerospace Corp. refs
(Contract N62269-85-C-0250)

A program has been instituted by the U.S. Navy for the evaluation of current and emerging adhesives technologies, in order to identify at least one adhesive system capable of developing enough strength to repair advanced composite structures under field conditions. These conditions encompass 1 year of storage at ambient temperature; acceptable mechanical strength must develop within a total cure envelope of two hours, using vacuum pressure processing at temperatures not greater than 149 C. FM 250/CA 3, which is a single-component adhesive system, meets these requirements. O.C.

A88-32992
WATER BASED PRIMERS FOR STRUCTURAL ADHESIVE BONDING OF AIRCRAFT
A. V. POCIUS and T. H. WILSON, JR. (3M Co., Adhesives, Coatings and Sealers Div., Saint Paul, MN) IN: International SAMPE Technical Conference, 19th, Crystal City, VA, Oct. 13-15, 1987, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1987, p. 177-189. refs
(Contract F33615-86-R-5009)

Physical characteristics, coating characteristics and performance characteristics of three new primers useful for structural adhesive bonding of aircraft are discussed. The most evident characteristic of these new primers is that they are primarily water vehicled primers in contrast to today's primers which are primarily solvent vehicled. Thus, these primers meet the stricter pollution control regulations now found in many states. Two of these primers, XB-3982, and XB-3983, can be spray applied using conventional methods and provide performance characteristics equivalent to today's solvent vehicled primers. Thus, these new primers can directly replace their solvent based analogs. The third primer, XA-3995, is a cathodic electrophoretically applied structural adhesive bonding primer. This primer is primarily water vehicled and provides good high temperature performance. In addition, the cathodic electrophoretic application method allows for uniform, reproducible application of thin coatings of primer with very efficient utilization of material. Author

A88-32999
ADHESIVE BONDING OF THERMOPLASTIC COMPOSITES. I - THE EFFECT OF SURFACE TREATMENT ON ADHESIVE BONDING
SZU-I. WU, ANN M. SCHULER, and DAN V. KEANE (Lockheed-California Co., Burbank) IN: International SAMPE Technical Conference, 19th, Crystal City, VA, Oct. 13-15, 1987, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1987, p. 277-290. refs

The effect of prebond surface treatment on the strength of graphite/PEEK composite bonding has been investigated. The chemical characteristics of the treated composite surfaces were studied using Electron Spectroscopy for Chemical Analysis (ESCA). The surface morphology was observed by means of Scanning Electron Microscope (SEM). Correlations between composite surface properties and adhesive bond strength were made to further understand surface characteristics that promote good bond adhesion. Author

A88-33023
EVALUATION AND KINEMATICS OF THE PREPREG RHEOLOGICAL CURVE
CLYDE FORD and FREDRICK W. KRAUSHAAR (Rockwell International Corp., Tulsa, OK) IN: International SAMPE Technical Conference, 19th, Crystal City, VA, Oct. 13-15, 1987, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1987, p. 609-618. refs

The rheological curve produced by a prepreg material under a constant temperature increase can be divided into three phases: (1) a gradual softening/melting of the matrix resin to maximum fluidity; (2) straightforward polymerization, characterized by a linear increase in average polymer molecular weight as a function of temperature increase (with observed decreases in polymerization rate serving as an index of previous matrix resin staging); and (3) a sharper increase in molecular weight/unit increase in temperature. The last phase is a result of an abrupt change in polymerization reaction mechanism with much more interlaminar cross-linking as the material approaches gelation. O.C.

A88-33028
SEMI-INTERPENETRATING POLYMER NETWORKS AS A ROUTE TO TOUGHENING OF EPOXY RESIN MATRIX COMPOSITES
M. S. SEFTON, P. T. MCGRAIL, J. A. PEACOCK, S. P. WILKINSON, R. A. CRICK (ICI, PLC, Cleveland, England) et al. IN: International SAMPE Technical Conference, 19th, Crystal City, VA, Oct. 13-15, 1987, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1987, p. 700-710. refs

One approach to toughening of brittle thermosetting systems is to prepare a blend of a thermoset with a high performance polyaromatic thermoplastic. The properties of such a system are reported in this paper, for blends of epoxy resins and high performance polyaromatic thermoplastics. It is shown that systematic modification to the thermoplastic backbone allows one to control the blend morphology, from a homogeneous one phase structure through spinodal morphologies to fully phase separated morphologies. The mechanical properties of these semi-IPN's are discussed. It is shown that optimum toughening is obtained with the spinodal morphology and that the toughness of the semi-IPN can be higher than that of either of the two components. In contrast, properties such as yield stress and modulus are shown to be independent of morphology, but to vary with the values of the pure components. Preliminary mechanical property data are reported for epoxy/thermoplastic blends as composite matrices. It is shown that the excellent improvement in resin toughness translates through to a very significant improvement in composite damage tolerance. This improvement is achieved without compromising the composite hot/wet properties. Author

A88-35946#
SHEAR STRENGTH OF ADVANCED ALUMINUM STRUCTURES
M. MOHAGHEGH (Boeing Commercial Airplane Co., Seattle, WA) AIAA, ASME, ASCE, and AHS, Structures, Structural Dynamics, and Materials Conference, 29th, Williamsburg, VA, Apr. 18-20, 1988. 22 p. refs
(AIAA PAPER 88-2369)

Shear strength of both low-density and high-strength advanced aluminum shear structures is evaluated and compared with shear strength of baseline 2024/7075 structures. The shear structures considered consist of a flat or sculptured web with fastened stiffeners or a monolithically stiffened web. The most significant material properties are considered to be the tensile strength properties at 45-deg to the longitudinal grain direction and the inplane shear strength. General engineering equations for determination of intermediate diagonal tension shear web strength are given as a function of web material inplane shear, L+45-deg yield and ultimate tensile strength, the diagonal tension factor, and web padup ratio. These equations are verified by large panel, picture frame, and rail shear tests of several aluminum alloys. Further refinement of analysis and verification testing is in progress. This engineering approach together with material and manufacturing cost data can be used for evaluation of various designs resulting in the most cost-effective and efficient shear structure. Author

A88-36967
THE TORSIONAL FATIGUE CHARACTERISTICS OF UNIDIRECTIONAL GLASS REINFORCED MATERIALS
R. DAVIDSON (Atomic Energy Research Establishment, Materials Development Div., Harwell, England) and C. J. SADDLER (Westland Helicopters, Ltd., Yeovil, England) IN: International Conference on Composite Materials, 6th, and European Conference on Composite Materials, 2nd, London, England, July 20-24, 1987, Proceedings. Volume 4 . London and New York, Elsevier Applied Science, 1987, p. 4.100-4.113. Research supported by the Ministry of Defence Procurement Executive.

This paper describes work in support of the development of a composite material system for the construction of a bearingless rotor linkage for a helicopter. Rigid matrix composites with a complex H cross-section can be designed to have the required flexural rigidities coupled with a low torsional rigidity. However, the torsional characteristics in fatigue of these components are relatively unknown. The work is concerned with the torsional characteristics of simple circular section unidirectional glass composites with Ciba Geigy 913 epoxide resin, tested both statically and in fatigue, and with similar measurements on components made from this composite material but with a Complex H section. Author

A88-36992
COMPOSITES - THE WAY AHEAD
R. I. HARESCEUGH (British Aerospace, PLC, Military Aircraft Div., Preston, England) IN: International Conference on Composite Materials, 6th, and European Conference on Composite Materials, 2nd, London, England, July 20-24, 1987, Proceedings. Volume 5 . London and New York, Elsevier Applied Science, 1987, p. 5.14-5.37.

The history of development and the current status of structural composites are reviewed with emphasis on aerospace applications. In particular, attention is given to the mechanical properties of fibers and matrix materials, further improvements required in composite properties, competition with improved metallic materials, material development strategies, and design approaches. The discussion also covers structural testing methods and failure prediction, detail manufacturing and assembly techniques, and ways of reducing manufacturing costs. V.L.

A88-37027
INFLUENCE OF FIBRE/MATRIX INTERACTIONS ON THE DAMAGE TOLERANCE BEHAVIOUR OF COMPOSITES
M. L. C. E. VERBRUGGEN (Akzo Research, Arnhem, Netherlands) IN: International Conference on Composite Materials, 6th, and European Conference on Composite Materials, 2nd, London, England, July 20-24, 1987, Proceedings. Volume 5 . London and New York, Elsevier Applied Science, 1987, p. 5.458-5.470.

An experimental test series indicated considerably lower strain energy release rates in case of poor adhesion. This feature was observed for both a peel (mode I, WTDCB-specimen) and a shear (mode II, ENF-specimen) loading mode. In a qualitative evaluation on damage tolerance it is shown that fiber/matrix debonding, being the cause of low interlaminar fracture toughness, can result in improved composite damage tolerance. The main reasons for this beneficial influence are decreasing stress concentration in debonded fibers and possible occurrence of secondary energy dissipating mechanisms like fiber pull-out. The advantageous effect of fiber/matrix debonding on damage tolerance can be expected for tension loaded (static or fatigue) specimens with damage and for general impact conditions. The debonding will generally be disadvantageous for compression loaded specimens. Author

A88-37035
PERFORMANCE MAPS OF TEXTILE STRUCTURAL COMPOSITES
JENN-MING YANG (California, University, Los Angeles) and TSU-WEI CHOU (Delaware, University, Newark) IN: International Conference on Composite Materials, 6th, and European Conference on Composite Materials, 2nd, London, England, July 20-24, 1987, Proceedings. Volume 5 . London and New York, Elsevier Applied Science, 1987, p. 5.579-5.588. refs

This paper provides a concise summary of recent accomplishments in analyzing the performance of various textile structural composites and introduces the concept of structure-performance maps. These maps provide the correlation of thermo-mechanical properties with various combinations of reinforcement configurations, matrix types, as well as reinforcing fibers. They can serve as an effective tool for assessing the merit of each reinforcement concept and guiding engineers in materials selection and design. Author

N88-20368# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
VISCOELASTIC BEHAVIOR OF A POLYETHERETHERKETONE (PEEK) COMPOSITE M.S. Thesis
RICHARD P. LOCKWOOD Dec. 1987 92 p
(AD-A189545; AFIT/GAE/AA/87D-10) Avail: NTIS HC A05/MF A01 CSCL 11D

The thermoplastic polyetheretherketone (PEEK) is being considered for structural applications in the Advanced Tactical Fighter. Previous efforts characterizing PEEK mechanical properties are reviewed. A study developing the viscoelastic frequency-temperature response to three point flexure of neat resin and PEEK/graphite fiber composites is detailed. The behavior of unidirectional laminates is compared to predictions from elastic plate theory, which also combines micro- and macromechanical approaches to predict transverse and longitudinal complex moduli. The experimental frequency-temperature shift factors, obtained under low strain in a Dynastat dynamic viscoelastic analyzer, are compared to shift factors predicted from the Williams-Landel-Ferry equation. Determining composite behavior from knowledge of matrix and fiber behavior is still applicable. The capability of the Dynastat to perform viscoelastic characterizations of stiff, unidirectional composites, based on comparisons of the various shift factors, is reduced due to the presence of the reinforcing fibers. Recommendations for future test and evaluations, including increasing the dynamic signal-to-noise ratio, are described. GRA

N88-20427# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
AIRCRAFT CORROSION PROBLEMS AND RESEARCH IN THE NETHERLANDS
R. J. H. WANHILL 20 Nov. 1986 10 p Presented at the European Corrosion Meeting EUROCORR '87, Karlsruhe, Federal Republic of Germany, Apr. 1987
(NLR-MP-86066-U; B8725239; ETN-88-91732) Avail: NTIS HC A02/MF A01

Corrosion in aircraft landing gear, engines and fuel systems, and aluminum alloy rotor blades of helicopters is reviewed. Measures to alleviate corrosion are discussed. ESA

N88-20455*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AVAILABILITY AND COST ESTIMATE OF A HIGH NAPHTHENE, MODIFIED AVIATION TURBINE FUEL
GEORGE M. PROK Apr. 1988 9 p
(NASA-TM-100823; E-4011; NAS 1.15:100823) Avail: NTIS HC A02/MF A01 CSCL 11B

Information from an Air Force study was used to determine the potential availability and cost of a modified conventional fuel with a naphthene content which could have a thermal stability near that of JP-7 for high-speed civil transports. Results showed sufficient capacity for a fuel made of a blend of 50 percent naphthenic straight run kerosene and 50 percent hydrocracked product, assuming a near-term requirement of 210,000 BBL per day. Fuel cost would be as low as 62.5 to 64.5 cents per gallon, assuming 20 dollars per barrel for crude. Author

N88-20484# Ashland Petroleum Co., Ky.
AVIATION TURBINE FUELS FROM TAR SANDS BITUMEN AND HEAVY OILS. PART 3: LABORATORY SAMPLE PRODUCTION Interim Technical Report, 1 Jul. 1983 - 30 Sep. 1986
H. F. MOORE, C. A. JOHNSON, R. M. BENSLAY, and W. A. SUTTON Dec. 1987 89 p
(Contract F33615-83-C-2301)
(AD-A189278; AFWAL-TR-84-2070-PT-3) Avail: NTIS HC A05/MF A01 CSCL 21D

The purpose of this research and development project is to provide sample quantities of aviation turbine fuel derived from tar sands and heavy oil feedstocks for testing and evaluation in programs sponsored by the Air Force Wright Aeronautical Laboratories (AFWAL). Samples of specification JP-4 Mil-T-5624L, JP-8 Mil-T-83133A, and variable quality JP-4 samples were produced via pilot plant operations. Data generated from Phases 1, 2, and 3, were used to: (1) optimize the processing scheme, (2) generate process material and energy balances for a commercial sized plant, and (3) provide a detailed final flow diagram of the processing scheme. A final economic analysis was performed based on all contract data available. GRA

N88-21314# Joint Publications Research Service, Arlington, Va.
EFFECT OF PROTECTIVE COATINGS ON HIGH-TEMPERATURE FATIGUE OF HEAT-RESISTANT ALLOYS Abstract Only
YU. G. VEKSLER, V. V. GRIBOV, V. P. LESNIKOV, A. A. RABINOVICH, G. F. MYALNITSA, and O. G. ZHIRITSKIY *In its* JPRS Report: Science and Technology. USSR: Materials Science p 11 10 Aug. 1987 Transl. into ENGLISH from Problemy Prochnosti (Kiev, USSR), no. 8, Aug. 1986 p 76-78 Original language document was announced in IAA as A87-17465
Avail: NTIS HC A05/MF A01

The fatigue properties of EP539LM alloy with an Al-Nb-Si fused slurry coating and a Co-Cr-Al-Y electron beam coating are investigated experimentally in vacuum and in air at 900 C. It is found that the protective coatings reduce the fatigue life of the specimens both in vacuum and in air, with the electron beam coating affecting the fatigue life of the alloy to a lesser degree than the fused slurry coating. The negative effect of the coatings on the fatigue life of the alloy is attributed largely to the properties of the coating materials. E.R.

N88-21510*# Cincinnati Univ., Ohio. Dept. of Aerospace Engineering and Engineering Mechanics.
A CONSTITUTIVE MODEL WITH DAMAGE FOR HIGH TEMPERATURE SUPERALLOYS
J. A. SHERWOOD and D. C. STOUFFER *In* NASA. Lewis Research Center, Nonlinear Constitutive Relations for High Temperature Applications, 1986 p 187-200 Apr. 1988 Sponsored in part by AF
(Contract NAG3-511)
Avail: NTIS HC A21/MF A01 CSCL 11F

A unified constitutive model is searched for that is applicable for high temperature superalloys used in modern gas turbines. Two unified inelastic state variable constitutive models were evaluated for use with the damage parameter proposed by Kachanov. The first is a model (Bodner, Partom) in which hardening is modeled through the use of a single state variable that is similar to drag stress. The other (Ramaswamy) employs both a drag stress and back stress. The extension was successful for predicting the tensile, creep, fatigue, torsional and nonproportional response of Rene' 80 at several temperatures. In both formulations, a cumulative damage parameter is introduced to model the changes in material properties due to the formation of microcracks and microvoids that ultimately produce a macroscopic crack. A back stress/drag stress/damage model was evaluated for Rene' 95 at 1200 F and is shown to predict the tensile, creep, and cyclic loading responses reasonably well. Author

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ENGINEERING

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

A88-33001
FIVE YEARS METAL BONDING WITH A NONCHROMATED ETCH
ROBERT M. SHEARER (Piper Aircraft Corp., Vero Beach, FL) IN: International SAMPE Technical Conference, 19th, Crystal City, VA, Oct. 13-15, 1987, Proceedings . Covina, CA, Society for the Advancement of Material and Process Engineering, 1987, p. 304-311.

In an effort to minimize the use of toxic materials, the nonchromate P2 etch was developed as an aircraft structural metal bond-etching alternative to the chrome-containing etch. The local government having jurisdiction over the industrial plant employing the P2 etch approved its use; in addition, environmental stress durability tests and physical tests with several adhesive systems indicated that the P2 etch compared favorably in performance with both the chromated etch and phosphoric acid anodization treatments. In the course of 5 years, 250 aircraft employing structural metal bonding have successfully used the P2 etch. O.C.

A88-33054#
PRESSURE MEASUREMENT FOR THE DETERMINATION OF WIND TUNNEL PERFORMANCE

J. W. WAGNON, J. W. MAYBERRY, C. D. ROSE, and W. H. COMER (Calspan Corp., Arnold Air Force Station, TN) IN: International Instrumentation Symposium, 33rd, Las Vegas, NV, May 3-8, 1987, Proceedings . Research Triangle Park, NC, Instrument Society of America, 1987, p. 49-72.

The Arnold Engineering Development Center/Propulsion Wind Tunnel (PWT) Facility pressure-measuring-system improvement project is described. The goals of this project were: (1) to provide sufficient accuracy in the measurement of tunnel operating conditions to meet user requirements for data quality, and (2) to provide adequate response characteristics to allow effective automatic control of tunnel operating conditions in the presence of rapid test-article movement. These goals were achieved via state-of-the-art transducers with a high tolerance for expected environmental conditions. They were mounted in environmental enclosures close to the measuring orifices. K.K.

A88-33057*# Complere, Inc., Palo Alto, Calif.
OPTICAL METHODS FOR MODEL ANGLE OF ATTACK AND TRANSITION MEASUREMENT
F. K. OWEN (Complere, Inc., Palo Alto, CA) and J. C. DAUGHERTY (NASA, Ames Research Center, Moffett Field, CA) IN: International Instrumentation Symposium, 33rd, Las Vegas, NV, May 3-8, 1987, Proceedings . Research Triangle Park, NC, Instrument Society of America, 1987, p. 85-93.

A novel laser-based sensor for the in situ measurement of wind tunnel model angle of attack is described and the results of a successful demonstration in the NASA Ames 9 x 7-ft. Supersonic wind tunnel are presented. The design concepts of a scanning laser-based turbulence detector, which will enable nonintrusive, microscopic studies of the onset and extent of transition on wind tunnel test models, is also described. Author

A88-33122
USAF R&M 2000 PROCESS
Journal of Environmental Sciences (ISSN 0022-0906), vol. 31, Mar.-Apr. 1988, p. 25-31.

The R&M approach to sustaining operational performance over time is to design systems that seldom break and, if they do, are easily repaired without a complex and costly support infrastructure. The goals, principles, and building blocks of the R&M 2000 process are discussed. The R&M Variability Reduction Program is described as well as R&M environmental stress screening. K.K.

A88-33270
EXPERIMENTAL RESULTS ON DUAL-POLARIZATION BEHAVIOR OF GROUND CLUTTER
M. FOSSI, M. GHERARDELLI, P. GIANNINO, and D. GIULI (Firenze, Universita, Florence, Italy) IN: International Conference on Radar, 1st, Nanjing, People's Republic of China, Nov. 4-7, 1986, Record . Beijing, China Academic Publishers, 1986, p. 675-681. Research supported by the Ministero della Pubblica Istruzione and Selenia S.p.A.

Some results are presented which refer to dual-polarization ground clutter measurements carried out with a radar system equipped with two orthogonally circularly polarized receiving channels. A statistical analysis of the parameters which describe the polarization behavior of ground clutter during dwell-time has been performed. Author

A88-33310
THE PHASE-SCANNED COMMUTATED ARRAY NETWORK
R. YOUNG (Plessey Radar, Ltd., Chessington, England) IN: Radar - 87; Proceedings of the International Conference, London, England, Oct. 19-21, 1987 . London and New York, Institution of Electrical Engineers, 1987, p. 50-53. Research supported by the Department of Trade and Industry.

An array feed network has been developed to demonstrate the P-Scan principle incorporating separate elevation and azimuth antennas. The microwave lens, switches, phase shifters, and amplitude control are discussed, and beam formation is described. The increased scan of the system is addressed, and the results of tests on the system are discussed. C.D.

A88-33315
CLASSIFICATION OF RADAR TARGETS BY MEANS OF MULTIPLE HYPOTHESES TESTING
A. FARINA and A. VISCONTI (Selenia S.p.A., Rome, Italy) IN: Radar - 87; Proceedings of the International Conference, London, England, Oct. 19-21, 1987 . London and New York, Institution of Electrical Engineers, 1987, p. 73-78.

