NASA

Aeronautical Engineering
A Continuing Bibliography with Indexes

NASA SP-7037 (116)
December 1979

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National Aeronautics and Space Administration

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NASA SP-7037(116)

AERONAUTICAL ENGINEERING

A Continuing Bibliography

Supplement 116

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 November 1979 in

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

Scientific and Technical Information Branch 1979
National Aeronautics and Space Administration
Washington, DC

INTRODUCTION

Under the terms of an interagency agreement with the Federal Aviation Administration this publication has been prepared by the National Aeronautics and Space Administration for the joint use of both agencies and the scientific and technical community concerned with the field of aeronautical engineering. The first issue of this bibliography was published in September 1970 and the first supplement in January 1971. Since that time, monthly supplements have been issued.

This supplement to *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 550 reports, journal articles, and other documents originally announced in November 1979 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 in two major sections, *IAA Entries* and *STAR Entries*, in that order. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* and *STAR*, including the original accession numbers from the respective announcement journals. This procedure, which saves time and money, accounts for the slight variation in citation appearances.

Three indexes -- subject, personal author, and contract number -- are included.

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All publications abstracted in this bibliography are available to the public through the sources as indicated in the *STAR Entries* and *IAA Entries* sections. It is suggested that the bibliography user contact his own library or other local libraries prior to ordering any publication inasmuch as many of the documents have been widely distributed by the issuing agencies, especially NASA. A listing of public collections of NASA documents is included on the inside back cover.

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REPORT NUMBERS

N79-10024*# Northrop Corp., Hawthorne, Calif. Aircraft Group.
STUDY OF AERODYNAMIC TECHNOLOGY FOR VSTOL FIGHTER/ATTACK AIRCRAFT: HORIZONTAL ATTITUDE CONCEPT Final Report
S. H. Brown May 1978 242 p refs Sponsored in part by the David Taylor Naval Ship Research and Development Center, Bethesda, Md.
(Contract NAS2-9771)
(NASA-CR-152130; NOR78-54) Avail: NTIS HC A11/MF A01 CSCL 01A

A horizontal attitude VSTOL (HAVSTOL) supersonic fighter attack aircraft powered by RALS turbofan propulsion system is analyzed. Reaction control for subaerodynamic flight is obtained in pitch and yaw from the RALS and roll from wingtip jets powered by bleed air from the RALS duct. Emphasis is placed on the development of aerodynamic characteristics and the identification of aerodynamic uncertainties. A wind tunnel program is shown to resolve some of the uncertainties. Aerodynamic data developed are static characteristics about all axes, control effectiveness, drag, propulsion induced effects and reaction control characteristics. G.Y.

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A79-10266 * # **An experimental study of three-dimensional turbulent boundary layer and turbulence characteristics inside a turbomachinery rotor passage.** A. K. Anand and B. Lakshminarayana (Pennsylvania State University, University Park, Pa.) *(American Society of Mechanical Engineers, Gas Turbine Conference and Products Show, London, England, Apr. 9-13, 1978, Paper 78-GT-114.) ASME, Transactions, Journal of Engineering for Power,* vol. 100, Oct. 1978, p. 676-687; Discussion, p. 688-690. 19 refs. Grant No. NGL-39-009-007.

Three-dimensional boundary layer and turbulence measurements of flow inside a rotating helical channel of a turbomachinery rotor are described. The rotor is a four-bladed axial flow inducer operated at large axial pressure gradient. The mean velocity profiles, turbulence intensities and shear stresses, and limiting stream-line angles are measured at various radial and chordwise locations, using rotating triaxial hot-wire and conventional probes. The radial flows in the rotor channel are found to be higher compared to those at zero or small axial pressure gradient. The radial component of turbulence intensity is found to be higher than the streamwise component due to the effect of rotation. Flow near the annulus wall is found to be highly complex due to the interaction of the blade boundary layers and the annulus wall resulting in an appreciable radial inward flow, and a large defect in the mainstream velocity. Increased level of turbulence intensity and shear stresses near the midpassage are also observed near this radial location. (Author)

AERONAUTICAL ENGINEERING

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IAA ENTRIES

A79-46995 **Surface-effect components of aerodynamic characteristics of air-cushion vehicle with ram pressurization.** M. A. Gur'ianov. *(Aviatsionnaia Tekhnika,* vol. 21, no. 2, 1978, p. 17-29.) *Soviet Aeronautics,* vol. 21, no. 2, 1978, p. 10-19. 8 refs. Translation.

In the present paper, the general laws of gasdynamics (laws of total pressure, flow rate, and momentum conservation in the gas stream) are used as a basis to derive formulas which relate the skirt components of the aerodynamic characteristics to the parameters defining the geometry and position of the skirts. The interaction force of the oncoming flow is taken into consideration only at the inner surface of the skirts. The latter are configured as a pi-shaped half-tunnel. It is shown that this geometry is characterized by a high L/D ratio and high stability with respect to pitch. V.P

A79-46996 **Statistical diagnostics of aircraft engines.** Iu. V. Kozhevnikov. *(Aviatsionnaia Tekhnika,* vol. 21, no. 2, 1978, p. 30-35.) *Soviet Aeronautics,* vol. 21, no. 2, 1978, p. 20-25. 5 refs. Translation.

The present paper deals with the linear statistical problem of aircraft engine parametric diagnostics for a given set of stable modes of operation. Some diagnostics problems with respect to one or more parameters are analyzed and solved. V.P.

A79-46997 **Optimal thermogasdynamic design of gas turbine engines using element prototypes. I.** Iu. V. Kozhevnikov, V. O. Borovik, V. S. Ivanov, V. A. Talyzin, I. N. Agliullin, and Iu. V. Meluzov. *(Aviatsionnaia Tekhnika,* vol. 21, no. 2, 1978, p. 36-43.) *Soviet Aeronautics,* vol. 21, no. 2, 1978, p. 26-32. Translation.

The problem of optimal thermogasdynamic designing on the basis of a mathematical model of a gas-turbine engine, containing the characteristics of prototype engine elements in similarity parameters is analyzed. Optimality criteria are derived for a two-spool bypass turbojet engine, making allowance for the engines modes of operation. V.P.

A79-46999 **Selection of geometric parameters and location of nose flap on swept wing root profile from tunnel test data. I.** A. I. Matiazh, V. A. Sterlin, V. A. Popov, V. V. Isaev, and G. A. Cheremukhin. *(Aviatsionnaia Tekhnika,* vol. 21, no. 2, 1978, p. 49-54.) *Soviet Aeronautics,* vol. 21, no. 2, 1978, p. 37-41. 5 refs. Translation.

A79-47000 **Analytic formulas for wing profile aerodynamic characteristics in incompressible flow.** N. M. Monakhov. *(Aviatsionnaia Tekhnika,* vol. 21, no. 2, 1978, p. 55-61.) *Soviet Aeronautics,* vol. 21, no. 2, 1978, p. 42-47. Translation.

In the present paper, conformal mapping is applied to the derivation of equations for calculating the lift coefficient, the moment coefficient, and the coordinates of the aerodynamic center and center of pressure for a wing profile in incompressible flow and the velocity at the wing surface. The high accuracy of the formulas is illustrated by examples. V.P.

A79-47001 **On a smooth approximation method and its application to mathematical description of wing aerodynamic characteristics.** V. A. Ovchinnikov, V. D. Osorgin, V. G. Pavlov, and E. Ia. Fedorov. *(Aviatsionnaia Tekhnika,* vol. 21, no. 2, 1978, p. 62-65.) *Soviet Aeronautics,* vol. 21, no. 2, 1978, p. 48-51. Translation.