The classification of targets using the theory of multiple hypotheses testing (MHT), a branch of the theory of statistical decision, is addressed. The basic mathematics of MHT are introduced, the scheme for classifying deterministic target signals is described, and the performance of the classifier for the case of target signal known completely a priori is discussed. The case of a target represented by the Swerling O model is considered, as is the case of a target modeled as a partially correlated Gaussian distributed random sequence. The problems of classifying hovering helicopters and of classification using a network of sensors are addressed. C.D.

A88-33320
WEATHER CHANNEL FOR A PRIMARY SURVEILLANCE RADAR
W. KLEMBOWSKI and R. JANKOWSKI (Radwar Co., Poland) IN: Radar - 87; Proceedings of the International Conference, London, England, Oct. 19-21, 1987 . London and New York, Institution of Electrical Engineers, 1987, p. 108-111. refs

A weather channel is described which consists of a set of means enabling a primary surveillance radar to detect meteorological phenomena. The weather channel is used to improve the detection of weather clutter and to display weather product on controller PPIs. The channel solves the controller problem of choosing the proper polarization. The concept of the weather channel is described, and signal processing in the channel is discussed. Some experimental results using it are briefly considered. C.D.

A88-33327
FULLY SOLID-STATE RADAR FOR AIR TRAFFIC CONTROL
N. DE LEDINGHEN and L. WONNEBERGER (Thomson-CSF, Division Systemes Defense et Controle, Bagneux, France) IN: Radar - 87; Proceedings of the International Conference, London, England, Oct. 19-21, 1987 . London and New York, Institution of Electrical Engineers, 1987, p. 145-149. refs

The use of transistors as the source of transmitter power in ATC systems, replacing the conventional magnetotron, klystron, or traveling wave tube, is considered. The necessary radar structure is addressed, and the characteristics of the solid state transmitter are described, including the frequency selection, transmitter breakdown, versatility, reliability, and maintainability. Reception and processing involving the solid state transmitter in ATC are discussed. C.D.

A88-33328
THE RAMP PSR, A SOLID-STATE SURVEILLANCE RADAR
H. R. WARD (Raytheon Co., Lexington, MA) IN: Radar - 87; Proceedings of the International Conference, London, England, Oct. 19-21, 1987 . London and New York, Institution of Electrical Engineers, 1987, p. 150-154. refs

The Ramp project, which will replace all of Canada's primary and secondary surveillance radars used for ATC, is discussed. The new primary radar is entirely solid-state, including the transmitter, and uses the latest digital technology for signal processing. The system architecture and the transmitter are described. The pulse compression, signal processing, and false alarm control are discussed. C.D.

A88-33330
MONOPULSE SECONDARY SURVEILLANCE RADAR
M. C. STEVENS (Cossor Electronics, Ltd., Harlow, England) IN: Radar - 87; Proceedings of the International Conference, London, England, Oct. 19-21, 1987 . London and New York, Institution of Electrical Engineers, 1987, p. 160-164.

A new generation of equipment which remedies some of the deficiencies of secondary surveillance radar (SSR) is described. SSR principles are briefly reviewed, and the main problems of bearing measurement, cochannel interference, and multipath are described. The use of improved antennas in SSR is briefly addressed, and the application of monopulse principles to bearing measurement and reply decoding in SSR is examined. The extension of monopulse to Mode S, which will add an extended datalink capability, is discussed. C.D.

A88-33335
SURVEILLANCE PROCESSING IN THE MODE S SENSOR
J. L. GERTZ (MIT, Lexington, MA) IN: Radar - 87; Proceedings of the International Conference, London, England, Oct. 19-21, 1987 . London and New York, Institution of Electrical Engineers, 1987, p. 189-194.

The Mode S sensor is an evolutionary upgrade of the current ATC Radar Beacon System which yields one report per aircraft per antenna scan; the report contains current aircraft range and azimuth, its transponder's identity code, and the altitude code as supplied by its encoding altimeter. The primary advantages obtained are in code improvements and false alarm rejection. Tabulations are presented of data illustrating the effectiveness of data-editing algorithms in detecting false alarm reports; without surveillance processing, these false alarms would have been given to ATC as outputs. O.C.

A88-33336
RADAR DATA PROCESSING WITH NEW GENERATION MONOPULSE SSR RADARS
J. M. SHAW (Royal Signals and Radar Establishment, Malvern, England) IN: Radar - 87; Proceedings of the International Conference, London, England, Oct. 19-21, 1987 . London and New York, Institution of Electrical Engineers, 1987, p. 195-199. Research sponsored by the Civil Aviation Authority. refs

Such new-generation radars as the monopulse secondary surveillance radars yield substantial improvements in the quality of plot data; the characteristics of these data have, moreover, a significant influence on radar data processing. While the smaller normal errors reduce the need for smoothing, sensitivity to exceptional errors is increased. In a multiradar environment, the effects of alignment errors become even more significant. Attention is given to the multiradar processing methods of mosaic plot selection, plot averaging, local track selection, local track averaging, and true multiradar tracking. O.C.

A88-33341
MODE S - A MONOPULSE SECONDARY SURVEILLANCE RADAR
E. L. COLE and R. A. ENSTROM (Westinghouse Electric Corp., Pittsburgh, PA) IN: Radar - 87; Proceedings of the International Conference, London, England, Oct. 19-21, 1987 . London and New York, Institution of Electrical Engineers, 1987, p. 232-236. refs

The FAA's 'Mode Select' radar beacon system (RBS), currently under development, will constitute a significant advancement in ATC automation, replacing the current ATC radar beacon system in order to furnish improvements in aircraft positional accuracy as well as reduced false target levels, reduced mutual interference, and the incorporation of a ground-air-ground data link capability. The 'Mode S sensor' ground component of the system consists of a computer-controlled interrogator, a data processor, and ground communication interfaces. Attention is given to the architecture of the Mode S interrogator and its projected performance, together with the software algorithms best suited for a monopulse ATC RBS secondary surveillance radar. O.C.

A88-33343
DEVELOPMENTS IN SSR MODE S STANDARDIZATION
A. J. EVANS (Civil Aviation Authority, London, England) IN: Radar - 87; Proceedings of the International Conference, London, England, Oct. 19-21, 1987 . London and New York, Institution of Electrical Engineers, 1987, p. 242-247. refs

The secondary surveillance radar (SSR) concept's 'mode S' extension is presently discussed with a view to the problems thus far encountered in the standardization of data link features in the UK, as well as the solutions thus far devised. Attention is also given to the techniques used to limit the interference effects of the proposed Airborne Collision Avoidance System. Mode S adds intermode interrogations, mode S interrogations, and mode S replies to standard SSR. O.C.

A88-33344
THE FUTURE OF SECONDARY SURVEILLANCE RADAR - MODE S AND TCAS
JEAN LAMBERT (Direction Generale de l'Aviation Civile, Paris, France) IN: Radar - 87; Proceedings of the International Conference, London, England, Oct. 19-21, 1987 . London and New York, Institution of Electrical Engineers, 1987, p. 248-251.

The principles of Mode S and TCAS operation are discussed and it is noted that the main characteristic of Mode S is selective addressing, in which each aircraft is given a unique address and thus can be interrogated individually. This leads to a real data-link channel combined with secondary surveillance radar; the availability of this channel paves the way for TCAS. Mode S development in France is detailed. K.K.

A88-33345
POSSIBLE INITIAL DATA LINK APPLICATIONS OF MODE S IN WESTERN EUROPE
M. E. COX (EUROCONTROL, Brussels, Belgium) IN: Radar - 87; Proceedings of the International Conference, London, England, Oct. 19-21, 1987 . London and New York, Institution of Electrical Engineers, 1987, p. 252-256. refs

The suitability of the Mode S data link for ATS purposes is examined as well as the factors likely to influence the choice of initial applications. Particular attention is given to the use of the link to: (1) improve upper-air meteorological data for ATS use, (2) provide pilots with the means for data retrieval from ground-based data banks, and (3) support approach-sequencing systems for use at busy airports. Factors likely to influence the choice of specific applications include the benefits expected in terms of safety enhancement, the ease of implementing it in the aircraft, and the costs that may be attributed directly to the application. K.K.

A88-33349
ON THE MAXIMUM ENTROPY METHOD FOR DOPPLER SPECTRAL ANALYSIS OF RADAR ECHOES FROM ROTATING OBJECTS
H. SCHNEIDER (Forschungsgesellschaft fuer angewandte Naturwissenschaften, Forschungsinstitut fuer Hochfrequenzphysik, Wachtberg-Werthhoven, Federal Republic of Germany) IN: Radar - 87; Proceedings of the International Conference, London, England, Oct. 19-21, 1987 . London and New York, Institution of Electrical Engineers, 1987, p. 279-282.

The performance of the maximum entropy (ME) method for the analysis of simulated and real measured radar signals backscattered by hovering helicopters is studied. Complex parameters characterizing the ME spectral estimator of order M are calculated using Burg's algorithm. It is found that the performance of the ME method is dependent on the sampling rate, which has to be substantially higher than the bandwidth of the reflection process. K.K.

A88-33378
RASTER SCAN RADAR DISPLAYS
D. H. THOMAS and E. E. HAYMAN (Cossor Electronics, Ltd., Harlow, England) IN: Radar - 87; Proceedings of the International Conference, London, England, Oct. 19-21, 1987 . London and New York, Institution of Electrical Engineers, 1987, p. 474-478.

The evolutionary stages of radar display development are identified. The criteria for raster scan displays are defined, and the relevant technology to meet present and future requirements for radar data display are discussed. A type of equipment which meets the requirements is outlined. C.D.

A88-33382
MUTUAL COUPLING AND FAR FIELD RADIATION FROM WAVEGUIDE ANTENNA ELEMENTS ON CONFORMAL SURFACES
R. W. WILLS (Plessey Radar, Ltd., Chessington, England) IN: Radar - 87; Proceedings of the International Conference, London, England, Oct. 19-21, 1987 . London and New York, Institution of Electrical Engineers, 1987, p. 515-519. Research supported by the Royal Signals and Radar Establishment.

The difficulties involved in designing conformal arrays are briefly reviewed. The effects of creeping fields on double curved conformal arrays of waveguide elements are then analyzed, and mutual coupling effects and far field patterns are computed. The theory is compared with measured results for an ellipsoidal array and found to be sufficiently accurate for practical design activities. V.L.

A88-33608
PHOTOELASTIC ANALYSIS OF THIN-WALLED COMPRESSOR HOUSING
R. O. CASE and H. MAHFUZ (Florida Atlantic University, Boca Raton) Experimental Mechanics (ISSN 0014-4851), vol. 28, March 1988, p. 98-104. refs

The fabrication, testing, and analysis of a full-sized photoelastic model of a thin-walled compressor housing are presented. The conical model and connecting bolts were stress frozen under axial and bending loads to simulate severe in-flight maneuver loads of jet aircraft sufficient to cause flange separation. Results and discussion are presented for stresses in and near the flange, for stresses experienced by the bolts, and for the fabrication techniques used. Author

A88-33658
A TECHNICAL COMPARISON OF FREQUENCY AND PHASE MODULATION RELATIVE TO PCM DATA TRANSMISSION SYSTEMS
DAVID LOVEJOY (New Mexico State University, Las Cruces) IN: ITC/USA/'87; Proceedings of the International Telemetering Conference, San Diego, CA, Oct. 26-29, 1987 . Research Triangle Park, NC, Instrument Society of America, 1987, p. 359-370.

Direct experience in the design and developement of airborne telemetry systems utilizing both principles of modulation. System level analysis of receiver phase coherency, bit sync error codes, data band width, transmission efficiency and overall system complexity. High reliability, miniaturized packaging and HI-G survivability will be stressed as well as illustrated. Author

A88-33810
CONTROL OF THE OPERATION OF FLIGHT COMPLEXES (2ND REVISED AND ENLARGED EDITION) [UPRAVLENIE EKSPLUATATSIEI LETATEL'NYKH KOMPLEKSOV /2ND REVISED AND ENLARGED EDITION/]
LEV IVANOVICH VOLKOV Moscow, Izdatel'stvo Vysshaia Shkola, 1987, 400 p. In Russian. refs

An approach to the control of the operation of flight complexes designed for unmanned guided flight vehicles is developed whereby the operation of the complex is treated as a complicated open-loop system. The output characteristics of the system are described, and methods for the calculation and statistical evaluation of these characteristics are presented. Optimization problems for such a system are solved with allowance for cost effectiveness factors. V.L.

A88-34181#
ELECTROMAGNETIC PULSE STANDARDS DEVELOPMENT FOR MILITARY AIRCRAFT
HAROLD M. MCCLENDON and MANUEL J. RODRIGUEZ (USAF, Directorate of Avionics Engineering, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1202-1205.

Concepts involved in the system-level standard philosophy adopted by the US Air Force's Aeronautical System Division (ASD) for hardening aircraft systems are presented. ASD's approach is to develop a totally new system-level military electromagnetic pulse (EMP) standard, which will be imposed on prime airframe contractors, and to modify existing electromagnetic interference (EMI) standards (MIL-STD-461 and MIL-STD-462), for subsystem/equipment-level requirements. The system-level standard is in the early stages of development and is scheduled for release in 1989. The changes to MIL-STD-461 and MIL-STD-462 are in the final stages of preparation and should be available for use in late 1987. It is noted that these changes are generic in that they do not specifically reference EMP due to their applicability to other transient environments such as lightning. I.E.

A88-34182
HIGH POWER MICROWAVE TEST RESULTS ON A DIGITAL ELECTRONIC ENGINE CONTROL
PHILIP E. BECKER and RAYMOND S. KAZMIERCZAK (Allied-Signal, Inc., Bendix Energy Controls Div., South Bend, IN) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1206-1210.

The authors discuss high-power microwave (HPM) testing performed on a digital electronic engine control. Descriptions of the protection design, test procedure used, test apparatus and results are presented. Testing was performed up to a field level of 8,262 W/sq cm (approximately 176,487 V/m) without operational upset. The test results indicate conventional electromagnetic compatibility protection techniques may adequately protect engine controls from the effects of HPM. I.E.

A88-34183
ENVIRONMENTAL TESTING OF UV-EPROMS, EE-PROMS, AND FUSIBLE-LINK PROMS
DALE L. HART, JOHN A. ZIEGENHAGEN, and RICHARD S. REIBEL (Dayton, University, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1226-1229.

The authors investigated the functional aspects of several programmable read only memory (PROM) devices. These included addressing memory, memory output (active or high impedance), long-term data retention and the integrity of the ceramic package when exposed to an airborne environment. The PROMs are being considered for use as the memory of an electronics package that will be mounted on or in close proximity to a jet engine. The maximum temperature that the devices are expected to experience is approximately 100 C. Environmental testing, thermal shock testing and X-ray sensitivity testing data are presented. I.E.

A88-34185#
PREDICTION OF AVIONIC STRUCTURAL RELIABILITY
AMARSHI BHUNGALIA (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1234-1245. refs

A description is presented of work towards the development of a method to evaluate life predictions for printed circuit boards and line replaceable units. Three efforts are presented: developing analytical methods development for vibration/thermal stress/strain prediction for avionics, vibration reliability life models for avionics, and thermal cycling reliability life models for avionics. The completion of the first effort is scheduled in May 1987; the second effort in June 1987; and the third effort in February 1988. Extensive testing is planned to fully validate all three preprocessors developed under these three separate programs. All three programs will then be integrated into a scenario-based solution. I.E.

A88-34187
AVIONICS INTEGRITY: OPTIMIZATION OF TODAY'S POWER SUPPLY TECHNOLOGY FOR MODERN SYSTEMS

JOHN J. DONNELLY (CEAG Electric Corp., Hauppauge, NY) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1254-1261.

The author examines the role that power supplies play in modern electronic systems and further defines the important design criteria for power supply, optimization, puts these interactive parameters into perspective and discusses their importance relative to their final application. The author also provides a logical pattern to be followed in prioritizing these optimizing design criteria and suggests a means of achieving reliability within a company. I.E.

A88-34188

REDUCE UNCONFIRMED REMOVALS THROUGH MECHANICAL DESIGN

ROBERT A. HOLLINGSEAD (Hollingsead International, Santa Fe Springs, CA) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1262-1265.

Airborne electronics are subjected to several external factors including shock, vibration, loss of cooling air, and connector misalignment, all of which can change the avionics engineer's original calculation of the expected mean time between failure (MTBF) of the black box. A major source for the introduction of these factors is the failure of the mechanical interface that holds the equipment in place Based on fifteen years of experience in the design of avionics support structures, the author explores these factors and provides recommendations for correcting problem areas. He examines the role of the airframe manufacturer, the role of the avionics manufacturer, and rack design. I.E.

A88-34189

THE TIME STRESS MEASUREMENT DEVICE: A NEW TECHNIQUE/TOOL FOR LIFE ANALYSIS AND TESTABILITY

JAMES A. COLLINS (USAF, Rome Air Development Center, Griffiss AFB, NY) and JON T. MCDERMOTT (Honeywell, Inc., Military Avionics Div., Minneapolis, MN) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1266-1271. refs

A technique/tool, currently being developed for use in reliability analysis and testability purposes is described. When addressing the field reliability of avionics/electronics and their indicated failures, very little is known about the prior mechanical and electrical stresses that the equipment has undergone prior to failure. A time stress management device (TSMD) is needed for the measurement and recording of this type of information. The authors describe the characteristics of a generalized TSMD, the development of TSMD hardware by Honeywell Military Avionics Division for field data collection and potential applications for TSMD information. I.E.

A88-34217#

STEP: A TOOL FOR ESTIMATING AVIONICS LIFE CYCLE COSTS

ERNEST E. CURRY (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1472-1474.

Estimation of life cycle costs (LCC) for avionics hardware and software presents a difficult challenge. The US Air Force has had significant success with the standardization evaluation program (STEP) model for estimating operating and support costs. The author describes the capabilities of the existing STEP model as well as ongoing enhancements to provide a total LCC estimating methodology. The paper discusses reliability sensitivity analyses, impact of retest OK, impact of fault isolation, acquisition cost enhancements, an automated database, analogy selection capability, and parametric estimating capability. I.E.

A88-34658

EFFECT OF SUPPORT FRICTION ON THE DYNAMICS OF THE FREE ROTATION OF A MODEL ABOUT ITS LONGITUDINAL AXIS [VLIIANIE TRENIIA V OPORAKH NA DINAMIKU SVOBODNOGO VRASHCHENIIA MODELI OTNOSITEL'NO PRODOL'NOI OSI]

R. I. ZUKAKISHVILI, R. CH. TARGAMADZE, V. P. KARIAGIN, and A. V. TERTERASHVILI (Gruzinskii Politekhnicheskii Institut, Tbilisi, Georgian SSR) Akademiia Nauk Gruzinskoi SSR, Soobshcheniia (ISSN 0132-1447), vol. 128, Dec. 1987, p. 569-572. In Russian.

The effect of friction in the suspension on the dynamics of the rotation of a flight vehicle model about its longitudinal axis is investigated analytically and experimentally using a 400-mm-diameter spherical model. The dependence of the friction moment on the angular velocity is determined for different wind tunnel flow velocities. An empirical method for determining aerodynamic derivatives with allowance for friction in the suspension is proposed. V.L.

A88-34928

INSTABILITY AND TRANSITION OF A THREE-DIMENSIONAL BOUNDARY LAYER ON A SWEPT FLAT PLATE

P. NITSCHKE-KOWSKY and H. BIPPES (DFVLR, Institut fuer experimentelle Stroemungsmechanik, Goettingen, Federal Republic of Germany) Physics of Fluids (ISSN 0031-9171), vol. 31, April 1988, p. 786-795. refs

Stability features are studied experimentally for the unstable three-dimensional boundary layer flow on a swept-back flat plate. A pressure gradient on the flat plate is induced by a displacement body. Infinite sweep conditions are approximated by means of contoured endplates. For the measurements, hot-wire and surface hot-film anemometry as well as flow visualization techniques are used. In addition to stationary waves, traveling waves are also traced. The cross-flow Reynolds numbers for the first appearance of either instability mode are of approximately the same magnitude. Wavelength and the direction of stationary vortices, as well as the frequencies of the most amplified traveling waves, are measured for different Reynolds numbers. The data obtained by the measurements are compared with the results of linear stability theory. Author

A88-35271

RF FIBER OPTIC LINKS FOR SPACECRAFT AND AIRCRAFT APPLICATIONS

W. M. BRUNO, W. E. STEPHENS, and T. R. JOSEPH (TRW Electro-Optics Research Center, Redondo Beach, CA) IN: Optical technologies for space communication systems; Proceedings of the Meeting, Los Angeles, CA, Jan. 15, 16, 1987 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1987, p. 142-149. refs

For many spacecraft and avionic applications, weight, size and layout flexibility are critical parameters for transmission media. This paper describes the advantages of using RF fiber optic links as replacements for waveguides and coaxial cable, and describes the measured performance of a 2.85 to 3.15 GHz link and a wideband 2 to 12 GHz link. Author

A88-35272

APPLICATIONS OF MONOLITHIC DETECTORS

D. J. JACKSON and D. L. PERSECHINI (Hughes Research Laboratories, Malibu, CA) IN: Optical technologies for space communication systems; Proceedings of the Meeting, Los Angeles, CA, Jan. 15, 16, 1987 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1987, p. 150-154. refs

The potential for incorporating lightwave technology into advanced space communications applications is discussed. With regard to the interconnection of microwave modulated analog signals, lightwave technology is compact, light weight, and capable of transmitting multi-Gb data rates. It is noted that the development of monolithic multiplexing and demultiplexing components at the receiver and transmitter ends of the fiber bus will permit a reduction in cross talk and improve system reliability. K.K.