A79-47002 **Solution of the inverse aerodynamics problem by the random search method.** G. D. Peshatov and Iu. N. Novoselov. *(Aviatsionnaia Tekhnika,* vol. 21, no. 2, 1978, p. 68-73.) *Soviet Aeronautics,* vol. 21, no. 2, 1978, p. 54-58. 7 refs. Translation.

A computer-aided method is proposed for designing subsonic and supersonic wing profiles for a given pressure distribution. An optimization procedure for designing a simply connected contour from the constraints on its shape is outlined, and its block diagram is discussed. V.P.

A79-47009 **Harmonic oscillations of annular wing in steady ideal fluid flow.** Z. N. Shesternina. *(Aviatsionnaia Tekhnika,* vol. 21, no. 2, 1978, p. 115-121.) *Soviet Aeronautics,* vol. 21, no. 2, 1978, p. 93-98. 7 refs. Translation.

Existing methods of solving problems concerning the harmonic vibrations of wings in translational flow are based on the substitution of a system of attached ring vortices for the wing. The methods reduce to the solution of a system of Fredholm integral equations of the first kind. In the method proposed in the present paper, use is made of the same substitution, however, by using the properties of the single-layer potential and a somewhat modified impermeability condition, the problem is reduced to a system of Fredholm integral equations of the second kind with respect to the density of the attached vortices. The detailed formalism of these equations made it possible to prove the uniqueness of the solution, to satisfy the Chaplygin-Joukowski condition, and to determine the influence of the wing profile configuration on the convergence of the iterations. V.P.

A79-47012 **Overall aerodynamic characteristics of caret and delta wings at supersonic speeds.** Iu. P. Gun'ko and I. I. Mazhul'. *(Aviatsionnaia Tekhnika,* vol. 21, no. 2, 1978, p. 129-132.) *Soviet Aeronautics,* vol. 21, no. 2, 1978, p. 107-110. 6 refs. Translation.

A79-47014 **Selecting the passenger airplane fuselage.** Iu. N. Egorov. *(Aviatsionnaia Tekhnika,* vol. 21, no. 2, 1978, p. 135-138.) *Soviet Aeronautics,* vol. 21, no. 2, 1978, p. 114-116. Translation.

Weight and drag criteria are presented for the fuselages of passenger aircraft, with consideration of the space required for passenger accomodations. An expression is obtained relating the surface area, diameter and length of a fuselage for purposes of weight- and drag-optimal design. Relationships between weight and aspect ratio are also examined. B.J.

A79-47093 * Some observations on four current subjects related to aeroelastic stability. H. Ashley (Stanford University, Stanford, Calif.). *(Israel Annual Conference on Aviation and Astronautics, 20th, Tel Aviv and Haifa, Israel, Feb. 22, 23, 1978.) Israel Journal of Technology,* vol. 16, no. 1-2, 1978, p. 3-22. 63 refs. Grants No. AF-AFOSR-74-2712; No. NGL-05-020-243.

After introductory comments on the literature and the purposes of this paper, a table is presented summarizing the author's views on some currently solved vs partially unsolved problems related to aeroelastic stability. The term 'solved' is used in the practical sense that engineers are able to cope confidently with that problem during the process of structural design. Selected entries in the table are reviewed, partially to motivate the topics in the rest of the paper. The 'four current subjects' are chosen both for timeliness and because they are among the ongoing interests of the Stanford group. The first involves the prediction of linearized unsteady aerodynamic loads due to arbitrary motions of streamlined shapes. Some contributions by Edwards are refined, which were motivated by the requirements of active control system design. The second subject is nonlinear unsteady aerodynamics for the transonic regime. After describing a few useful developments from locally-linear theory and computational fluid dynamics, there is suggested an empirical procedure for interim-analysis purposes. The third and fourth subjects concern recent discoveries regarding the aeroelastic stability of large-aspect-ratio wings and wind turbines. The former work is mainly that of Petre and Boyd. The latter includes some of the author's own preliminary discoveries about the performance and dynamics of vertical-axis machines. (Author)

A79-47098 Analysis of optimal loop and split-S by energy state modeling. J. Shinar (Technion - Israel Institute of Technology, Haifa, Israel), D. Yair, and Y. Rotman. *(Israel Annual Conference on Aviation and Astronautics, 20th, Tel Aviv and Haifa, Israel, Feb. 22, 23, 1978.) Israel Journal of Technology,* vol. 16, no. 1-2, 1978, p. 70-82. 13 refs.