A88-35276
TRUE THREE-DIMENSIONAL IMAGING TECHNIQUES AND DISPLAY TECHNOLOGIES; PROCEEDINGS OF THE MEETING, LOS ANGELES, CA, JAN. 15, 16, 1987
DAVID F. MCALLISTER, ED. and WOODROW E. ROBBINS, ED. (North Carolina State University, Raleigh) Meeting sponsored by SPIE. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Volume 761), 1987, 192 p. For individual items see A88-35277 to A88-35282.
(SPIE-761)

The present conference on state-of-the-art three-dimensional imaging techniques and displays discusses a liquid crystal video stereoscope, the chromostereoscopic single-image stereoscopic process, 'alcove' holograms for CAD, factors affecting 'ghosting' in time-multiplexed planostereoscopic CRT displays, and three-dimensional stereographic pictorial visual interfaces and displays for flight simulation. Also discussed are radiologic applications of holography, the use of lenses to enhance depth perception, truly three-dimensional animation in motion pictures, three-dimensional displays of radiation therapy planning, a high definition graphics application in fluid flow simulations, the digital generation of stereoscopic perspective scenes, and a truly four-dimensional graphics laboratory for nongeometric grid-based data. O.C.

A88-35526
RECENT TRENDS IN AEROELASTICITY, STRUCTURES, AND STRUCTURAL DYNAMICS; PROCEEDINGS OF THE R. L. BISPLINGHOFF MEMORIAL SYMPOSIUM, UNIVERSITY OF FLORIDA, GAINESVILLE, FL, FEB. 6, 7, 1986
PRABHAT HAJELA, ED. (Florida, University, Gainesville) Symposium sponsored by NSF, USAF, and MIT;. Gainesville, FL, University Presses of Florida, 1987, 424 p. For individual items see A88-35527 to A88-35547.
(Contract NSF ECE-86-02170)

The papers contained in this volume provide an overview of the state of the art in the field of aeroelasticity and aeronautical structures, including surveys of well-developed fields of study and new contributions in emerging areas of technology. The subject areas covered include fixed and rotary wing aeroelasticity; aeroelastic considerations in rotating machinery; aeroelastic problems in bridge design; structural analysis and structural dynamics in aerospace applications; aeroservoelastic considerations; and the emerging discipline of optimal structural design. Papers are presented on the whirl flutter of swept tip propfans; aeroelasticity of very light aircraft; structural stability in turbulent flow; and structural tailoring of aircraft performance. V.L.

A88-35531
REVIEW OF FLOQUET THEORY IN STABILITY AND RESPONSE ANALYSES OF DYNAMIC SYSTEMS WITH PERIODIC COEFFICIENTS
G. H. GAONKAR (Florida Atlantic University, Boca Raton) and D. A. PETERS (Georgia Institute of Technology, Atlanta) IN: Recent trends in aeroelasticity, structures, and structural dynamics; Proceedings of the R. L. Bisplinghoff Memorial Symposium, Gainesville, FL, Feb. 6, 7, 1986 . Gainesville, FL, University Presses of Florida, 1987, p. 101-119. refs

The feasibility of Floquet theory applications in large-scale design analysis is examined with emphasis on computational constraints which currently prevent the use of Floquet theory in design applications. A brief review of the components of Floquet analysis is presented, illustrating the computational aspects of these components. Although the results presented here refer to relatively small order systems, they demonstrate that Floquet analysis offers promise for design applications. V.L.

A88-35533
EXPERIMENTAL STUDIES IN AEROELASTICITY OF UNSWEPT AND FORWARD SWEPT GRAPHITE/EPOXY WINGS
JOHN DUGUNDJI (MIT, Cambridge, MA) IN: Recent trends in aeroelasticity, structures, and structural dynamics; Proceedings of the R. L. Bisplinghoff Memorial Symposium, Gainesville, FL, Feb. 6, 7, 1986 . Gainesville, FL, University Presses of Florida, 1987, p. 149-160. USAF-supported research. refs

Three separate experimental studies on the aeroelastic flutter and divergence behavior of stiffness coupled, graphite/epoxy composite wing models are described. These studies were conducted at M.I.T. and dealt with cantilever unswept wings, cantilever forward swept wings, and forward swept wings with rigid body freedoms. For the cantilever wings, bending-torsion flutter and divergence was observed at low angles of attack while torsional stall flutter and bending stall flutter was observed at high angles of attack. For the wings with rigid body freedoms, body freedom flutter, bending-torsion flutter, and tunnel support related dynamic instability was observed. Good agreement with linear theory was found for all the observed instabilities at low angles of attack. The present studies extend the experimental base for aeroelastic tailoring with composites, and provide further insight into actual aeroelastic behavior of composite wing aircraft in flight. Author

A88-35536* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
PROBLEMS AND PROGRESS IN AEROELASTICITY FOR INTERDISCIPLINARY DESIGN
E. CARSON YATES, JR. (NASA, Langley Research Center, Hampton, VA) IN: Recent trends in aeroelasticity, structures, and structural dynamics; Proceedings of the R. L. Bisplinghoff Memorial Symposium, Gainesville, FL, Feb. 6, 7, 1986 . Gainesville, FL, University Presses of Florida, 1987, p. 203-219. refs

Some problems and progress in the development of aerodynamic and aeroelastic computational capabilities are reviewed with emphasis on needs for use in current interdisciplinary design procedures as well as for stand-alone analyses. The primary focus is on integral-equation methods which are well suited for general, accurate, efficient, and unified treatment of flow around vehicles having arbitrary shapes, motions, and deformations at subsonic, transonic, and supersonic speeds up to high angles of attack. Computational methods for potential flows and viscous flows are discussed, and some applications are shown. Calculation of steady and unsteady aeroelastic characteristics of aircraft with nonlinear aerodynamic behavior is also addressed briefly. Author

A88-35538
CATASTROPHIC FAILURE OF LAMINATED CYLINDERS UNDER INTERNAL PRESSURE
JAMES W. MAR and JEROME C. HYBSAKER (MIT, Cambridge, MA) IN: Recent trends in aeroelasticity, structures, and structural dynamics; Proceedings of the R. L. Bisplinghoff Memorial Symposium, Gainesville, FL, Feb. 6, 7, 1986 . Gainesville, FL, University Presses of Florida, 1987, p. 236-250. USAF-supported research. refs

The damage tolerance of cylindrical shells fabricated of graphite/epoxy filamentary composite materials has been studied. The damage, called 'flaws', was in the form of longitudinal slits, slits at angles to the longitudinal axis, colinear slits, circular holes, long holes and holes with slits. The original series of cylinders used six plies of unidirectional prepreg in the laminate while the remainder used four plies of fabric. In one set of experiments the damage was inflicted by a guillotine which dropped a knife onto a cylinder under pressure. In another series, the flaw was pre-cut, covered with a non-intrusive patch and then monotonically pressurized to failure. It has been determined that the catastrophic failure, i.e., rapid fracture of these cylinders, can be correlated to the fracture of flat coupons of the same laminate under uni-axial tension. Author

A88-35540
STRUCTURAL STABILITY TURBULENT FLOW
Y. K. LIN (Florida Atlantic University, Boca Raton) IN: Recent trends in aeroelasticity, structures, and structural dynamics; Proceedings of the R. L. Bisplinghoff Memorial Symposium, Gainesville, FL, Feb. 6, 7, 1986 . Gainesville, FL, University Presses of Florida, 1987, p. 259-270. refs

Turbulence in the ambient flow is shown to affect the dynamic

stability of a structure. It can be either stabilizing or de-stabilizing depending on the type of structure and the way in which the structure interacts with the surrounding flow. In particular, turbulence always de-stabilizes a single degree of freedom linear system, but its effect is likely to be small in the case of gusty wind exciting earth-bound structures. Under favorable conditions turbulence can increase the stability of a linear structure of more than one degree of freedom by providing a conduit to feed energy from the least stable mode to other more stable modes, but the effect is again likely small. Greater effects, either beneficial or otherwise, may be expected of a nonlinear system, as exemplified by the coupled flap-lag motion of a helicopter rotor blade.
Author

A88-35547
A SURVEY OF METHODS AND PROBLEMS IN AEROELASTIC OPTIMIZATION
PRABHAT HAJELA (Florida, University, Gainesville) IN: Recent trends in aeroelasticity, structures, and structural dynamics; Proceedings of the R. L. Bisplinghoff Memorial Symposium, Gainesville, FL, Feb. 6, 7, 1986 . Gainesville, FL, University Presses of Florida, 1987, p. 401-413. refs
The applications of optimization methods in the aeroelastic design environment are reviewed. Extension of the structural optimization problem to include aeroelastic contraints, is assessed for static divergence, flutter and gust response problems. Application in the area of fixed-wing and rotary-wing aeroelasticity are considered. In addition to the structural optimization problem, the state-of-the-art in active control technology is presented with a special emphasis on the use of formal optimization methods.
Author

A88-35822
DESIGN CONSIDERATIONS FOR A SERVO OPTICAL PROJECTION SYSTEM
MICHAEL NADALSKY (Recon/Optical, Inc., Pacific Optical Div., Torrance, CA), DANIEL ALLEN, and JOSEPH BIEN (McDonnell Douglas Helicopter Co., Mesa, AZ) IN: Large screen projection displays; Proceedings of the Meeting, Los Angeles, CA, Jan. 15, 1987 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1987, p. 12-15.
The present servooptical projection system (SOPS) furnishes 'out-the-window' scenery for a pilot-training flight simulator; attention is given to the parametric tradeoffs made in the SOPS' optical design, as well as to its mechanical packaging and the servonetwork performance of the unit as integrated into a research/training helicopter flight simulator. The final SOPS configuration is a function of scan head design, assembly modularity, image deterioration method, and focal lengths and relative apertures.
O.C.

A88-35896
METHODS OF HANDLING AND PROCESSING IMAGERY; PROCEEDINGS OF THE MEETING, LOS ANGELES, CA, JAN. 15, 16, 1987
JULIAN MARSHALL, ED. (Viewgraphics, Inc., Mountain View, CA) Meeting sponsored by SPIE. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Volume 757), 1987, 145 p. For individual items see A88-35897 to A88-35900.
(SPIE-757)
Various papers on methods of handling and processing imagery are presented. The general topics addressed include data compression, algorithms and analysis, architectures and hardware, and general applications. Some of the individual subjects considered include: destriping of Landsat data using power spectral filtering, analyses of light simulation systems employing real imagery, digital photogrammetry on an advanced data and picture transformation system, and address generation and memory management for memory-centered image processing systems.
C.D.

A88-35898
SOME ANALYSES OF FLIGHT SIMULATION SYSTEMS EMPLOYING REAL IMAGERY
JENFENG LI and M. T. MANRY (Texas, University, Arlington) IN: Methods of handling and processing imagery; Proceedings of the Meeting, Los Angeles, CA, Jan. 15, 16, 1987 . Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1987, p. 76-83. refs
Several sources of error in flight simulation systems are analyzed. Guidelines are derived for selecting the observation points so that jump errors due to hilly terrain can be minimized. Additional guidelines are found that insure that the necessary scenery is available on the aerial photographs. Characteristics of the camera are derived such that the photographs have the required resolution.
C.D.

A88-36299#
AN APPROACH TO AN AERO/THERMAL/ELASTIC DESIGN SYSTEM
F. F. ABDI, L. G. AUSTEL, and P. W. CHANG (Rockwell International Corp., North American Aircraft Div., Los Angeles, CA) AIAA, ASME, ASCE, and AHS, Structures, Structural Dynamics and Materials Conference, 29th, Williamsburg, VA, Apr. 18-20, 1988. 10 p. Research supported by Rockwell International Corp.
(AIAA PAPER 88-2383)
Integrated multidisciplinary systems using mathematical optimization techniques and automated information exchange are needed rapidly to design optimal airframe structures of vehicles with hypervelocity missions. This paper describes an aero/thermal/elastic design system (RSOP) which implements mathematical optimization techniques to account for interdisciplinary interactions. This capability is combined in RSOP with automated data exchange between disciplines and design analysis and optimization on a finite element basis to produce an early estimate of the structural weight during the design process. As an example, the RSOP system is used in a 'real world' environment to optimize the core and wing structures of a hypervelocity vehicle concept.
C.D.

A88-36312
FLOW VISUALIZATION AND AERO-OPTICS IN SIMULATED ENVIRONMENTS; PROCEEDINGS OF THE MEETING, ORLANDO, FL, MAY 21, 22, 1987
H. THOMAS BENTLEY, III, ED. (Sverdrup Technology, Inc., Arnold Air Force Station, TN) Meeting sponsored by SPIE. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Volume 788), 1987, 130 p. For individual items see A88-36313 to A88-36322.
(SPIE-788)
The present conference on high speed aerooptics facilities, aerodynamic holography, and photooptical techniques gives attention to the prediction of image degradation through a turbulent medium, wind tunnel studies of optical beam degradation through heterogeneous aerodynamic flows, wavelength effects on images formed through turbulence, holographic visualizations of hypersonic flow viscous interactions, holographic interferometry for gas flow pattern studies, and a holographic flow field analysis of Spacelab-3 crystal growth experiments. Also discussed are the interferometric reconstruction of continuous flow fields, the flow visualization of turbine film cooling flows, the use of the phosphor technique for remote thermometry in a combustor, pulsed laser cinematography of deflagration, and a digital image sequence analysis for optical flow computation in flame propagation visualization.
O.C.

A88-36316* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
REAL-TIME LASER HOLOGRAPHIC INTERFEROMETRY FOR AERODYNAMICS
GEORGE LEE (NASA, Ames Research Center, Moffett Field, CA) IN: Flow visualization and aero-optics in simulated environments; Proceedings of the Meeting, Orlando, FL, May 21, 22, 1987 .

Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1987, p. 54-61. Previously announced in STAR as N87-22956. refs

Recent developments in thermoplastic recording holograms and advancements in automated image digitalization and analysis make real-time laser holographic interferometry feasible for two-dimensional flows such as airfoil flows. Typical airfoil measurements would include airfoil pressure distributions, wake and boundary layer profiles, and flow field density contours. This paper addresses some of the problems and requirements of a real-time laser holographic interferometer. Author

A88-36322

ELECTRO-OPTICALLY SLAVED, FORWARD-SCATTER RECEIVER/TRAVERSE SYSTEM FOR LASER VELOCIMETRY

F. L. CROSSWY and P. M. SHERROUSE (Calspan Corp., Arnold Air Force Station, TN) IN: Flow visualization and aero-optics in simulated environments; Proceedings of the Meeting, Orlando, FL, May 21, 22, 1987. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1987, p. 118-122. Army-USAF-supported research. refs

Electro-optical position sensing and position control system techniques have been combined to precisely couple the 2-axis motions of a slave traverse system to the 2-axis motions of a master traverse system. This scheme is used to implement a laser Doppler velocimeter (LDV) optical system in the forward-scatter configuration. The slaved traverse approach is useful for LDV applications in large aerodynamic or aeropropulsion testing facilities where a yoke assembly for diametrically positioning the LDV transmitter and receiver may be impractical. The slaved traverse system has, to date, been used successfully for LDV measurements in a large transonic wind tunnel and a large supersonic wind tunnel at AEDC. Author

A88-36483

ICIASF '87 - INTERNATIONAL CONGRESS ON INSTRUMENTATION IN AEROSPACE SIMULATION FACILITIES, 12TH, COLLEGE OF WILLIAM AND MARY, WILLIAMSBURG, VA, JUNE 22-25, 1987, RECORD

Congress sponsored by IEEE. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, 395 p. For individual items see A88-36484 to A88-36526.

Papers are presented on such topics as laser Doppler anemometry, measurement acquisition/process/control/transmission, general instrumentation, transition detection, pressure measurements, and velocimetry. Attention is also given to optical diagnostics, force balances, the magnetic suspension and balance system, boundary layer measurements, and skin friction measurements. B.J.

A88-36490

ROTATING OPTOELECTRONIC DATA TRANSMITTER FOR LOCAL HEAT TRANSFER MEASUREMENTS

GUENTER KAPPLER, WOLFGANG ERHARD, and HORST BRAUN (Muenchen, Technische Universitaet, Munich, Federal Republic of Germany) IN: ICIASF '87 - International Congress on Instrumentation in Aerospace Simulation Facilities, 12th, Williamsburg, VA, June 22-25, 1987, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 77-82.

A test facility is presented that was used for the experimental determination of the local heat transfer coefficients of rotating gas turbine disks. The technique involves the measurement of the transient temperature distribution on a specially instrumented and preheated rotating disk. A small optoelectronic telemetric system that was developed for the contactless data transmission of seven thermocouples adjusted on the rotating disk is described. I.E.

A88-36491* Virginia Polytechnic Inst. and State Univ., Blacksburg.

A COMBINATION PROBE FOR HIGH-FREQUENCY UNSTEADY AERODYNAMIC MEASUREMENTS IN TRANSONIC WIND TUNNELS

WING F. NG and THOMAS G. POPERNACK, JR. (Virginia Polytechnic Institute and State University, Blacksburg) IN: ICIASF '87 - International Congress on Instrumentation in Aerospace Simulation Facilities, 12th, Williamsburg, VA, June 22-25, 1987, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 83-91. NASA-supported research. refs

A combination probe for time-resolved measurements for unsteady compressible flows is described. The probe measures stagnation (total) temperature and pressure, static pressure, and flow angles in two planes. From these, the fluctuating mass flux, Mach number, and velocity as well as their components in three directions can be deduced. The combination probe consists of a dual hot-wire aspirating temperature and pressure probe mounted piggyback with a high-frequency angle probe. The angle probe has four surface-mounted silicon pressure sensors. A scheme is described for retrieving from the four pressure signals the stagnation and static pressures, Mach number, and flow angles in two planes. The calibrations forming the basis for this procedure, obtained from steady-state tests, are given. Typical data obtained in the Karman vortex street shed from a cylinder and at the exit of a Mach-0.4 air jet are presented. I.E.

A88-36499*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

REMOTE NONCONTACTING MEASUREMENTS OF HEAT TRANSFER COEFFICIENTS FOR DETECTION OF BOUNDARY LAYER TRANSITION IN WIND TUNNEL TESTS

D. MICHELE HEATH, WILLIAM P. WINFREE, DEBRA L. CARRAWAY, and JOSEPH S. HEYMAN (NASA, Langley Research Center, Hampton, VA) IN: ICIASF '87 - International Congress on Instrumentation in Aerospace Simulation Facilities, 12th, Williamsburg, VA, June 22-25, 1987, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 135-140. refs

An infrared measurement system is used that consists of a laser heating source, an infrared camera for data acquisition, and a video recorder for data storage. A laser beam is scanned over an airfoil, heating its surface to a few degrees above ambient. An infrared camera then measures the temperature of the airfoil over a two-dimensional field, and these temperatures are stored as a function of time on a video recorder. The resulting temperature pictures are digitized and an iterative approximation algorithm is used to extract the heat transfer coefficient. The resulting values are normalized to the natural convection condition. The technique has been applied in low-speed wind tunnel tests and compared to well-established hot-film measurements which were made simultaneously to confirm the flow conditions. Heat transfer coefficients were determined using a linear scanning pattern, to indicate the position of natural and of artificially induced transition on an airfoil, at various wind speeds. The technique is shown to be sensitive to transition at low Mach numbers. The advantages of the technique are discussed. I.E.

A88-36500*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

STATUS OF A SPECIALIZED BOUNDARY LAYER TRANSITION DETECTION SYSTEM FOR USE IN THE U.S. NATIONAL TRANSONIC FACILITY

CHARLES B. JOHNSON, DEBRA L. CARRAWAY, PURNELL HOPSON, JR., and SANG Q. TRAN (NASA, Langley Research Center, Hampton, VA) IN: ICIASF '87 - International Congress on Instrumentation in Aerospace Simulation Facilities, 12th, Williamsburg, VA, June 22-25, 1987, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 141-155. refs

An improved deposition technique for cryogenic hot films used for transition detection in cryogenic tunnels is reported. Tests of the hot films in a low-speed tunnel demonstrated the ability to obtain online transition data. The capability of an enhanced hot film data acquisition system was also demonstrated. A comparison of data from the new system with stability theory shows the detection of Tollmein-Schlicting waves at transition onset. I.E.

A88-36501
CALIBRATION OF SEVEN-HOLE PROBES WITHIN MACH NUMBER RANGE 0.50-1.30 IN FFA HIGH SPEED WIND TUNNEL FACILITY
BJORN PETTERSSON (Flygtekniska Forsoksanstalten, Bromma, Sweden) IN: ICIASF '87 - International Congress on Instrumentation in Aerospace Simulation Facilities, 12th, Williamsburg, VA, June 22-25, 1987, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 156-165. refs

The calibration of a nonnulling seven-hole conical pressure probe is described. It was carried out in a closed-circuit continuous tunnel with an octagonal test section of 0.7 m2. The probe is capable of measuring flow conditions as local-total and total-minus-static pressures, and relative flow angles up to 75 deg. Three variable third-degree polynomial functions are used to represent local values of relative flow angles, total pressure and total minus static pressure. These flow properties can be determined explicitly, from measured probe pressures. Flow angles are determined within 0.75 deg and Mach number within 0.04 with 95 percent certainty. The probe can be used in the Mach number range from 0.5 to 1.3. I.E.

A88-36503
FURTHER BASE BLEED TESTS
H. VOS HATTINGH and LOUIS R. BOSCH (Stellenbosch, University, Republic of South Africa) IN: ICIASF '87 - International Congress on Instrumentation in Aerospace Simulation Facilities, 12th, Williamsburg, VA, June 22-25, 1987, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 177-182.

A dedicated hot air tunnel, providing Mach number and stagnation enthalpy simulation, was used to determine the drag reduction achievable with base bleed. The tunnel's simulation capabilities were extended by fitting a larger heater. An indirect determination of the base pressure was replaced by measurement of the actual base pressure. Test results are presented. I.E.

A88-36508*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
A DIGITAL VIDEO MODEL DEFORMATION SYSTEM
A. W. BURNER, W. L. SNOW, W. K. GOAD, and B. A. CHILDERS (NASA, Langley Research Center, Hampton, VA) IN: ICIASF '87 - International Congress on Instrumentation in Aerospace Simulation Facilities, 12th, Williamsburg, VA, June 22-25, 1987, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 210-220. refs

The use of solid-state array cameras and a PC-controlled image acquisition system to measure model deformation in a wind tunnel is discussed. This digital system improves an earlier video model deformation system that used high-resolution tube cameras and required the manual measurement of targets on video hardcopy images. The new system eliminates both the vibration-induced distortion associated with tube cameras and the manual readup of video images necessary in the earlier version. Camera calibration and data reduction procedures necessary to convert pixel image plane data from two cameras into wing deflections are presented. Laboratory tests to establish the uncertainty of the system with the geometry to be used are described. I.E.

A88-36511
PROGRESS IN VISUALIZING CRYOGENIC FLOW USING THE VAPOR-SCREEN TECHNIQUE
GREGORY V. SELBY (Old Dominion University, Norfolk, VA) IN: ICIASF '87 - International Congress on Instrumentation in Aerospace Simulation Facilities, 12th, Williamsburg, VA, June 22-25, 1987, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 233-238. refs

The vortical flow on the leeward side of a delta-wing model has been visualized at several different tunnel conditions in the NASA Langley 0.3-m transient cryogenic tunnel using a vapor-screen flow-visualization technique. Vapor-screen photographs of the subject flow field are presented and are interpreted relative to phenomenological implications. Results indicate that the use of nitrogen fog in conjunction with the vapor-screen technique is feasible. I.E.

A88-36513*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FOUR SPOT LASER ANEMOMETER AND OPTICAL ACCESS TECHNIQUES FOR TURBINE APPLICATIONS
MARK P. WERNET (NASA, Lewis Research Center, Cleveland, OH) IN: ICIASF '87 - International Congress on Instrumentation in Aerospace Simulation Facilities, 12th, Williamsburg, VA, June 22-25, 1987, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 245-254. Previously announced in STAR as N87-18057. refs

A time-of-flight anemometer (TOFA) system utilizing a spatial lead-lag filter for bipolar pulse generation has been constructed and tested. This system, called a four-spot laser anemometer, was specifically designed for use in high-speed, turbulent flows in the presence of walls or surfaces. The TOFA system uses elliptical spots to increase the flow acceptance angle to be comparable with that of a fringe-type anemometer. The tightly focused spots used in the four spot yield excellent flare light rejection capabilities. Good results have been obtained to 75 microns normal to a surface, with an f/2.5 collection lens. This system is being evaluated for use in a warm turbine facility. Results from both a particle-lag velocity experiment and boundary layer profiles will be discussed. In addition, an analysis of the use of curved windows in a turbine casing will be presented. Curved windows, matching the inner radius of the turbine casing, preserve the flow conditions, but introduce astigmatic aberrations. A correction optic was designed that virtually eliminates these astigmatic aberrations throughout the intrablade survey region for normal incidence. Author

A88-36516
AN EXTERNAL DRAG MEASURING ELEMENT
MORDECHAI RINGEL, DANIEL LEVIN, and ARNAN SEGINER (Technion - Israel Institute of Technology, Haifa) IN: ICIASF '87 - International Congress on Instrumentation in Aerospace Simulation Facilities, 12th, Williamsburg, VA, June 22-25, 1987, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 269-273. refs

The accurate measurement of the axial-force component acting on small wind-tunnel models has traditionally made use of integral string balances, which eliminated many accuracy problems, such as friction and hysteresis, but also introduced interactions between the various force and moment sensing elements due to nonlinear elastic phenomena. The reduction of these interactions usually calls for complicated designs, expensive manufacturing, hard-to-handle calibration processes, and cumbersome data reduction programs. An approach is presented that is based on an external axial-force-measuring element and avoids the ill-conditioned design problems of integral balances. Other difficulties that are encountered, such as friction, misalignment, and relative motion between metric elements are considered, and their solution is examined. Calibration and test results show that the new approach duplicates and surpasses the results of much more complicated and expensive integral balances. I.E.

A88-36518
MAGNETIC SUSPENSION AND BALANCE SYSTEMS FOR USE WITH WIND TUNNELS
EUGENE E. COVERT (MIT, Cambridge, MA) IN: ICIASF '87 - International Congress on Instrumentation in Aerospace Simulation Facilities, 12th, Williamsburg, VA, June 22-25, 1987, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 283-294. refs

The requisite properties of magnetic suspension and balance systems are outlined. A small number of results that can be considered classical are classified. Some examples of particular systems are provided, and the several possible ways to meet each of these needs are discussed. I.E.

A88-36520*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

STRAIN-GAGE BALANCE CALIBRATION OF A MAGNETIC SUSPENSION AND BALANCE SYSTEM

PAUL W. ROBERTS and PING TCHENG (NASA, Langley Research Center, Hampton, VA) IN: ICIASF '87 - International Congress on Instrumentation in Aerospace Simulation Facilities, 12th, Williamsburg, VA, June 22-25, 1987, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 308-321. refs

A load calibration of the NASA 13-in magnetic suspension and balance system (MSBS) is described. The calibration procedure was originally intended to establish the empirical relationship between the coil currents and the external loads (forces and moments) applied to a magnetically suspended calibrator. However, it was discovered that the performance of a strain-gage balance is not affected when subjected to the magnetic environment of the MSBS. The use of strain-gage balances greatly reduces the effort required to perform a current-vs.-load calibration as external loads can be directly inferred from the balance outputs while a calibrator is suspended in MSBS. It is conceivable that in the future such a calibration could become unnecessary, since an even more important application for the use of a strain-gage balance in MSBS environment is the acquisition of precision aerodynamic force and moment data by telemetering the balance outputs from a suspended model/core/balance during wind tunnel tests. I.E.

A88-36524* Old Dominion Univ., Norfolk, Va.

MODEL OF HOT-FILM SENSOR WITH SUBSTRATE

GRIFFITH J. MCREE and DAVID M. JUDGE (Old Dominion University, Norfolk, VA) IN: ICIASF '87 - International Congress on Instrumentation in Aerospace Simulation Facilities, 12th, Williamsburg, VA, June 22-25, 1987, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 350-355. NASA-supported research. refs

A detailed model is constructed to investigate parameters influencing a hot-film anemometer system used to study cross-flow phenomena on swept wings. This anemometer is designed to detect vortices set up by cross-flow. The nature of the vortices is not well known, and a well-verified instrumentation model is considered essential to allow accurate interpretation of experimental results. Previous investigators have indicated that heat conduction to the film's substrate is significant. Two variations on the inclusion of substrate effects in the model are discussed. In the first, the substrate is assumed to have a constant temperature throughput: in the second more elaborate model, the temperature of the substrate is allowed to vary. This variation is related to the convective heat removal at the substrate/gas interface. I.E.

A88-36525

MEASUREMENTS IN 3-DIMENSIONAL BOUNDARY LAYERS AND NARROW WAKES USING A SINGLE SENSOR HOT WIRE PROBE

RODNEY V. BARRETT (Bristol, University, England) IN: ICIASF '87 - International Congress on Instrumentation in Aerospace Simulation Facilities, 12th, Williamsburg, VA, June 22-25, 1987, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 356-368.

An anemometer system is described in which a single hot wire is used to obtain mean flow velocity and direction, together with turbulence information, in a plane perpendicular to the probe axis by step rotation of the probe about this axis. The method can be applied in many boundary layer and narrow wake situations in which the flow remains essentially in the plane of measurement. For determination of the mean flow quantities, the system operates over a range of +/-90 deg in the flow direction and gives close resolution of the flow velocity profile when traversed in the direction of the probe axis. The anemometer is self-contained, using a microcomputer to control the traverse sequences of the probe and to handle the data. The performance and limitations of the system are discussed, largely in relation to results obtained in a recent study of the flow in the region of the outer end of a flap under high lift conditions. I.E.

A88-36534

IAC BASED MICROWAVE/MILLIMETER-WAVE TESTING

ALAN J. PATE (Allied-Signal Aerospace Co., Bendix Test Systems Div., Teterboro, NJ) IN: AUTOTESTCON '87; Proceedings of the International Automatic Testing Conference, San Francisco, CA, Nov. 3-5, 1987 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 35-40.

A discussion is presented of the problems of developing instruments on a card (IAC) for microwave and millimeter-wave test instrumentation. The use of frequency translation to extend the capabilities of existing low-frequency IAC-based instrumentation into the microwave/millimeter-wave region is described. The results of a test arrangement using frequency translation are presented, and a specific implementation suited to IAC-based testing is described. It uses a combination of gallium arsenide monolithic microwave integrated circuits and dielectrically stablizied oscillators (DSOs) assembled on a microstrip board to realize a 10-MHz-18-GHz frequency translator in a physical format suitable for an IAC assembly. A calibration feature is described enabling the frequency drift with temperature of the DSO to be determined. I.E.

A88-36552

WAVEFORM STIMULUS SUBSYSTEM: AN ADVANCED TECHNOLOGY MULTIFUNCTION SUBSYSTEM ON A CARD

DAVID J. PRITCHARD (Honeywell, Inc., Military Avionics Div., Minneapolis, MN) IN: AUTOTESTCON '87; Proceedings of the International Automatic Testing Conference, San Francisco, CA, Nov. 3-5, 1987 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 201-204.

The F-15 TISS ATE (automatic test equipment) requires subsystem-on-a-card technology to achieve the required functionality within the space constraints. The waveform stimulus subsystem (WSS), an example of this advanced technology, is considered. The WSS circuit card consists of two 40-MHz pulse generators and an 80-MHz aribtrary waveform generator. Each generator is independently programmed and is available simultaneously to the user. The implementation of this highly integrated malfunction-detection system on a card is described, and the benefits to performance and maintainability are highlighted. I.E.

A88-36565

THE DEVELOPMENT OF A PORTABLE, AUTOMATIC, MICROWAVE TRANSMISSION LINE TEST SET

VAL DE LA FUENTE (USAF, San Antonio Air Logistics Center, Kelly AFB, TX), GLENN KARUSCHKAT, and FREDERICK SIMONE (Prospective Computer Analysts, Inc., Roslyn, NY) IN: AUTOTESTCON '87; Proceedings of the International Automatic Testing Conference, San Francisco, CA, Nov. 3-5, 1987 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 303-309. refs

Existing test sets for flightline testing of microwave transmission lines are complex, semiportable systems requiring the piece-part testing of waveguides, antennas, and transmission line components in the aircraft. Moreover, these systems are not fully automated and require a large degree of manual intervention. Therefore, advances in test-set miniaturization and automatic control techniques can now be utilized to develop a fully portable, automatic test set for the flightline functional and diagnostic fault isolation testing of RF avionics and microwave transmission lines. A description is given of the proposed capabilities of such a tester, and the benefits expected to be derived from its use. I.E.

A88-36578

A GENERIC, MATE COMPATIBLE ELECTRO-OPTIC TESTER

DAVID W. EDWARDS (Eaton Corp., Information Management Systems Div., Westlake Village, CA) IN: AUTOTESTCON '87; Proceedings of the International Automatic Testing Conference, San Francisco, CA, Nov. 3-5, 1987 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 397-402. refs

In order to enhance the testing of electrooptic systems, a US Air Force Modular Automatic Test Equipment (MATE)-compatible electrooptic test station is proposed. This ATE station would consist of two sections; the first section consisting of a MATE-compatible analog, digital, radio frequency (RF), or radar/electronic warfare (R/EW) ATE station, and the second section consisting of a roll-up, reconfigurable, electrooptic subassembly. The author discusses these two sections, along with the electrooptic ATE components involved, and how these electrooptic ATE components are integrated into a MATE-compatible test station. I.E.

A88-36743#

GAS TURBINE SAFETY IMPROVEMENT THROUGH RISK ANALYSIS

T. M. CROSBY and G. L. REINMAN (Pratt and Whitney, West Palm Beach, FL) ASME, Transactions, Journal of Engineering for Gas Turbines and Power (ISSN 0022-0825), vol. 110, April 1988, p. 265-270. refs

(ASME PAPER 87-GT-15)

This paper is intended to provide the engineer with the information necessary to understand certain statistical methods that are used to improve system safety. It will provide an understanding of Weibull analysis, in that it describes when the Weibull distribution is appropriate, how to construct a Weibull plot, and how to use the parameters of the Weibull distribution to calculate risk. The paper will also provide the engineer with a comprehension of Monte Carlo simulation as it relates to quantifying safety risk. The basic components of Monte Carlo simulation are discussed as well as the formulation of a system model and its application in the gas turbine industry. Author

A88-36923* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

ENERGY ABSORPTION IN COMPOSITE MATERIALS FOR CRASHWORTHY STRUCTURES

GARY L. FARLEY (NASA, Langley Research Center; U.S. Army, Aerostructures Directorate, Hampton, VA) IN: International Conference on Composite Materials, 6th, and European Conference on Composite Materials, 2nd, London, England, July 20-24, 1987, Proceedings. Volume 3 . London and New York, Elsevier Applied Science, 1987, p. 3.57-3.66. refs

Crash energy-absorption processes in composite materials have been studied as part of a research program aimed at the development of energy absorbing subfloor beams for crashworthy military helicopters. Based on extensive tests on glass/epoxy, graphite/epoxy, and Kevlar/epoxy composites, it is shown that the energy-absorption characteristics and crushing modes of composite beams are similar to those exhibited by tubular specimens of similar material and architecture. The crushing mechanisms have been determined and related to the mechanical properties of the constituent materials and specimen architecture. A simple and accurate method for predicting the energy-absorption capability of composite beams has been developed. V.L.

A88-36996

DURABILITY OF GRAPHITE/EPOXY STIFFENED PANELS UNDER CYCLIC POSTBUCKLING COMPRESSION LOADING

ALEXANDER SEGAL, GIVON SITON (Israel Aircraft Industries, Ltd., Lod), and TANCHUM WELLER (Technion - Israel Institute of Technology, Haifa) IN: International Conference on Composite Materials, 6th, and European Conference on Composite Materials, 2nd, London, England, July 20-24, 1987, Proceedings. Volume 5 . London and New York, Elsevier Applied Science, 1987, p. 5.69-5.78. refs

The following study presents an investigation into the capability of flat stiffened composite panels to sustain repeated axial compression loads far in excess of their initial buckling loads. The panels were made of AS4/3502 graphite/epoxy tape (0.135 mm per ply). Each panel consisted of a basic skin of 12 plies, integrally stiffened by four equally spaced stiffeners of either 'I' or 'J' shape. Both types of stiffeners had a web of 12 plies and a cap of 24 plies. Panels were tested to 250000 cycles at increasing load levels, the highest level being close to the static limit load of the panels. The panels were then loaded to failure. Failure occurred at the stiffener's cap and spread to the panel. Manufacturing defects were shown to have some effect on the final failure. Analytical prediction of buckling was obtained using the MSC NASTRAN computer program. Author

A88-37001

FREQUENCY AND FLUTTER ANALYSIS OF WING-TYPE STRUCTURES AND THE RELEVANT OPTIMAL DESIGN

SHENG LIU (Chinese Aeronautical Establishment, Chengdu, People's Republic of China) and QIAO XIN (Nanjing Aeronautical Institute, People's Republic of China) IN: International Conference on Composite Materials, 6th, and European Conference on Composite Materials, 2nd, London, England, July 20-24, 1987, Proceedings. Volume 5 . London and New York, Elsevier Applied Science, 1987, p. 5.144-5.152. refs

This paper investigates the vibration and flutter analysis of wing-type structures and the relevant optimal design. First, the linite element model is formulated by use of a variable-linking technique. The transformation from the static model to the dynamic one is done by means of the static compliance method. Several methods for eigenproblems are discussed and used to analyze several structures models. The optimal design under the frequency constraint is studied. Three-dimensional aerodynamic analysis is made using a subsonic doublet-lattice method and the V-g method. Toward the end, this paper presents the derivatives of the unsteady aerodynamics and the flutter speed with respect to design variables and studies the optimal design subjected to the flutter speed constraint. Author

N88-20519# National Bureau of Standards, Boulder, Colo. Electromagnetic Fields Div.

TIME-DOMAIN SYSTEM FOR IDENTIFICATION OF THE NATURAL RESONANT FREQUENCIES OF AIRCRAFT RELEVANT TO ELECTROMAGNETIC COMPATIBILITY TESTING

J. W. ADAMS, A. R. ONDREJKA, and H. W. MEDLEY Nov. 1987 54 p Sponsored by Army Aviation Systems Command, St. Louis, Mo.

(PB88-164520; NBSIR-87/3077) Avail: NTIS HC A04/MF A01 CSCL 20N

A method of measuring the natural resonant frequencies of a structure is described. The measurement involves irradiating this structure, in this case a helicopter, with an impulsive electromagnetic (EM) field and receiving the echo reflected from the helicopter. Resonances are identified by using a mathematical algorithm based on Prony's method to operate on the digitized reflected signal. The measurement system consists of special TEM horns, pulse generators, a time-domain system, and Prony's algorithm. The frequency range covered is 5 megahertz to 250 megahertz. This range is determined by antenna and circuit characteristics. The measurement system is demonstrated, and measured data from several different helicopters are presented in different forms. These different forms are needed to determine which of the resonant frequencies are real and which are false. The false frequencies are byproducts of Prony's algorithm. GRA

N88-20572# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung Trans-Ueberschall-Entwurfsverfahren.

SOLUTION OF TWO-DIMENSIONAL EULER EQUATIONS: EXPERIENCE WITH A FINITE VOLUME CODE

NORBERT KROLL and ROMESH KUMAR JAIN Sep. 1987 144 p

(DFVLR-FB-87-41; ISSN-0171-1342; ETN-88-91924) Avail: NTIS HC A07/MF A01; DFVLR, VB-PL-DO, Postfach 90 60 58, 5000, Cologne, Federal Republic of Germany, 44.50 deutsche marks

A numerical method for the solution of two-dimensional Euler equations using a finite volume spatial discretization and Runge Kutta time stepping schemes, given by Jameson, Schmidt, and

Turkel (1981) is described. Critical features of the algorithm like implementation of boundary conditions, influence of the artificial dissipation, multistage time stepping schemes, and acceleration techniques for the convergence to steady state, are analyzed. Accuracy and reliability of the computer code is tested in computing subsonic and transonic flows around various airfoils. Results are satisfactory. ESA

N88-20574*# Old Dominion Univ., Norfolk, Va. Dept. of Mechanical Engineering and Mechanics.
DEVELOPMENT OF DISTURBANCES IN SWEPT WING FLOWS Final Report, 1 Jun. 1987 - 15 Apr. 1988
OSAMA A. KANDIL and NABIL M. EL-HADY Apr. 1988 7 p
(Contract NAG1-729)
(NASA-CR-182675; NAS 1.26:182675) Avail: NTIS HC A02/MF A01 CSCL 20D

The development of a subharmonic secondary instability in a boundary layer with pressure gradients controlled by suction was investigated. The effect of suction control on this early stage leading to transition is evaluated. The secondary three-dimensional instability problem for compressible boundary layers was formulated to investigate theoretically the effect of finite amplitude two-dimensional wave on the growth of three-dimensional perturbations in compressible boundary layers. Only a range of Mach numbers up to the transonic, where the critical primary disturbance is two dimensional, was covered. Thr evolution of resonant triads in three-dimensional boundary layers was investigated. The triads investigated were comprised of different modes, stationary crossflow (CF), traveling crossflow, vertical vorticity (VV), and Tollmein-Schlichting (TS) modes. The mean flow used in the calculations is the boundary layer on a modern LFC transonic 23 swept wing. In the analysis the growth of the boundary layer is taken into account assuming that it is of the same order as the nonlinear effects. B.G.