Maneuverability in the vertical plane has great importance in performance assessment of high-thrust aircraft. In the paper two basic vertical turning maneuvers are analyzed as minimum-time optimal control problems with terminal constraint. To avoid the complexity of the solution of a TPBVP a reduced order model, based on energy-state approximation, is proposed. This approach is the implementation of the 'maximum maneuver concept' in the vertical plane and leads to the solution of a more simple initial value problem. Moreover, the solution can be expressed in a feedback form, calling for an eventual real-time airborne application. The results of the approximation compare very well to the solution of the original TPBVP. Though the reduced order model identifies only a part of the admissible optimal trajectories, it provides a useful tool to performance comparison and an important insight into the problem of optimal vertical turning maneuvers. (Author)

A79-47099 The calculation of non-linear aerodynamic characteristics of wings and their wakes in subsonic flow. C. R. Zorea and J. Rom (Technion - Israel Institute of Technology, Haifa, Israel). *(Israel Annual Conference on Aviation and Astronautics, 20th, Tel Aviv and Haifa, Israel, Feb. 22, 23, 1978.) Israel Journal of Technology,* vol. 16, no. 1-2, 1978, p. 83-96. 32 refs. Grant No. AF-AFOSR-71-2145.

The paper presents a method for calculating the nonlinear characteristics of wings of rectangular and delta planforms for high down to low aspect ratios in the subsonic speed range. This method can be used to calculate the characteristics of the wings and its wake as a unified system. The numerical calculations are based on the discretization of the vortex sheet into line vortices, and the numerical problems due to this discretization are discussed. Calculations are performed for rectangular wings with aspect ratios of 5.33, 1.0, and 0.25 and for triangular wings with ratios of 1.0, 1.5, and 2.0. The results obtained for the aerodynamic coefficients, the center of pressure position, the load distribution and the wake characteristics are in good agreement with the experimental results particularly for the rectangular wings. Finally, it is noted that the computer time required is a function of the number of cells into which the wings are divided. M.E.P.

A79-47119 # A method of the theory of airfoil profiles with a jet flap (Ob odnom metode v teorii profilia so struinym zakrylkom). I. T. Selezov and I. E. Kornilov (Akademiia Nauk Ukrainskoi SSR, Institut Gidromekhaniki, Kiev, Ukrainian SSR). *Gidromekhanika,* no. 39, 1979, p. 3-6. In Russian.

Sato (1973) has proposed a discrete vortex method for calculating flows past jet-flapped wings, which is based on classical conformal mapping of the wing into a unit circle. In the present paper, Sato's method is subjected to a rigorous analysis. It is shown that introduction of a certain correction term leads to a shift in the position of the jet and a redistribution of the pressure over the wing, which provide a better agreement with the experiment. V.P.

A79-47302 # High-performance reinforced plastic structures for civil aviation (Les structures hautes performances en plastiques renforcés pour l'aviation civile). M. E. Heitz. *Verre Textile, Plastiques Renforcés,* vol. 17, Mar. 1979, p. 37-45. In French.

A79-47341 * # Experiments of shock associated noise of supersonic jets. J. M. Seiner and T. D. Norum (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1526.* 16 p. 17 refs.