N88-20575# Toronto Univ., Downsview (Ontario). Inst. for Aerospace Studies.
AN INTERFEROMETRIC INVESTIGATION OF THE DIFFRACTION OF PLANAR SHOCK WAVES OVER A HALF-DIAMOND CYLINDER IN AIR
D. L. ZHANG and I. I. GLASS Mar. 1988 107 p
(Contract DNA-001-85-C-0368; AF-AFOSR-0124-87; NSERC-A1647)
(UTIAS-322; ISSN-0082-5255) Avail: NTIS HC A06/MF A01

An investigation is conducted on the diffraction of planar shock waves over a half-diamond (45 deg wedge angles) cylinder (28 mm x 28 mm x 56 mm cross section) in air at initial pressures ranging from 6.67 Kpa to 80.3 Kpa (50 torr to 605 torr), at an initial temperature near 300 K in all cases and at initial Mach numbers ranging from 1.35 equal to or less than M sub S equal to or less than 2.82. More than 150 experiments were conducted including models with smooth, spongy (plastic), rough (sandpaper) and saw-tooth surfaces. Infinite fringe interferograms were used throughout. The UTIAS 10 cm x 18 cm hypervelocity shock tube and the 23 cm diam field-of-view Mach-Zehnder interferometer were utilized for this purpose. The induced flows behind the incident shock waves were subsonic, transonic and supersonic. The subsequent intersections with the initial wedge produced regular, single Mach, complex Mach, and double Mach reflections. The isopycnics over the entire flowfields were evaluated and the pressure fields determined using the isentropic equation of state. A half-size model was also used to study the effects of longer flow durations. Author

N88-20579 Cornell Univ., Ithaca, N.Y.
AN ADAPTIVE GRID TECHNIQUE FOR SOLUTION OF THE EULER EQUATIONS Ph.D. Thesis
DUN CHARLES LIU 1987 245 p
Avail: Univ. Microfilms Order No. DA8725831

To reduce errors associated with large solution gradients, under constraints of a fixed number of grid points, it is desirable to have the grid clustered in regions of large gradient and loosely arranged in regions of small gradient. Such mesh systems cannot be constructed without knowledge of the behavior of the solution. The grid equations are formed from linear combination of the Euler-Lagrange equations derived from functionals measuring smoothness, orthogonality and concentration. A directional concentration functional is proposed to take into consideration the effect of the direction of changing cell dimensions. Some salient features of the grid equations are explored by examining the existence of characteristic lines. The adaptive grid technique is applied to solve a finite volume approximation of the Euler equations for the transonic flow in quasi-one-dimensional nozzles and past two-dimensional airfoils. The multigrid method is incorporated to facilitate convergence when solving the grid equations. To speed up the convergence of the flow calculation, a new four stage coefficient set used in the Runge-Kutta scheme is derived, based upon the idea of reducing the growth factor in the high wavenumber region. Dissert. Abstr.

N88-20596# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany). Unternehmensgruppe Hubschrauber und Flugzeuge.
GENERAL FUSELAGE COORDINATES FOR THE CALCULATION OF THREE-DIMENSIONAL BOUNDARY LAYERS Thesis - Technische Univ., Munich, Fed. Republic of Germany [ALLGEMEINE RUMPFKOORDINATEN FUER DIE BERECHNUNG DREIDIMENSIONALER GRENZSCHICHTEN]
R. HOELD 14 Jul. 1986 91 p In GERMAN
(MBB/LKE-122/S/PUB/244; ETN-88-91436) Avail: NTIS HC A05/MF A01

A programming package for the numerical calculation of three-dimensional boundary layers in aerodynamics was developed. It is suited for sub-, trans-, and supersonic flows. The fundamentals of general boundary layer coordinates and boundary layer theory are presented. The boundary layer calculation package consists of several programs, allowing a flexible application. Emphasis is placed on the control and the presentation of the results, facilitating the recognition and elimination of errors. A calculation network, adapted to the flow pattern about the body, was developed, with a view to the parabolic character of the boundary layer-equations. The developed program version was tested on a rotation ellipsoid; the calculated results agree with experimental results for an angle of attack of 0 deg, but differ substantially for increasing angles. ESA

N88-20597# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
ACTIVITIES REPORT OF THE LILLE INSTITUTE OF FLUID MECHANICS Annual Report, 1986
Sep. 1987 15 p Original contains color illustrations
(ETN-88-91983) Avail: NTIS HC A03/MF A01

Analysis and modeling of flight dynamics at high angles of attack; composite blade models; turn over of light aircraft when landing; computation of elastomer structures; a cryogenic model of the A320 aircraft for the wind tunnel; modeling of an isotropic explosion in a uniform flow; validation of tracer behavior models in a flow by holographic velocimetry; and qualification of the lift system of the NES 200 L surface effect ship are discussed. ESA

N88-20598*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, Calif.
PRELIMINARY IN-FLIGHT BOUNDARY LAYER TRANSITION MEASUREMENTS ON A 45 DEG SWEPT WING AT MACH NUMBERS BETWEEN 0.9 AND 1.8
J. BLAIR JOHNSON Mar. 1988 47 p
(NASA-TM-100412; H-1436; NAS 1.15:100412) Avail: NTIS HC A03/MF A01 CSCL 20D

A preliminary flight experiment was flown to generate a full-scale supersonic data base to aid the assessment of computational codes, to improve instrumentation for measuring boundary layer transition at supersonic speeds, and to provide preliminary information for the definition of follow-on programs. The experiment was conducted using an F-15 aircraft modified with a small cleanup test section on the right wing. Results are presented for Mach

(M) numbers from 0.9 to 1.8 at altitudes from 25,000 to 55,000 ft. At M greater than or = 1.2, transition occurred near or at the leading edge for the clean configuration. The furthest aft that transition was measured was 20 percent chord at M = 0.9 and M = 0.97. No change in transition location was observed after the addition of a notch-bump on the leading edge of the inboard side of the test section which was intended to minimize attachment line transition problems. Some flow visualization was attempted during the flight experiment with both subliming chemicals and liquid crystals. However, difficulties arose from the limited time the test aircraft was able to hold test conditions and the difficulty of positioning the photo chase aircraft during supersonic test points. Therefore, no supersonic transition results were obtained.
Author

N88-20661# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
EUROPEAN APPROACHES IN STANDARD SPECTRUM DEVELOPMENT
A. A. TENHAVE 26 Jan. 1987 17 p Presented at the ASTM Symposium on Development of Fatique Loading Spectra, Cincinnati, Ohio, 29 Apr. 1987
(NLR-MP-87007-U; B8729622; ETN-88-91735) Avail: NTIS HC A03/MF A01

Typical characteristics of various types of aircraft service loading are presented as they were discussed during the establishment of standardized test load sequences. Counting methods are reviewed and a simple and powerful algorithm is given to perform rainflow counting and to store the counting results afterwards. Synthesis procedures that generate rainflow consistent load sequences from matrix-based counting results are discussed.
ESA

N88-20665*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
OPTIMAL PLACEMENT OF TUNING MASSES FOR VIBRATION REDUCTION IN HELICOPTER ROTOR BLADES
JOCELYN I. PRITCHARD (Army Aviation Research and Development Command, Hampton, Va.) and HOWARD M. ADELMAN Mar. 1988 16 p Presented at the 29th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, Williamsburg, Va., 18-20 Apr. 1988
(NASA-TM-100562; NAS 1.15:100562; AVSCOM-TM-88-B-003)
Avail: NTIS HC A03/MF A01 CSCL 20K

Described are methods for reducing vibration in helicopter rotor blades by determining optimum sizes and locations of tuning masses through formal mathematical optimization techniques. An optimization procedure is developed which employs the tuning masses and corresponding locations as design variables which are systematically changed to achieve low values of shear without a large mass penalty. The finite-element structural analysis of the blade and the optimization formulation require development of discretized expressions for two performance parameters: modal shaping parameter and modal shear amplitude. Matrix expressions for both quantities and their sensitivity derivatives are developed. Three optimization strategies are developed and tested. The first is based on minimizing the modal shaping parameter which indirectly reduces the modal shear amplitudes corresponding to each harmonic of airload. The second strategy reduces these amplitudes directly, and the third strategy reduces the shear as a function of time during a revolution of the blade. The first strategy works well for reducing the shear for one mode responding to a single harmonic of the airload, but has been found in some cases to be ineffective for more than one mode. The second and third strategies give similar results and show excellent reduction of the shear with a low mass penalty.
Author

N88-20666*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
FLUID-THERMAL-STRUCTURAL STUDY OF AERODYNAMICALLY HEATED LEADING EDGES
PRAMOTE DEUCHAMPHAI, EARL A. THORNTON (Old Dominion Univ., Norfolk, Va.), and ALLAN R. WIETING Apr. 1988 16 p Presented at the AIAA/ASME/ASCS/AHS 29th Structures, Structural Dynamics and Materials Conference, Williamsburg, Va., 18-20 Apr. 1988
(NASA-TM-100579; NAS 1.15:100579) Avail: NTIS HC A03/MF A01 CSCL 20K

A finite element approach for integrated fluid-thermal-structural analysis of aerodynamically heated leading edges is presented. The Navier-Stokes equations for high speed compressible flow, the energy equation, and the quasi-static equilibrium equations for the leading edge are solved using a single finite element approach in one integrated, vectorized computer program called LIFTS. The fluid-thermal-structural coupling is studied for Mach 6.47 flow over a 3-in diam cylinder for which the flow behavior and the aerothermal loads are calibrated by experimental data. Issues of the thermal-structural response are studied for hydrogen-cooled, super thermal conducting leading edges subjected to intense aerodynamic heating.
Author

N88-20672# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Structures Dept.
ACTIVITIES REPORT OF THE STRUCTURES DEPARTMENT Annual Report, 1986
Jul. 1987 25 p Original contains color illustrations
(ETN-88-91986) Avail: NTIS HC A03/MF A01

Finite element computation of composite plates with a nonlinear model of degradation and fracture related to a behavior instability; response of an elasto-acoustical structure to a diffuse, low frequency noise; and random vibrations in the medium frequency domain of the main elements of the SA 365 Dauphin helicopter are discussed. Active control of a deformable aircraft subjected to turbulence: numerical simulation; multicontrols in unsteady aerodynamics with spoilers; flight test systems for flutter study; technical assistance to aircraft builders for dynamic identification of aeronautic structures; unsteady aerodynamic forces induced on an oscillating jet engine with jet flow; aeroelasticity of compressor blades; and prediction of helicopter rotor loads are reviewed. Prediction of lifetime of structures operating at high temperature; damage mechanics and local approaches to cracking; synthesis of plastic and viscoplastic constitutive equations; and the strength of the fiber-matrix interface in a composite material are considered.
ESA

N88-21136 Joint Publications Research Service, Arlington, Va.
PROPAGATION OF ARTIFICIAL DISTURBANCES IMMERSED IN THICK TURBULENT BOUNDARY LAYER Abstract Only
XIAO MING and H. U. MEIER *In its* JPRS Report: Science and Technology. China p 34 5 Jun. 1987 Transl. into ENGLISH from Kongqi Donglixue Xuebao (Mianyang, People's Republic of China), v. 5, no. 1, 1987 p 76-81 Original language document was announced in IAA as A87-37559
Avail: Issuing Activity

In wind tunnel tests, trip wires or local surface roughness are often applied to fix the boundary layer transition on airfoils or wings. The propagation of such artificial disturbances, immersed in a turbulent boundary layer, on a flat wind tunnel side wall is investigated at zero and adverse pressure gradient. It was found that the momentum loss resulting from boundary layer disturbance remains in the boundary layer downstream. In zero pressure gradient flow, this local momentum loss is almost an additive constant quantity. On the other hand, an adverse pressure gradient results in amplification of this momentum loss. The boundary layer disturbances resulting from wires of different diameters and locations can be quantified.
Author

N88-21408# Center for Mathematics and Computer Science, Amsterdam (Netherlands). Dept. of Numerical Mathematics.
AN EXPERIMENTAL-COMPUTATIONAL INVESTIGATION OF TRANSONIC SHOCK WAVE-TURBULENT BOUNDARY LAYER INTERACTION IN A CURVED TEST SECTION
C. NEBBELING and B. KOREN Jul. 1987 20 p Submitted for publication Sponsored in part by the Netherlands Foundation for the Technical Sciences

(CWI-NM-R8716; B8729647; ETN-88-91788) Avail: NTIS HC A03/MF A01

A transonic shock wave-turbulent boundary layer interaction was studied in a curved test section in which the flow was computed by a 2-D Euler flow method. The flow field near the shock wave at the convex wall corresponds to that near the shock wave at the upper surface of a transonic airfoil. The Mach number distributions from the Euler flow computations are compared to those obtained from holographic interferometry, at flow Mach numbers upstream of the shock wave of 1.15 and 1.37. At both Mach numbers the stream-line curvature leads to a supersonic region downstream of the shock wave. Relying on the Euler flow computations this must be attributed to viscous effects. Surface curvature and the adverse pressure gradient induce, compared to flat plate experiments without adverse pressure gradient, an increase of the boundary layer displacement thickness and of the shape factor. No increase of the separation length is measured with respect to experiments at noncurved surfaces. The separation criterion of ALBER et al. (1971) agrees with the present findings; this does not apply to the reattachment criterion. ESA

N88-21414*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

WAVE INTERACTIONS IN A THREE-DIMENSIONAL ATTACHMENT LINE BOUNDARY LAYER Final Report

PHILIP HALL and SHARON O. MACKERRELL Mar. 1988 35 p Submitted for publication

(Contract NAS1-18107)

(NASA-CR-181653; ICASE-88-22; NAS 1.26:181653) Avail: NTIS HC A03/MF A01 CSCL 20D

The 3-D boundary layer on a swept wing can support different types of hydrodynamic instability. Attention is focused on the so-called spanwise contamination problem, which occurs when the attachment line boundary layer on the leading edge becomes unstable to Tollmien-Schlichting waves. In order to gain insight into the interactions important in that problem, a simplified basic state is considered. This simplified flow corresponds to the swept attachment line boundary layer on an infinite flat plate. The basic flow here is an exact solution of the Navier-Stokes equations and its stability to 2-D waves propagating along the attachment can be considered exactly at finite Reynolds number. This has been done in the linear and weakly nonlinear regimes. The corresponding problem is studied for oblique waves and their interaction with 2-D waves is investigated. In fact, oblique modes cannot be described exactly at finite Reynolds number so it is necessary to make a high Reynolds number approximation and use triple deck theory. It is shown that there are two types of oblique wave which, if excited, cause the destabilization of the 2-D mode and the breakdown of the disturbed flow at a finite distance from the leading edge. First, a low frequency mode related to the viscous stationary crossflow mode is a possible cause of breakdown. Second, a class of oblique wave with frequency comparable with that of the 2-D mode is another cause of breakdown. It is shown that the relative importance of the modes depends on the distance from the attachment line. Author

N88-21421*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

HIGH-SPEED FLOW CALCULATIONS PAST 3-D CONFIGURATIONS BASED ON THE REYNOLDS AVERAGED NAVIER-STOKES EQUATIONS

DENNY S. CHAUSSEE Mar. 1988 12 p

(NASA-TM-100082; A-88118; NAS 1.15:100082) Avail: NTIS HC A03/MF A01 CSCL 20D

A computational fluid dynamics tool has been developed capable of analyzing the viscous supersonic/hypersonic flow about realistic configurations. This techniques can predict the flow in regions of canopies, wings, and canards in addition to the usual simple symmetric configurations. It also allows for interactions between aerodynamic surfaces such as the vortex interaction between canards and wings. Author

N88-21426# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung Systemtechnik und Navigation.

DESIGN, SIMULATION AND LABORATORY TESTING OF AN INERTIAL SYSTEM FOR MEASURING THE ATTITUDE AND NARROW-SPACED MOTIONS

BERNHARD STIELLER, EGMAR LUEBECK, and VOLKER WETZIG Nov. 1986 184 p In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-1104)

(DFVLR-FB-87-42; ISSN-0171-1342; ETN-88-92111) Avail: NTIS HC A09/MF A01; DFVLR, VP-PL-DO, Postfach 90 60 58, 5000, Cologne, Fed. Republic of Germany, 62 Deutsche marks

A system for accurately measuring the attitude of an aircraft model under dynamic conditions in a wind tunnel was developed. Accuracy is within 0.03 deg using strapdown sensors of limited quality. The system also allows accurate measurement of fast narrow-spaced motions. Sensor errors are calibrated while the system is at rest, and their constant part is compensated during the measurement phase. ESA

N88-21454*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

ADVANCED TRANSMISSION STUDIES

JOHN J. COY and ROBERT C. BILL (Army Aviation Research and Development Command, Cleveland, Ohio.) 1988 15 p Proposed for presentation at the 44th Annual Forum of the American Helicopter Society, Washington, D.C., 16-18 Jun. 1988

(Contract DA PROJ. 1L1-62209-AH-76)

(NASA-TM-100867; E-4089; NAS 1.15:100867; AVSCOM-TR-88-C-002) Avail: NTIS HC A03/MF A01 CSCL 131

The NASA Lewis Research Center and the U.S. Army Aviation Systems Command share an interest in advancing the technology for helicopter propulsion systems. In particular, this paper presents highlights from that portion of the program in drive train technology and the related mechanical components. The major goals of the program are to increase the life, reliability, and maintainability; reduce the weight, noise, and vibration; and maintain the relatively high mechanical efficiency of the gear train. The current activity emphasizes noise reduction technology and analytical code development followed by experimental verification. Selected significant advances in technology for transmissions are reviewed, including advanced configurations and new analytical tools. Finally, the plan for future transmission research is presented. Author

N88-21461# Bristol Univ. (England). Dept. of Aerospace Engineering.

STRUCTURAL AND MATERIAL TESTING OF A COMPOSITE MICROLITE WING MODEL B.E. Thesis

G. R. DEANUS and M. J. ELWELL Jun. 1987 83 p Original contains color illustrations

(BU-355; ETN-88-91895) Avail: NTIS HC A05/MF A01

A composite wing structure made from foam supported GFRP sheet material, proposed as a replacement for the conventionally constructed wing used on the MW5 microlight aircraft was studied. A full chord, one third span wing model was used for testing. Simulation of a critical load case and torsion tests were carried out, followed by an ultimate load test. Failure occurs at 2.3 times the proof load and reveals failure mechanisms which should be considered in future designs. Material tests establish the composite's true properties, and contribute to explaining the discrepancy between experimental and theoretical stress values. Weight analysis of the composite was carried out, but further work is necessary to achieve significant weight reduction. The separate effects of damage and reducing foam thickness were investigated in a series of panel buckling tests. The foam thickness tests were compared with values found by laminated plate buckling theory and a good correlation between the two is seen. ESA

N88-21476*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

QUICK ACTUATING CLOSURE AND HANDLING SYSTEM

JOHNNY W. ALLRED, DORSEY E. WHITE, III, BENJAMIN T.

UPDIKE, and PEYTON B. GREGORY *In its* The 22nd Aerospace Mechanisms Symposium, p 99-114 May 1988
Avail: NTIS HC A18/MF A01 CSCL 13E

A quick activating closure and handling system, which utilizes conical sections for locking, was developed to allow quick access to the combustor internal components of the 8 ft High Temperature Tunnel. These critical components include the existing methane spraybar, a transpiration cooled nozzle and the new liquid oxygen (LOX) injection system housed within the combustor. A substantial cost savings will be realized once the mechanism is installed since it will substantially reduce the access time and increase the time available for conducting wind tunnel tests. A need exists for more frequent inspections when the wind tunnel operates at the more severe conditions generated by using LOX in the combustor. A loads analysis and a structural (finite element) analysis were conducted to verify that the new closure system is compatible with the existing pressure shell. In addition, strain gages were placed on the pressure vessel to verify how the pressure shell reacts to transient pressure loads. A scale model of the new closure system was built to verify the operation of the conical sections in the locking mechanisms. Author

N88-21482*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DEVELOPMENT OF DRIVE MECHANISM FOR AN OSCILLATING AIRFOIL
CLIFFORD D. STICHT *In* NASA. Langley Research Center, The 22nd Aerospace Mechanisms Symposium p 189-197 May 1988
Avail: NTIS HC A18/MF A01 CSCL 13I

The design and development of an in-draft wind tunnel test section which will be used to study the dynamic stall of airfoils oscillating in pitch is described. The hardware developed comprises a spanned airfoil between schlieren windows, a four bar linkage, flywheels, a drive system and a test section structure. Author

N88-21511*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EVALUATION OF STRUCTURAL ANALYSIS METHODS FOR LIFE PREDICTION
A. KAUFMAN, J. F. SALTSMAN, G. R. HALFORD, and M. TONG (Sverdrup Technology, Inc., Cleveland, Ohio.) *In its* Nonlinear Constitutive Relations for High Temperature Applications, 1986 p 201-216 Apr. 1988
Avail: NTIS HC A21/MF A01 CSCL 20K

The utility of advanced constitutive models and structural analysis methods are evaluated for predicting the cyclic life of an air-cooled turbine blade for a gas turbine aircraft engine. Structural analysis methods of various levels of sophistication were exercised to obtain the cyclic stress-strain response at the critical airfoil location. Calculated strain ranges and mean stresses from the stress-strain cycles were used to predict crack initiation lives by using the total strain version of the strain range partitioning life prediction method. The major results are given and discussed. Author

N88-21522*# Pratt and Whitney Aircraft, East Hartford, Conn.
NONLINEAR STRUCTURAL ANALYSIS OF A TURBINE AIRFOIL USING THE WALKER VISCOPLASTIC MATERIAL MODEL FOR B1900 + HF
T. G. MEYER, J. T. HILL, and R. M. WEBER *In* NASA. Lewis Research Center, Nonlinear Constitutive Relations for High Temperature Applications, 1986 p 359-369 Apr. 1988
Avail: NTIS HC A21/MF A01 CSCL 20K

A viscoplastic material model for the high temperature turbine airfoil material B1900 + Hf was developed and was demonstrated in a three dimensional finite element analysis of a typical turbine airfoil. The demonstration problem is a simulated flight cycle and includes the appropriate transient thermal and mechanical loads typically experienced by these components. The Walker viscoplastic material model was shown to be efficient, stable and easily used. The demonstration is summarized and the performance of the material model is evaluated. Author

N88-21524*# General Electric Co., Cincinnati, Ohio.
CONSTITUTIVE RESPONSE OF RENE 80 UNDER THERMAL MECHANICAL LOADS
K. S. KIM, T. S. COOK, and R. L. MCKNIGHT *In* NASA. Lewis Research Center, Nonlinear Constitutive Relations for High Temperature Applications, 1986 p 395-418 Apr. 1988
Avail: NTIS HC A21/MF A01 CSCL 20K

The applicability of a classical constitutive model for stress-strain analysis of a nickel base superalloy, Rene' 80, in the gas turbine thermomechanical fatigue (TMF) environment is examined. A variety of tests were conducted to generate basic material data and to investigate the material response under cyclic thermomechanical loading. Isothermal stress-strain data were acquired at a variety of strain rates over the TMF temperature range. Creep curves were examined at 2 temperature ranges, 871 to 982 C and 760 to 871 C. The results provide optimism on the ability of the classical constitutive model for high temperature applications. Author

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GEOSCIENCES

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

A88-34584
MOMENTUM FLUX IN THE SUBCLOUD LAYER OF A MICROBURST-PRODUCING THUNDERSTORM DETERMINED FROM JAWS DUAL-DOPPLER DATA
YEONG-JER LIN and PATRICK M. CONDRAY (Missouri-Saint Louis, University, Saint Louis) Boundary-Layer Meteorology (ISSN 0006-8314), vol. 43, no. 1-2, April 1988, p. 125-141. USAF-supported research. refs
(Contract NSF ATM-83-12172-01)

A three-dimensional wind field has been produced based on dual-Doppler wind data for the July 14, 1982 convective storm collected during the Joint Airport Weather Studies project. Fields of deviation perturbation pressure and virtual temperature, retrieved from a detailed wind field, were used to calculate the generation of the vertical transport of horizontal momentum in the subcloud layer of a microburst-producing storm during the quasi-steady mature stage. The results indicate that the microburst occurrence in the atmospheric boundary layer enhances eddy transfer of momentum. Processes contributing to the generation/dissipation of horizontal momentum flux were identified. R.R.

A88-35137
THE CLASSIFICATION AND PREDICTION OF SMALL-SCALE WINDSHEAR EVENTS IN A DRY ENVIRONMENT
FERNANDO CARACENA (NOAA, Environmental Research Laboratories, Boulder, CO) and JOHN A. FLUECK (Colorado, University; NOAA, Environmental Research Laboratories, Boulder) IN: Aerospace century XXI: Space sciences, applications, and commercial developments; Proceedings of the Thirty-third Annual AAS International Conference, Boulder, CO, Oct. 26-29, 1986 . San Diego, CA, Univelt, Inc., 1987, p. 1349-1360. refs
(AAS PAPER 86-404)

Two conceptual models of microbursts are discussed, and the environmental characteristics of the dry microburst are considered. Dry or virga-type microbursts are shown to be associated with high based cumulonimbus clouds with almost vanishing rain at the surface, and it is noted that they form in environments that occur commonly in the western U.S. The present prediction method involves the use of input predictors based on local morning sounding data and a linear model which yields predictions of microburst activity for the ensuing convective cycle. R.R.

A88-35138
SPATIAL AND TEMPORAL SCALES OF ATMOSPHERIC DISTURBANCES
A. J. BEDARD, JR. (NOAA, Environmental Research Laboratories, Boulder, CO) IN: Aerospace century XXI: Space sciences, applications, and commercial developments; Proceedings of the Thirty-third Annual AAS International Conference, Boulder, CO, Oct. 26-29, 1986 . San Diego, CA, Univelt, Inc., 1987, p. 1361-1378. refs
(Contract DOT-FA01-84-Z-02007)
(AAS PAPER 86-405)

Atmospheric disturbances that influence flight are reviewed. These range from microbursts (diverging, short-lived flows in the lower boundary layer) to gravity/shear waves (which can persist for many hours and influence large areas). This paper documents properties, such as typical wind speed changes, scale lengths, and lifetimes, that can be used to model vehicle response. Additional background is provided by extensive references. Finally, the potential of remote sensors for improving detection, warning, and characterization of these disturbances is discussed. Author

A88-35139
DOPPLER RADAR FOR PREDICTION AND WARNING
MICHAEL D. EILTS (NOAA, National Severe Storms Laboratory, Norman, OK) IN: Aerospace century XXI: Space sciences, applications, and commercial developments; Proceedings of the Thirty-third Annual AAS International Conference, Boulder, CO, Oct. 26-29, 1986 . San Diego, CA, Univelt, Inc., 1987, p. 1379-1389. refs
(Contract DOT-FA01-80-Y-10524)
(AAS PAPER 86-417)

The utility of a Doppler weather radar to detect wind shears, precipitation, and turbulence hazards is shown. Possible ways to warn of these harzards 5-30 minutes in advance using Doppler radar data are given. Because Doppler radar can map the wind and convergence fields in the clear air, convective boundary layer prediction of preferred areas of storm and cloud formation is possible. Author

A88-35140* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
HIGH ALTITUDE TURBULENCE FOR SUPERSONIC CRUISE VEHICLES
L. J. EHERNBERGER (NASA, Flight Research Center, Edwards, CA) IN: Aerospace century XXI: Space sciences, applications, and commercial developments; Proceedings of the Thirty-third Annual AAS International Conference, Boulder, CO, Oct. 26-29, 1986 . San Diego, CA, Univelt, Inc., 1987, p. 1391-1405. Previously announced in STAR as N87-23100. refs
(AAS PAPER 86-418)

The characteristics of high altitude turbulence and its associated meteorological features are reviewed. Findings based on data from NASA flight research programs with prototype military aircraft, the XB-70 and YF-12A, are emphasized. An example of detailed numerical atmospheric simulations, which may provide greatly increased understanding of these earlier turbulence observations, is presented. Comparisons between observation and numerical simulation should help to delineate the limitations of analysis techniques and improve our understanding of atmospheric processes in the stratosphere. Author

N88-20757# Massachusetts Inst. of Tech., Cambridge. Lincoln Lab.
A PRELIMINARY ASSESSMENT OF THUNDERSTORM OUTFLOW WIND MEASUREMENT WITH AIRPORT SURVEILLANCE RADARS
MARK E. WEBER and WILLIAM R. MOSER 15 May 1987 90 p
(Contract F19628-85-C-0002)
(AD-A189064; ATC-140; DOT/FAA/PM-86-38) Avail: NTIS HC A05/MF A01 CSCL 17I

Modern airport surveillance radars (ASR) situated on or near most major air terminals, feature coherent pulse Doppler processing, a vertical fan beam and rapid azimuthal antenna scanning for detection and tracking of aircraft. These radars might serve an additional useful role by making radial wind measurements in the immediate vicinity of an airport so as to provide data on thunderstorm outflow winds. This report presents a preliminary analysis of the capabilities and limitations of ASRs in measuring outflow winds. Principal results are: (1) radar sensitivity is adequate to measure winds associated with weakly reflecting (5 to 20 dBZ) thunderstorm outflows at ranges less than 20 km provided that appropriate operating parameters are chosen; (2) overhanging precipitation, often moving at a markedly different radial velocity than the outflow, will be a significant source of interference owing to the vertical-fan antenna pattern. If radar reflectivity is approximately constant with altitude, this interference will limit the maximum range for reliable outflow velocity measurements to about 20 km for an outflow that extends 1000 m above the surface and to 7 km for an outflow that extends only 300 m above the surface; (3) At two example major air terminals (Memphis International and Denver Stapleton) ground clutter suppression of approximately 40 dB, combined with the use of inter-clutter visibility techniques, would result in an adequate signal-to-interference ratio for thunderstorm outflow velocity measured over the significant approach/departure corridors. GRA

N88-20758*# South Dakota School of Mines and Technology, Rapid City. Inst. of Atmospheric Sciences.
ATMOSPHERIC ELECTRICAL MODELING IN SUPPORT OF THE NASA F-106 STORM HAZARDS PROJECT Final Report, 15 Mar. 1984 - 14 Jun. 1987
JOHN H. HELSDON, JR. Mar. 1988 137 p
(Contract NAG1-463)
(NASA-CR-181639; NAS 1.26:181639; SDSMT/IAS/R-87/02)
Avail: NTIS HC A07/MF A01 CSCL 04B

A recently developed storm electrification model (SEM) is used to investigate the operating environment of the F-106 airplane during the NASA Storm Hazards Project. The model is 2-D, time dependent and uses a bulkwater microphysical parameterization scheme. Electric charges and fields are included, and the model is fully coupled dynamically, microphysically and electrically. One flight showed that a high electric field was developed at the aircraft's operating altitude (28 kft) and that a strong electric field would also be found below 20 kft; however, this low-altitude, high-field region was associated with the presence of small hail, posing a hazard to the aircraft. An operational procedure to increase the frequency of low-altitude lightning strikes was suggested. To further the understanding of lightning within the cloud environment, a parameterization of the lightning process was included in the SEM. It accounted for the initiation, propagation, termination, and charge redistribution associated with an intracloud discharge. Finally, a randomized lightning propagation scheme was developed, and the effects of cloud particles on the initiation of lightning investigated. Author

N88-20773*# Michigan Technological Univ., Houghton. Dept. of Mechanical Engineering and Engineering Mechanics.
POWER SPECTRAL DENSITY ANALYSIS OF WIND-SHEAR TURBULENCE FOR RELATED FLIGHT SIMULATIONS M.S. Thesis
TONY R. LAITURI 1988 219 p
(Contract NAG1-717)
(NASA-CR-182721; NAS 1.26:182721) Avail: NTIS HC A10/MF A01 CSCL 04B

Meteorological phenomena known as microbursts can produce abrupt changes in wind direction and/or speed over a very short distance in the atmosphere. These changes in flow characteristics have been labelled wind shear. Because of its adverse effects on aerodynamic lift, wind shear poses its most immediate threat to flight operations at low altitudes. The number of recent commercial aircraft accidents attributed to wind shear has necessitated a better understanding of how energy is transferred to an aircraft from wind-shear turbulence. Isotropic turbulence here serves as the basis of comparison for the anisotropic turbulence which exists in the low-altitude wind shear. The related question of how isotropic turbulence scales in a wind shear is addressed from the perspective of power spectral density (psd). The role of the psd in related Monte Carlo simulations is also considered. Author

N88-21593*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

COMPARISON OF PRESSURE DISTRIBUTIONS ON MODEL AND FULL-SCALE NACA 64-621 AIRFOILS WITH AILERONS FOR WIND TURBINE APPLICATION Final Report

G. M. GREGOREK, R. J. KUNIEGA (Ohio State Univ., Columbus.), and T. W. NYLAND Apr. 1988 14 p
(Contract DE-AI01-76ET-20320)
(NASA-TM-100802; DOE/NASA/20320-75; E-3982; NAS 1.15:100802) Avail: NTIS HC A03/MF A01 CSCL 10B

The aerodynamic similarity between a small (4-inch chord) wind tunnel model and a full-scale wind turbine blade (24-foot tip section with a 36-inch chord) was evaluated by comparing selected pressure distributions around the geometrically similar cross sections. The airfoils were NACA 64-621 sections, including trailing-edge ailerons with a width equal to 38 percent of the airfoil chord. The model airfoil was tested in the OSU 6- by 12-inch High Reynolds Number Wind Tunnel; the full-scale blade section was tested in the NASA Langley Research Center 30- by 60-foot Subsonic Wind Tunnel. The model airfoil contained 61 pressure taps connected by embedded tubes to pressure transducers. A belt containing 29 pressure taps was fixed to the full-scale section at midspan to obtain surface pressure data. Lift coefficients were obtained by integrating pressures, and corrections were made for the 3-D effects of blade twist and downwash in the blade tip section. The results of the two different experimental methods correlated well for angles of attack from minus 4 to 36 degrees and aileron reflections from 0 to 90 degrees. Author

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MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

A88-32958

OPTIMAL CONTROL; PROCEEDINGS OF THE CONFERENCE ON OPTIMAL CONTROL AND VARIATIONAL CALCULUS, OBERWOLFACH, FEDERAL REPUBLIC OF GERMANY, JUNE 15-21, 1986

ROLAND BULIRSCH, ED. (Muenchen, Technische Universitaet, Munich, Federal Republic of Germany), ANGELO MIELE, ED. (Rice University, Houston, TX), JOSEF STOER, ED. (Wuerzburg, Universitaet, Federal Republic of Germany), and K. H. WELL, ED. (DFVLR, Institut fuer Dynamik der Flugsysteme, Oberpfaffenhofen, Federal Republic of Germany) Conference supported by the Universitaet Kaiserslautern. Berlin and New York, Springer-Verlag (Lecture Notes in Control and Information Sciences. Volume 95), 1987, 343 p. In English and German. For individual items see A88-32959 to A88-32973.

The conference presents papers on optimal control theory and computational methods, aircraft trajectory control, control system design, robot control, water resources management, and control of flexible structures. Attention is given to singular perturbations and asymptotic expansions in nonlinear optimal control, an approach to control theory by fixed point algorithms, the sensitivity and optimal control of elastic structures with distributed parameters, aircraft trajectory optimization by curvature control, and the synthesis of optimal nonlinear feedback laws. Other topics include nonlinear system analysis by direct collocation, numerical computation of singular control functions for a two-link robot arm, and optimal control of a distributed system. K.K.

A88-33632

EXPERT SYSTEMS IN DATA ACQUISITION

BOB MCCAULEY (Computer Sciences Corp., Lompoc, CA) IN: ITC/USA/'87; Proceedings of the International Telemetering Conference, San Diego, CA, Oct. 26-29, 1987 . Research Triangle Park, NC, Instrument Society of America, 1987, p. 41-49.

A prototype expert system has been implemented in order to monitor F15 VSTOL aircraft engine tests and predict engine stalls. The development and validation of the system is described, and the architecture is discussed, including the use of a symbolic processor using an expert system compiler/generator. The implementation problems are examined, as are the difficulties associated with extracting the expert information from the experts. C.D.

A88-33805

FUNDAMENTALS OF THE SYSTEMS DESIGN OF AIRCRAFT COMPLEXES [OSNOVY SISTEMNOGO PROEKTIROVANIIA KOMPLEKSOV LETATEL'NYKH APPARATOV]

SERGEI FEOFANOVICH MATVEEVSKII Moscow, Izdatel'stvo Mashinostroenie, 1987, 240 p. In Russian. refs

The book is concerned with the general principles of the systems design of aircraft complexes, which are treated as large technical systems. Topics discussed include general analysis of large technical systems, a macromodel of a large technical system, strategies of the human operator of a large technical system, and objective and subjective estimates of the efficiency of large technical systems. The discussion also covers organizational aspects of large technical systems, including selection of system organization alternatives under conditions of risk and indeterminacy. V.L.

A88-34054

DESIGNING A MASTER EXECUTIVE FOR A DISTRIBUTED MULTIPROCESSOR AVIONICS SYSTEM

BRIAN CLAUSING (Symbolic Systems, Inc., Mason, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 174-179.

The design of a master executive program for an avionics system with many conventional processors loosely coupled in a two-tier, high-bandwidth network must utilize the inherent advantages and avoid the disadvantages of the architecture, guarantee not only real-time performance but also failsafe operation, use Ada, and present a usable interface to applications. It is possible to design a real-time master executive that is reusable and largely independent of hardware specifications. An analysis of some of the major issues in the design of a distributed processing operating system is presented and some suggestions on the use of Ada are made. I.E.

A88-34058

A REVIEW OF TRADITIONAL SYSTEM RECONFIGURATION TECHNIQUES AND THEIR APPLICABILITY TO THE UNIQUE REQUIREMENTS OF DIGITAL AVIONICS

MARK R. RUTENBERG (ITT Corp., ITT Avionics Div., Nutley, NJ) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 192-198.

The major approaches to reconfiguration for the achievement of fault tolerance are surveyed with a view toward identifying the underlying fundamental technical challenges. The implications on fault detection and isolation resulting from the fact that digital systems do not have a representative continuous transfer function is stressed. It is shown that implementation of reconfiguration in digital avionics would require serious system reliability analysis and probably extend the state-of-the-art in reliable system design. This is because digital avionics falls directly between the two classical modes of application of reconfiguration to achieve fault tolerance. Suggestions are made as to how this gap can most effectively be bridged. I.E.

A88-34104
SIMPLIFYING FAULT/ERROR HANDLING MODELS
PAUL G. HIGGINS (General Electric Co., Binghamton, NY) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 583-587.

The increased complexity of flight-critical control systems has led to the development of a new of reliability prediction tools (e.g., CARE II, SURE, and HARP). The methodologies and fault/error handling models (FEHMs) used by these tools have considerably increased the level of comprehension of the issues and problems associated with system failure modes and reliability prediction. However, the reliability prediction process has become much more complicated. This problem provided the motivation to search for a practical and reasonably accurate FEHM. The results of this search are documented and demonstrate that (with the proper assumptions) the simpler SURE FEHM can be derived from the more detailed CARE III FEHM. I.E.

A88-34115#
NONLINEAR MATRIX DIFFERENTIAL EQUATIONS ARISING IN FLIGHT CONTROL
JOHN JONES, JR. (USAF, Institute of Technology, Wright-Patterson AF, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 664-671.

Matrix differential equations arising in flight control theory are considered. The questions of establishing the existence of solutions of the Riccati matrix differential equation of the form dX (z)/dz = (A(z)X(z) + X (z)B(z) + C(z) + X(z)D(z)X(z) where X (z 0) = X0 holds for z belonging to a closed bounded simply-connected region D in the complex z-plane will be considered. The equations belong to the algebra mn(z) of n by n holomorphic matrices. I.E.

A88-34132#
THREE DIMENSIONAL PICTORIAL FORMAT GENERATION
RONALD E. OPP, II, JOHN P. ZENYUH, and JOHN M. REISING (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 815-818.

The crew stations of future military and civilian aircraft will increasingly rely on computer-generated display formats to present information to the aircrew. The authors discuss both the software developed to display true three-dimensional (3-D) stereo formats, and the algorithms and calibrations used to develop the software. They also describe the equipment used to generate the 3-D pictorial formats, including the graphics generator and the 3-D display system. I.E.

A88-34133#
BUILT-IN-TEST SOFTWARE FOR AN ADA AVIONICS HOT BENCH
BEVERLY L. MOODY, DAVID A. HENSLEY, and JAMES W. BENNETT (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 820-824. refs

The built-in-test (BIT) software project is part of the Ada avionics hot bench (AAHB) project at Wright-Patterson Air Force Base. The BIT software project, written entirely in the Ada programming language, provides a means of testing all the avionics hardware on the hot bench. BIT tests all systems and subsystems connected to the MIL-STD-1553B data bus. BIT software, is described, including error detection and exception handling, the error log file, useful tasking features, message processing, and enumeration types. I.E.

A88-34160
A CLOSED-LOOP SIMULATOR FOR TACTICAL AIRCRAFT SYSTEMS
ALAN N. STEINBERG (Litton Industries, Amecom Div., College Park, MD) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 3 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1034-1041.

A practical concept for a closed-loop software engagement simulator for tactical systems has been developed. This simulator may be used to evaluate the effectiveness of aircraft sensor/response systems and to develop and assess tactics for using these systems. The simulator reduces processing load and software complexity to practical levels through: (a) an architecture that features a small number of model templates, with a few simple interface types; (b) the extensive use of simple performance models; and (c) partitioning the simulator to streamline run-time operation. I.E.

A88-34195
A GENERALIZED AIRSPACE EXPERT SYSTEM
STEVEN O. SCOTT (Texas Instruments, Inc., Dallas) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1315-1317. refs

The design and development of a generalized airspace expert system (AES) for use in military and commercial aircraft are presented. The AES is designed with a layered approach, with increasing levels of functionality and responsibility. Built around a spatial database core, the layers expand in capability toward the level of expert reasoning. Details are given on the airspace database, the intelligent query translator, the computational layer, expert reasoning capabilities, and the map display. I.E.

A88-34196
CITS EXPERT PARAMETER SYSTEM (CEPS) MULTIPLE LAYER-MULTIPLE PATH KNOWLEDGE BASE STRUCTURE
KEVIN F. CAVANAUGH (Boeing Military Airplane Co., Seattle, WA) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1318-1323.

The expert system developed by Boeing for the CEPS program uses features such as functional partitioning, multiple layer rules, and multiple path rules. This structure was developed to enhance speed, maintainability, and flexibility. Functional partitioning limits the number of rules the expert system must exercise, multiple layers provides a simpler and more maintainable structure, and multiple paths allows for missing elements in the expert system's facts base. The concepts discussed provide practical solutions to some of the considerations that must be dealt with to make CEPS effective. I.E.

A88-34197
KNOWLEDGE ENGINEERING FOR A PILOTING EXPERT SYSTEM
CHRISTA MCNULTY (Texas Instruments, Inc., Computer Science Center, Dallas) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1326-1330. DARPA-supported research. refs
(Contract F33615-82-C-1841)

The author describes the knowledge engineering process for the design and implementation of a piloting expert system for a robotic air vehicle. The paper then highlights the techniques for acquiring the pertinent fighter pilot knowledge and the evolution of a knowledge representation strategy. I.E.

A88-34200
THE TI DALLAS INFERENCE ENGINE (TIDIE) KNOWLEDGE REPRESENTATION SYSTEM

GARR S. LYSTAD (Texas Instruments, Inc., Defense Systems and Electronics Group, Dallas) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1348-1351.

The TIDIE knowledge representation system, used on the robotic air vehicle program, is described. The basic constructs, called plans and needs, are described in detail. The advantages of plans and needs in representing the knowledge used to control a vehicle are briefly discussed. Other features of the knowledge representation are mentioned. The first and second implementations are noted. I.E.

A88-34204
AN INTELLIGENT SPATIAL DATABASE SYSTEM FOR INTERACTION WITH A REAL-TIME PILOTING EXPERT SYSTEM
JOYCE M. GRAHAM (Texas Instruments, Inc., Dallas) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1375, 1376.

The approach being used by Texas Instruments to develop an intelligent spatial database system is described. This system must represent three-dimensional airspace containing both static and dynamic objects. Information will be accessed by a piloting expert system and a passive navigation system. I.E.

A88-34205
A KNOWLEDGE BASED APPROACH TO STRATEGIC ON-BOARD MISSION MANAGEMENT
GEORGE F. WILBER (Boeing Military Airplane Co., Seattle, WA) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1377-1381.

The author outlines some strategic inflight mission management issues, then sketches an onboard mission manager that uses artificial intelligence techniques. Tasks handled by the mission manager include mission planner, global flight path generator, local flight path generator, crew interface, database manager, and navigation and guidance. I.E.

A88-34207
AVIONICS EXPERT SYSTEMS: THE TRANSITION TO EMBEDDED SYSTEMS
S. C. PILET and R. O. STENERSON (Boeing Military Airplane Co., Seattle, WA) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1388-1393. refs

An approach to the transition of expert systems into an embedded environment has been described. This approach improves reliability while reducing integration costs. However, the issues of fault tolerances, applications interfaces, and validation require further investigation. The ability to insert current expert systems into prototype avionics environments was necessary to research these issues as, it is noted, they can only be solved within a systems context. I.E.

A88-34210
A SIMULATION ENVIRONMENT FOR THE DEVELOPMENT OF INTELLIGENT VEHICLE SYSTEMS
KEVIN J. LEHNERT and MARION LINEBERRY (Texas Instruments, Inc., Computer Science Center, Dallas) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1415-1420.

The goal of the intelligent vehicle workstation is to provide a realistic, distributed simulation environment for the prototyping of intelligent vehicle systems. By observing simulated vehicle behavior, the user can develop systems of superior fidelity, reducing the cost and difficulty of the transition from simulated to actual systems. The issues associated with simulating various vehicle system configurations under realistic conditions in a field or flight test environment are addressed. I.E.

A88-34213
DISTRIBUTED EXPERT MANAGEMENT SYSTEM (DEMANS)
VINCE WALDRON, HAROLD W. SHARP (Systran Corp., Dayton, OH), and SCOTT A. STEFANOV (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) IN: NAECON 87; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 18-22, 1987. Volume 4 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1442-1447.

The distributed expert management system concept has been developed as a means of coordinating the operations of multiple pilot aiding expert systems. The concept currently includes an executive expert system called the Expert Manager and three subordinate systems. The Expert Manager reduces subordinate system autonomy when conflicts between systems arise, when higher level decision making is required, or when multiple system outputs must be combined for display to the pilot. I.E.

A88-34474
REAL-TIME POLYGON IN-FILL
D. J. ALLERTON, J. D. EVEMY, and E. J. ZALUSKA (Southampton, University, England) IN: Computer applications in spacecraft design and operation. Berlin and New York, Springer-Verlag, 1987, p. 137-152. refs

The design of a microprocessor-based computer-generated image (CGI) system for flight simulation incorporating novel techniques to provide a high degree of fidelity at a relatively low cost is presented. The system uses a stream processor capable of in-filling polygons in real time, which is shown to provide significant advantages. The architecture of the CGI system, software requirements, and in-fill algorithms are discussed. V.L.

A88-34730* Massachusetts Inst. of Tech., Cambridge.
STABILITY AND ROBUSTNESS OF SLOWLY TIME-VARYING LINEAR SYSTEMS
JEFF S. SHAMMA and MICHAEL ATHANS (MIT, Cambridge, MA) IN: IEEE Conference on Decision and Control, 26th, Los Angeles, CA, Dec. 9-11, 1987, Proceedings. Volume 1 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 434-439. refs
(Contract NAG2-297)

A well-known result for finite-dimensional time-varying linear systems is that if each 'frozen time' is stable, then the time-varying system is stable for sufficiently slow time-variations. These results are reviewed and extended to a class of Volterra integrodifferential equations, specifically, differential equations with a convolution operator in the right-hand-side. The results are interpreted in the context of robustness of time-varying linear systems with special emphasis on analysis of gain-scheduled control systems. I.E.

A88-34777
MULTIPLE TARGET TRACKING USING SENSOR ARRAYS
CHARLES K. SWORD, MARWAN SIMAAN, and EDWARD W. KAMEN (Pittsburgh, University, PA) IN: IEEE Conference on Decision and Control, 26th, Los Angeles, CA, Dec. 9-11, 1987, Proceedings. Volume 2 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 1061-1064. refs
(Contract N00014-86-K-0543)

An algorithm for tracking independently moving targets using a sensor array is introduced. The algorithm is designed to track the angle of arrival of the signals emitted or reflected from the targets. Tracking is initiated by using a MUSIC algorithm based on an eigenstructure analysis of the covariance matrix estimated from the sensor outputs. Tracking is maintained by recursively updating the direction vectors associated with each target. Updates of the direction vectors may be computed using a Newton-type iterative procedure for minimizing the trace of a quadratic matrix expression. I.E.

A88-34882
DESIGN OF SET-POINT TRACKING SYSTEMS INCORPORATING INNER-LOOP COMPENSATORS AND FAST-SAMPLING ERROR-ACTUATED DIGITAL CONTROLLERS FOR IRREGULAR LINEAR MULTIVARIABLE PLANTS USING STEP-RESPONSE MATRICES
B. PORTER (Salford, University, England) IN: IEEE Conference on Decision and Control, 26th, Los Angeles, CA, Dec. 9-11, 1987, Proceedings. Volume 3 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 2109-2114. refs

Singular perturbation methods are used to exhibit the asymptotic structure of the transfer function matrices of discrete-time set-point tracking systems incorporating irregular linear multivariable plants that are amenable to inner-loop compensation and associated fast-sampling error-actuated digital control but for which mathematical models are unavailable for design purposes. It is shown that these results facilitate, using only the step-response matrices of compensated open-loop plants, the determination of controller matrices which ensure that the closed-loop behavior of such discrete-time tracking systems becomes increasingly noninteracting as the sampling frequency is increased. These general results are illustrated by designing a fast-sampling error-actuated digital flight controller for the longitudinal dynamics of an aircraft, using only the open-loop step-response matrix of the compensated plant. It is indicated that similar general results are also available for discrete-time set-point tracking systems incorporating regular linear multivariable plants. I.E.

A88-35368* Draper (Charles Stark) Lab., Inc., Cambridge, Mass.
FAR-FIELD MISSION PLANNING FOR NAP-OF-THE-EARTH FLIGHT
OWEN L. DEUTSCH, MUKUND DESAI (Charles Stark Draper Laboratory, Inc., Cambridge, MA), and LEONARD A. MCGEE (NASA, Ames Research Center, Moffett Field, CA) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 13 p. refs
(Contract NAS2-12419)

In the face of numerically superior hostile forces, deployment of individual vehicles to the right place, at the right time, and the ability to plan missions with less conservatism, will become significant force multipliers. Far-field mission planning is one of the enabling technologies that will facilitate force coordination through management of mission timeline, vehicle survivability and fuel constraints. On-board replanning is required to deal responsively with departures from nominal plan execution that result from imperfect knowledge of and temporal variability in the mission environment. The far-field planning problem is posed as a constrained optimization problem and algorithms and structural organization are proposed for the solution. Author

A88-35384
KNOWLEDGE BASED SYSTEM CONCEPTS AND TECHNIQUES APPLIED TO INTEGRATED DIAGNOSTICS
JERRY POOLE (Boeing Military Airplane Co., Wichita, KS), EDDIE R. FOWLER, RON HIGHTOWER, and KEITH HEFTY (Kansas State University of Agriculture and Applied Science, Manhattan) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 14 p. refs

The generic methodology presented for the design of knowledge-based diagnostic systems gives attention to the airborne and ground diagnostics of avionics systems. The methodology encompasses three major steps; its substeps, however, also furnish insights into the design concepts with which a knowledge engineer must be familiar and adept throughout the diagnostic system development cycle. A proof-of-concept project review is given for an avionics diagnostics system. O.C.

A88-35385
ARTIFICIAL INTELLIGENCE APPLICATION TO DIAGNOSTICS/PROGNOSTICS OF FLIGHT CONTROL SYSTEMS
RICHARD S. TEAL (Boeing Helicopter Co., Philadelphia, PA) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 5 p.

An improved and highly cost-effective method for diagnosis and prognosis of flight control system malfunctions is presently sought through the application of AI techniques that combine conventional built-in-testing (BIT) with expert system heuristics. Initial results obtained with this hybrid system exhibit improvements over both conventional stand-alone expert systems and BIT approaches; the implementation features preflight/postflight tests requiring no additional sensors or test equipment. O.C.

A88-35386
THE INTEGRATION OF KNOWLEDGE-BASED EXPERT SYSTEM AND ROTORCRAFT SIMULATION MODELS
DANIEL P. SCHRAGE and MICHAEL W. HEIGES (Georgia Institute of Technology, Atlanta) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 6 p. refs

An approach is prsented to the integration of an existing knowledge-based system with a rotorcraft simulation model, in the interest of the prospective development of such systems as a rotorcraft pilot's associate and a completely autonomous rotary wing aircraft. The existing Autonomous Helicopter System encompasses vision, planning, and control sections that are respectively concerned with (1) local visual scene analysis and global digital terrain analysis; (2) task assignment, goal, and subgoal analyses in view of a situation assessment and a knowledge base; and (3) mission plan-generation/conflict resolution, which generates inputs to the flight control system. O.C.

A88-35388
ROTORCRAFT APPLICATIONS OF DARPA'S PILOT'S ASSOCIATE
PHILIP A. MERKEL (BDM Corp., McLean, VA) IN: Rotorcraft flight controls and avionics; Proceedings of the National Specialists' Meeting, Cherry Hill, NJ, Oct. 13-15, 1987 . Alexandria, VA, American Helicopter Society, 1987, 5 p.

This paper describes the background for the Pilot's Associate program with emphasis on its technical goals. It describes how the technical concept is being implemented in both hardware and software for the planned flight simulation environment. It provides an early description and assessment of the advanced computing and machine intelligence technologies that are being used in the program and how these technologies might be applied to another type of combat aircaft, a helicopter or rotorcraft, in a Rotorcraft Pilot's Associate. Author

A88-36262#
RISK ANALYSIS APPROACH TO TRANSPORT AIRCRAFT TECHNOLOGY ASSESSMENT
ROBERT G. BATSON (Alabama, University, Tuscaloosa) and ROBERT M. LOVE (Lockheed-Georgia Co., Marietta) Journal of Aircraft (ISSN 0021-8669), vol. 25, Feb. 1988, p. 99-105. refs
(Contract F33615-81-C-3031)

The need to quantify uncertainty in the assessment of the costs and benefits of potential applications of advanced aircraft technology is recognized. In this paper, we present a Monte Carlo simulation approach that was successfully implemented in a recent USAF-sponsored technology assessment study. Details are given of the math model used to represent the sensitivity of aircraft performance and fleet cost-effectiveness to technology variations. The uncertainty analysis process is described, and results from the study are presented. Advantages of including risk analysis in all conceptual design studies are discussed. Author

A88-36272*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
LANGLEY ADVANCED REAL-TIME SIMULATION (ARTS) SYSTEM

DANIEL J. CRAWFORD and JEFF I. CLEVELAND, II (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 25, Feb. 1988, p. 170-177.

A system of high-speed digital data networks was developed and installed to support real-time flight simulation at the NASA Langley Research Center. This system, unlike its predecessor, employs intelligence at each network node and uses distributed 10-V signal conversion equipment rather than centralized 100-V equipment. A network switch, which replaces an elaborate system of patch panels, allows the researcher to construct a customized network from the 25 available simulation sites by invoking a computer control statement. The intent of this paper is to provide a coherent functional description of the system. This development required many significant innovations to enhance performance and functionality such as the real-time clock, the network switch, and improvements to the CAMAC network to increase both distances to sites and data rates. The system has been successfully tested at a usable data rate of 24 M. The fiber optic lines allow distances of approximately 1.5 miles from switch to site. Unlike other local networks, CAMAC does not buffer data in blocks. Therefore, time delays in the network are kept below 10 microsec total. This system underwent months of testing and was put into full service in July 1987. Author

A88-36489#
AEDC'S FACILITY COMPUTER ENHANCEMENT PROJECT
DAVID C. BOND and JAMES L. COGBURN (USAF, Arnold Engineering Development Center, Arnold Air Force Station, TN) IN: ICIASF '87 - International Congress on Instrumentation in Aerospace Simulation Facilities, 12th, Williamsburg, VA, June 22-25, 1987, Record . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 69-76. refs

As part of an investment program to decrease the cost of aerospace testing by improving test efficiency as well as preparing for test requirements projected through 1993, data processing and communication capabilities are being upgraded at the Arnold Engineering Development Center (AEDC) in Tennessee. Tradeoffs and technical considerations made during the first year of the program and the design of the new system are discussed. Capabilities that will support test objectives at the completion of the project in 1989 are presented. I.E.

A88-36528
AUTOTESTCON '87; PROCEEDINGS OF THE INTERNATIONAL AUTOMATIC TESTING CONFERENCE, SAN FRANCISCO, CA, NOV. 3-5, 1987
Conference sponsored by IEEE. New York, Institute of Electrical and Electronics Engineers, Inc., 1987, 509 p. For individual items see A88-36529 to A88-36586.

Topics discussed include the Air Force MATE program, the Navy CASS program, the Army IFTE program, RF testing, artificial intelligence, maintenance and training, design for testability, and ATPG techniques. Consideration is also given to diagnostic techniques, TPS developoment, military tesitng, digital testing, electrooptics testing, integrated diagnostics/testability, and documentation and training. B.J.

A88-36529
THE MATE INTEGRATION PROGRAM
ARNOLD M. GREENSPAN and BARRY A. BENDEL (SofTech, Inc., Alexandria, VA) IN: AUTOTESTCON '87; Proceedings of the International Automatic Testing Conference, San Francisco, CA, Nov. 3-5, 1987 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 3-6.

A brief historical sketch of the MATE program is presented, and the current status of this program is then assessed. Particular emphasis is placed on the MATE program during its integrated phase. An effort is made to provide a coherent view of how the lessons that have been learned are being used to ensure that the MATE program will represent the best possible cost-effective application of the acquisition proces to meet the needs of the U.S. Air Force. B.J.

A88-36532
THE DESIGN OF THE MATE TEST EXECUTIVE
DONALD J. JOHANN, JR. (Unisys Corp., Great Neck, NY) IN: AUTOTESTCON '87; Proceedings of the International Automatic Testing Conference, San Francisco, CA, Nov. 3-5, 1987 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 23-25.

An overview is presented of the design of the MATE (Modular Automatic Test Equipment) test executive (MTE). Descriptions of the salient data structures and algorithms are presented with an emphasis on the interpretation of the MATE ATLAS compiler code stream and the generation of the control interface intermediate language. Also discussed are MTE task interactions and the IEEE 488 bus interface. I.E.

A88-36539
POTENTIAL AND DOCUMENTED COST-SAVINGS USING IN-ATE
RICHARD CANTONE (Automated Reasoning Corp., New York) IN: AUTOTESTCON '87; Proceedings of the International Automatic Testing Conference, San Francisco, CA, Nov. 3-5, 1987 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 65-71.

A description is given of eight potential areas in integrated diagnostics where the IN-ATE fault diagnosis expert system environment can produce real cost savings. The Northrop Aircraft Division, in a detailed comparison study, independently developed two test programs to test the F-5 radar system on the Emerson E-8205 ATE. A 40 percent savings in two areas, test program development time and test program run time, was documented. I.E.

A88-36540
A PC BASED EXPERT DIAGNOSTIC TOOL
PAUL M. BURSCH, JOHN W. MEISNER, and KEITH F. WINEGAR (Honeywell, Inc., Minneapolis and Golden Valley, MN) IN: AUTOTESTCON '87; Proceedings of the International Automatic Testing Conference, San Francisco, CA, Nov. 3-5, 1987 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 73-77.

Trends in future military avionic systems indicate that advanced maintenance techniques will be required. To better facilitate advanced diagnostics, a knowledge-based system for a personal computer (PC) has been developed by porting knowledge bases from a symbolic computing environment to a conventional PC system. This system demonstrates the feasibility of advanced maintenance diagnostics techniques using a frame system and object-oriented programming to implement the diagnostic inference mechanism. I.E.

A88-36546
AI AND ATLAS - THE PROSPECTS FOR A MARRIAGE
ROY T. OISHI (ManTech Support Technology, Inc., Alexandria, VA) IN: AUTOTESTCON '87; Proceedings of the International Automatic Testing Conference, San Francisco, CA, Nov. 3-5, 1987 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 161-166.

The possibility of combining the ATLAS language, used for sequential diagnostic test programs, with expert system technology is explored. Extensions to ATE (automatic test equipment) software architectures needed to combine these two technologies are proposed. The advantages of such an approach are discussed. I.E.

A88-36548
ESATE - EXPERT SYSTEM ATE
PHILLIP M. KNAPP (AAI Corp., Hunt Valley, MD) IN: AUTOTESTCON '87; Proceedings of the International Automatic Testing Conference, San Francisco, CA, Nov. 3-5, 1987 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 177-180. refs

ESATE is a study effort to evaluate the potential advantages of using expert systems in conjunction with existing ATLAS test program sets (TPSs). The predicted advantages of expert systems as they apply to automatic test equipment (ATE) are reviewed. In most cases, these advantages counter the shortfall of ATLAS and data-driven diagnostic programs, whose structural rigidity and precomputed testing strategy create limitations for the automated testing community. The author addresses the question of whether a knowledge base can be extracted automatically from existing TPSs so that a database automatically created from these TPSs can work with expert systems. Analysis has shown the need for a dependency structure overlay for these existing TPSs, which would define which tests within the ATLAS test program are independent of other tests, and which were really just one step in a sequential series of dependent tests. The lack of this dependency data in current analog and hybrid TPSs presents the major obstacle in achieving the desired goal. The author examines this issue and presents some early conclusions and recommendations. I.E.

A88-36563

THIRD GENERATION MATE - TODAY'S SOLUTIONS

GARY J. GROSS (AAI Corp., Hunt Valley, MD) IN: AUTOTESTCON '87; Proceedings of the International Automatic Testing Conference, San Francisco, CA, Nov. 3-5, 1987 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 289-291.

The author discusses specific hardware and software advances that increase effective digital test pattern rates and ease test-program-set integration. These advances have been incorporated in the third-generation Modular Automatic Test Equipment (MATE) systems. The most significant advance discussed is the state-of-the-art digital test capability. This capability contains not just stimulus and response hardware, but all of the elements required for efficient test development and execution capability to test SRUs and LRUs (shop-replaceable and line-replaceable units) efficiently. I.E.

A88-36566

DUAL PORT AUTOMATIC TESTING: A PROVEN APPROACH

WILLIAM G. JOLLEY (Honeywell, Inc., Minneapolis, MN) IN: AUTOTESTCON '87; Proceedings of the International Automatic Testing Conference, San Francisco, CA, Nov. 3-5, 1987 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 315-317.

A description is given of a four-year test-program-set development effort for intermediate-level testing of the B-52 ALQ-172 electronic warfare system LRUs (line-replaceable units) using the dual-port AN/USM-603 electronic test set. The efficiency of the dual-port test system concept has been established in the areas of test throughput, mission availability, costs, and facilities requirements. The ability to use a single computer to control both the testing of two LRUs simultaneously, in any combination, and the sharing of common station stimulus and measurement capabilities offer a significant throughput advantage when compared with single-port architecture. I.E.

A88-36573

APU MAID: A DIAGNOSTIC EXPERT SYSTEM USING HEURISTIC AND CAUSAL REASONING

PATRICIA M. MCCOWN and DAVID B. LEWY (Allied-Signal Aerospace Co., Bendix Test Systems Div., Teterboro, NJ) IN: AUTOTESTCON '87; Proceedings of the International Automatic Testing Conference, San Francisco, CA, Nov. 3-5, 1987 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 371-375. refs

The APU (auxiliary power unit) maintenance aid (APU MAID) is an expert-system-based tool developed to enhance flightline maintenance. It utilizes an application-independent event-based knowledge representation that describes the causal relationships between the events of the system and the components that comprise the system, as well as the ascribed symptom/fault relationships. The APU MAID was designed to assist the flightline maintenance technician in performing test, fault detection, fault isolation, and repair of the C-130 APU. It is hosted on a portable, battery-operated computer specifically designed to accommodate the requirements of expert systems diagnostic software. I.E.

A88-36575

AN INTELLIGENT MAINTENANCE AID FOR PORTABLE ATE

KEITH A. HICKEY, THANH C. KIEU, and NANCY L. ADAMS (Emerson Electric Co., Electronics and Space Div., Saint Louis, MO) IN: AUTOTESTCON '87; Proceedings of the International Automatic Testing Conference, San Francisco, CA, Nov. 3-5, 1987 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 383-386. refs

A description is given of the development approach taken to embed a diagnostic expert system within an existing avionics portable automated test equipment (ATE) system. The objective of the project was to enhance the built-in-test (BIT) data by relating the BIT data to user observations, maintenance and test documentation, and failure history. The result was the dual effect of simultaneously increasing the sophistication and capability of the testing system and maintaining the compactness of a portable ATE system. I.E.

A88-36584

TESTABILITY ALLOCATION AND PROGRAM MONITORING FOR FAULT-TOLERANT SYSTEMS PRIOR TO DETAILED DESIGN

DON ALLEN, EDMOND JOE (Northrop Corp., Hawthorne, CA), RANDALL FLEMING, and JILL V. JOSSELYN (Systems Control Technology, Inc., Palo Alto, CA) IN: AUTOTESTCON '87; Proceedings of the International Automatic Testing Conference, San Francisco, CA, Nov. 3-5, 1987 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 441-446. refs

The authors describe a testability allocation methodology, based on linear programming, that treats fault detection and isolation. The linear program links fault coverage to such measures as probability of mission success, hazard risk, life-cycle cost, and sortie availability. The allocation methodology applies to system, subsystem, line-replaceable unit/module (LRU/LRM) and lower hierarchical system levels. The methodology is capable of handling a reconfigurable avionics system containing 1000 LRU/LRMs. I.E.

A88-36586

A MULTILEVEL HIERARCHICAL APPROACH TO BIT

PAUL BERRETT, DOUGLAS DOSKOCIL, and STEVE HADDEN (General Electric Co., Automated Systems Dept., Burlington, MA) IN: AUTOTESTCON '87; Proceedings of the International Automatic Testing Conference, San Francisco, CA, Nov. 3-5, 1987 . New York, Institute of Electrical and Electronics Engineers, Inc., 1987, p. 451-454.

Built-in test (BIT) is envisioned as consisting of three different dimensions: mode, level, and technique. The authors address this three-dimensional strategy which may be used to begin the systems engineering of a BIT system, and describe how the advantages of BIT being a part of the initial design considerations can lead to comprehensive built-in fault detection and isolation. BIT modes are described as being either continuous noninterfering, operator-initiated, technician-initiated maintenance, or augmented. A multilevel hierarchical approach to the entire BIT system is addressed, and it is described how the BIT hierarchy may match the system hierarchy for ease of integration and minimization of unnecessary replications of hardware and software. Finally, the three basic techniques of BIT-monitor, application simulation, and special functions-are given operational definitions, and specific tests are introduced within each group. I.E.

A88-36632

A MATHEMATICAL ANALYSIS OF HUMAN-MACHINE INTERFACE CONFIGURATIONS FOR A SAFETY MONITORING SYSTEM

TOSHIYUKI INAGAKI and YASUHIKO IKEBE (Tsukuba, University, Ibaraki, Japan) IEEE Transactions on Reliability (ISSN 0018-9529), vol. 37, April 1988, p. 35-40. refs

Two human-machine interface configurations for safety monitoring systems are discussed: (1) A conventional fault-warning configuration, which gives an alarm message on detecting plant failure and (2) a safety-presentation configuration introduced here, which can give a safety message as well as an alarm message. It is proved mathematically that the safety-presentation configuration is superior to the fault-warning configuration in the well-defined sense of avoiding catastrophic accidents. I.E.

N88-20832*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
CONFIGURATION MANAGEMENT ISSUES AND OBJECTIVES FOR A REAL-TIME RESEARCH FLIGHT TEST SUPPORT FACILITY
STEPHEN YERGENSEN and DONALD C. RHEA May 1988 12 p Presented at the AIAA 4th Flight Test Conference, San Diego, Calif., 18-20 May 1988
(NASA-TM-100437; H-1463; NAS 1.15:100437) Avail: NTIS HC A03/MF A01 CSCL 12A

Presented are some of the critical issues and objectives pertaining to configuration management for the NASA Western Aeronautical Test Range (WATR) of Ames Research Center. The primary mission of the WATR is to provide a capability for the conduct of aeronautical research flight test through real-time processing and display, tracking, and communications systems. In providing this capability, the WATR must maintain and enforce a configuration management plan which is independent of, but complimentary to, various research flight test project configuration management systems. A primary WATR objective is the continued development of generic research flight test project support capability, wherein the reliability of WATR support provided to all project users is a constant priority. Therefore, the processing of configuration change requests for specific research flight test project requirements must be evaluated within a perspective that maintains this primary objective. Author

N88-20895*# Research Triangle Inst., Research Triangle Park, N.C. Center for Digital Systems Research.
A FAULT INJECTION EXPERIMENT USING THE AIRLAB DIAGNOSTIC EMULATION FACILITY
ROBERT BAKER, SCOTT MANGUM, and CHARLOTTE SCHEPER Mar. 1988 130 p
(Contract NAS1-17964)
(NASA-CR-178390; NAS 1.26:178390) Avail: NTIS HC A07/MF A01 CSCL 09B

The preparation for, conduct of, and results of a simulation based fault injection experiment conducted using the AIRLAB Diagnostic Emulation facilities is described. An objective of this experiment was to determine the effectiveness of the diagnostic self-test sequences used to uncover latent faults in a logic network providing the key fault tolerance features for a flight control computer. Another objective was to develop methods, tools, and techniques for conducting the experiment. More than 1600 faults were injected into a logic gate level model of the Data Communicator/Interstage (C/I). For each fault injected, diagnostic self-test sequences consisting of over 300 test vectors were supplied to the C/I model as inputs. For each test vector within a test sequence, the outputs from the C/I model were compared to the outputs of a fault free C/I. If the outputs differed, the fault was considered detectable for the given test vector. These results were then analyzed to determine the effectiveness of some test sequences. The results established coverage of selt-test diagnostics, identified areas in the C/I logic where the tests did not locate faults, and suggest fault latency reduction opportunities. Author

N88-20896*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
THE USE OF AN AUTOMATED FLIGHT TEST MANAGEMENT SYSTEM IN THE DEVELOPMENT OF A RAPID-PROTOTYPING FLIGHT RESEARCH FACILITY
EUGENE L. DUKE, MARLE D. HEWETT, RANDAL W. BRUMBAUGH, DAVID M. TARTT, ROBERT F. ANTONIEWICZ, and ARVIND K. AGARWAL May 1988 21 p Presented at the 4th Conference on Artificial Intelligence Applications, Long Beach, Calif., 4-6 May 1988
(NASA-TM-100435; H-1477; NAS 1.15:100435) Avail: NTIS HC A03/MF A01 CSCL 09B

An automated flight test management system (ATMS) and its use to develop a rapid-prototyping flight research facility for artificial intelligence (AI) based flight systems concepts are described. The ATMS provides a flight test engineer with a set of tools that assist in flight planning and simulation. This system will be capable of controlling an aircraft during the flight test by performing closed-loop guidance functions, range management, and maneuver-quality monitoring. The rapid-prototyping flight research facility is being developed at the Dryden Flight Research Facility of the NASA Ames Research Center (Ames-Dryden) to provide early flight assessment of emerging AI technology. The facility is being developed as one element of the aircraft automation program which focuses on the qualification and validation of embedded real-time AI-based systems. Author

N88-21683# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
EXAMINATION OF THE EFFECTS OF USING ADA (TRADE NAME) IN FLIGHT CONTROL SOFTWARE M.S. Thesis
JOHN D. KLEMENS Dec. 1987 76 p
(AD-A189679; AFIT/GCS/MA/87D-3) Avail: NTIS HC A05/MF A01 CSCL 12E

This research characterizes flight control software in terms of the Ada (TM) constructs used and of the performance characteristics that determine the suitability of a particular compiler/processor system for flight control software. A new set of three flight control software benchmarks based on this characterization was evaluated on two MIL-STD-1750A processors using two Ada compilers. Results show that compiler/processor combinations can be compared for their ability to implement flight control software in execution speed and memory size required. The benchmarks provide time and space requirements for a typical sample of flight control software. GRA

N88-21740*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
USER'S MANUAL FOR LINEAR, A FORTRAN PROGRAM TO DERIVE LINEAR AIRCRAFT MODELS
EUGENE L. DUKE, BRIAN P. PATTERSON, and ROBERT F. ANTONIEWICZ Dec. 1987 109 p
(NASA-TP-2768; H-1259; NAS 1.60:2768) Avail: NTIS HC A06/MF A01 CSCL 12B

This report documents a FORTRAN program that provides a powerful and flexible tool for the linearization of aircraft models. The program LINEAR numerically determines a linear system model using nonlinear equations of motion and a user-supplied nonlinear aerodynamic model. The system model determined by LINEAR consists of matrices for both state and observation equations. The program has been designed to allow easy selection and definition of the state, control, and observation variables to be used in a particular model. 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.

A88-35939*# McDonnell-Douglas Corp., St. Louis, Mo.
ACOUSTICS TECHNOLOGIES FOR STOVL AIRCRAFT
DAVID S. GROEN (McDonnell Douglas Corp., Saint Louis, MO) AIAA SDM Issues of the International Space Station, Conference, Williamsburg, VA, Apr. 21, 22, 1988. 17 p. refs

(Contract NAS3-24621)
(AIAA PAPER 88-2238)

State-of-the-art acoustic fatigue technologies that are relevant to supersonic Short Takeoff/Vertical Landing (STOVL) aircraft are investigated. Data and methods assessments of acoustic fatigue technologies for acoustic load predictions and stress response predictions are evaluated. Subsonic and supersonic jet noise generation mechanisms, axisymmetric and two-dimensional nozzles, and noise suppression methods are discussed. STOVL far field noise during hover, near field noise, and internal cockpit noise levels are predicted. Stress response prediction methods for acoustic, thermal, and maneuvering loads are addressed and the need for structural analysis methods with all three types of loads applied simultaneously is assessed. Author

A88-36270*# Sverdrup Technology, Inc., Cleveland, Ohio.
HIGH-SPEED PROPELLER NOISE PREDICTIONS - EFFECTS OF BOUNDARY CONDITIONS USED IN BLADE LOADING CALCULATIONS
M. NALLASAMY (Sverdrup Technology, Inc., Cleveland, OH), B. J. CLARK, and J. F. GROENEWEG (NASA, Lewis Research Center, Cleveland, OH) Journal of Aircraft (ISSN 0021-8669), vol. 25, Feb. 1988, p. 154-162. Previously cited in issue 09, p. 1328, Accession no. A87-24978. refs

N88-20964# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Physics Dept.
ACTIVITIES REPORT OF THE PHYSICS DEPARTMENT Annual Report, 1986
Sep. 1987 40 p Original contains color illustrations
(ETN-88-91985) Avail: NTIS HC A03/MF A01

An antistatic coating tester; measurement of tip clearance in turbomachines; the GRADIO Project and electrostatic three-axis accelerometers for space applications; a dedicated processor for correcting the signal from CCD array; and improvement of barometric and accelerometric sensitivities of quartz-crystal resonators are discussed. Effects of aerodynamic flows on image generation; bispectral infrared imaging; infrared cameras; and wavefront analysis are reviewed. Impulsive noise of main helicopter rotors is treated. Application of holographic interferometry on two wavelengths to measuring the density of a plasma; and a secondary emission electron gun are described. Lightning monitoring and warning by radioelectric interferometry and electrostatic measurements; space-time analysis of the electromagnetic radiation associated with lightning discharges; airborne lightning characterization; electromagnetic interference generated on the fly-by-wire controls of an Airbus aircraft by a simulated direct lightning strike; electromagnetic radiation generated by junction of a lightning channel with ground; and determination of the charge distribution within an E-irradiated dielectric are considered. ESA

N88-20966# Applied Research Lab., State College, Pa.
MEASUREMENT AND ANALYSIS OF THE NOISE RADIATED BY LOW MACH NUMBERS CENTRIFUGAL BLOWERS Ph.D. Thesis
D. M. YEAGER and G. C. LAUCHLE Nov. 1987 222 p Prepared in cooperation with IBM Corp., Poughkeepsie, N.Y.
(Contract N00024-85-C-6041)
(AD-A189226; ARL/PSU/TR-87-009) Avail: NTIS HC A10/MF A01 CSCL 20A

The broad band, aerodynamically generated noise in low tip-speed Mach number, centrifugal air moving devices is investigated. An interdisciplinary approach was taken which involved investigation of the aerodynamic and acoustic fields, and their mutual relationship. The noise generation process was studied using two experimental vehicles: (1) a scale model of a homologous family of centrifugal blowers typical of those used to cool computer and business equipment, and (2) a single blade from a centrifugal blower impeller which was placed in a known, controllable flow field. The radiation characteristics of the model blower were investigated by measuring the acoustic intensity distribution near the blower inlet and comparing it with the intensity near the inlet to an axial flow fan. Aerodynamic studies of the flow field in the inlet and at the discharge to the rotating impeller were used to assess the mean flow distribution through the impeller blade channels and to identify regions of excessive turbulence near the rotating blade row. New frequency-domain expressions for the correlation area and dipole source strength per unit area on a surface immersed in turbulence were developed which can be used to characterize the noise generation process over a rigid surface immersed in turbulence. An investigation of the noise radiated from the single, isolated airfoil (impeller blade) was performed using modern correlation and spectral analysis techniques. 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.

A88-36738
SOME CONSIDERATIONS OF THE DRAFT FOR THE CONVENTION ON AN INTEGRATED SYSTEM OF INTERNATIONAL AVIATION LIABILITY
DOO HWAN KIM (Soong Sil University, Seoul, Republic of Korea) Journal of Air Law and Commerce (ISSN 0021-8642), vol. 53, Spring 1988, p. 765-796. refs

The history, background, plan and structure, and guiding principles of the Convention on an Integrated System of International Aviation Liability are discussed. Issues with respect to the Warsaw Convention and reasons why the latter should be amended are examined. The issues of absolute, unlimited, and secured liability and channeling of liability are addressed. Critiques of the Draft for the Convention are described. C.D.

19

GENERAL

N88-21115# National Aerospace Lab., Amsterdam (Netherlands).
ACTIVITIES REPORT IN AERONAUTICS AND ASTRONAUTICS Annual Report, 1986 [VERSLAG OVER HET JAAR 1986]
1986 104 p In DUTCH Original document contains color illustrations
(ETN-88-91332) Avail: NTIS HC A06/MF A01

Research concerning flow (inlet channel of the Fokker-50 engine, development of computer programs); aircraft (development of a measuring, registration, and processing system for the evaluation of the Fokker-50 and Fokker-100); aircraft structures and composite materials; spacecraft control and remote sensing; applied computer sciences; and environment management is summarized. Technical facilities are described. The properties and applications of composites, and the development of satellite ground stations are discussed. ESA

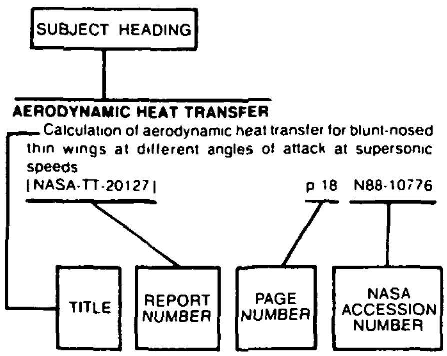
N88-22000# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Cologne (West Germany).
ACTIVITIES REPORT IN FLIGHT AND SPACE TRAVEL Annual Report, 1986
Aug. 1987 126 p In GERMAN; ENGLISH summary Original document contains color illustrations
(ISSN-0070-3966; ETN-88-92102) Avail: NTIS HC A07/MF A01;

Research concerning air traffic management (DIVA Flight Test

Analysis for ATTAS); boundary layer transition investigations with the LFU-205 aircraft; fire safety of aircraft cabins; thermal propulsion systems and high energy lasers; nonnuclear energy systems (wind energy converter); satellite communication and localization (satellite experiments for aeronautical communication); remote sensing of forest damage; a facility to simulate operations in the proximity of spacecraft; and a ringless ceramic Diesel engine is summarized.

ESA

Typical Subject Index Listing



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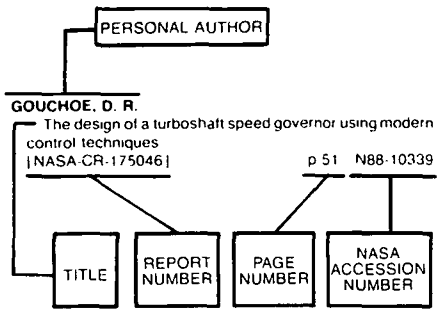

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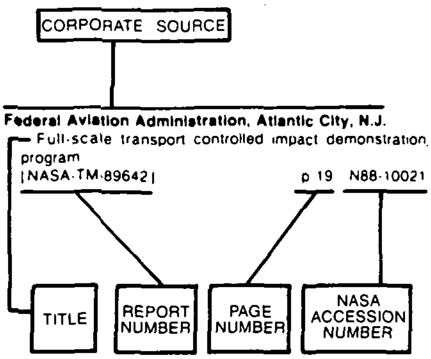
CORPORATE SOURCE INDEX

Typical Corporate Source Index Listing



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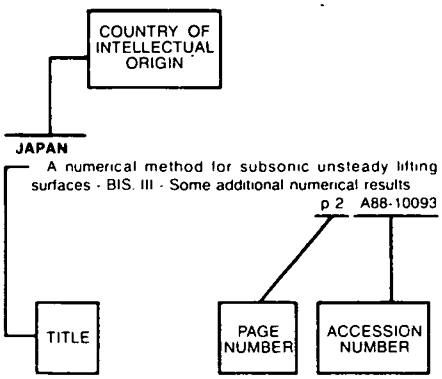
FOREIGN TECHNOLOGY INDEX

Typical Foreign Technology Index Listing



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AERONAUTICAL ENGINEERING / *A Continuing Bibliography (Supplement 229)* August 1988

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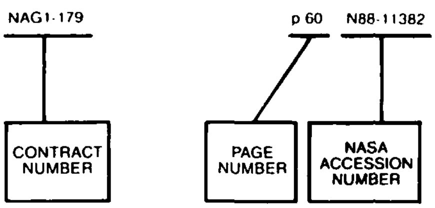

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AERONAUTICAL ENGINEERING / *A Continuing Bibliography (Supplement 229)* August 1988

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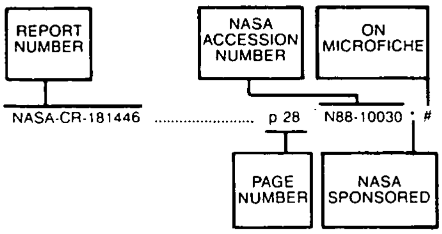

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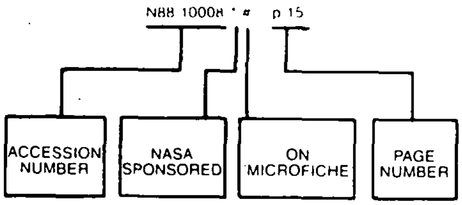

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