The paper examines the aeroacoustics associated with model nozzles operating supersonically. In particular, the shock structure and radiated shock noise of Mach 1.5 and 2.0 nozzles are compared with those of a convergent nozzle over a wide nozzle pressure ratio range corresponding to a fully expanded Mach number between unity and 2.37. The nozzles were operated unheated both with and without a tab for screech tone suppression. The measurements show differences between the shock cell spacing of convergent and convergent-divergent nozzles, and the scaling relation appears to be a function of the exit-to-throat velocity ratio of each nozzle type. The acoustic measurements indicate the extent of the pressure ratio range where a C-D nozzle achieves a noise reduction benefit. At the design point of the Mach 1.5 nozzle, the total integrated sound power from this nozzle is 6 dB less than a convergent nozzle operating at the same pressure ratio and thrust. (Author)

A79-47342 # Fully conservative numerical solutions for unsteady irrotational transonic flow about airfoils. R. Chipman (Grumman Aerospace Corp., Bethpage, N.Y.) and A. Jameson (New York University, New York, N.Y.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1555.* 10 p. 19 refs.

Numerical difference schemes are presented for the computation of unsteady transonic flows about airfoils. A first-order system of equations in conservation form is developed for irrotational (full potential) flow and solved by finite difference methods. To enable the boundary conditions to be imposed directly on the airfoil surface, a time-varying sheared-rectilinear coordinate transformation is used. Explicit differencing schemes are used to solve both lifting and non-lifting cases. Additionally, an alternating direction implicit (ADI) scheme has been coded for efficient solutions in the non-lifting case. Calculated time-accurate solutions for several cases are compared with the results of other unsteady transonic codes. Good correlation is shown with results produced by the more exact but computationally slower Euler-equations codes. Shock location is demonstrated to be better predicted than by small-perturbation or quasi-conservative schemes. (Author)

A79-47345 # **Experimental measurements of shock/boundary-layer interaction of a supercritical airfoil.** K. P. Burdges (Lockheed-Georgia Co., Marietta, Ga.). *American Institute of Aeronautics and Astronautics, Fluid and Plasma Dynamics Conference, 12th, Williamsburg, Va., July 23-25, 1979, Paper 79-1499.* 11 p. 12 refs.

A recent investigation of the shock/boundary-layer interaction region of a state-of-the-art supercritical airfoil in the Lockheed-Georgia Compressible Flow Wind Tunnel is summarized. The test apparatus is a half airfoil model mounted on the floor of the tunnel which provides a boundary layer with proper upstream history from stagnation point through the shock wave to the trailing edge. A four-tube probe traversed the boundary layer in the vicinity of the shock wave. Measurements were made at all flow boundaries to provide boundary conditions for Navier-Stokes calculations of the entire flow field. (Author)

A79-47346 * # **Wing aerodynamic loading caused by jet-induced lift associated with STOL-OTW configurations.** U. von Glahn and D. Groesbeck (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Atmospheric Flight Mechanics Conference, Boulder, Colo., Aug. 6-8, 1979, Paper 79-1664.* 38 p. 5 refs.

Surface pressure distributions were obtained with model-scale STOL-OTW configurations using various nozzles designed to promote flow attachment to the wing-flap surface. The nozzle configurations included slot-types and both circular and slot nozzles with external flow deflectors. The wing aerodynamic loading caused by the jet-induced lift is presented in conventional terms of delta p/q as a function of chordwise surface distance in the nozzle centerline plane as well as outboard of the nozzle centerline. Included in the geometric variables affecting the wing loading are nozzle roof/deflector angle, chordwise location of the nozzle, wing size, and flap deflection angle. (Author)

A79-47347 * # **Performance of a V/STOL tilt nacelle inlet with blowing boundary layer control.** A. L. Johns, R. C. Williams (NASA, Lewis Research Center, Cleveland, Ohio), and H. C. Potonides (Grumman Aerospace Corp., Bethpage, N.Y.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1163.* 11 p. 5 refs.

A scale model of a V/STOL tilt nacelle fitted to a 0.508 m single stage fan was tested in the NASA Lewis low speed wind tunnel to determine the effect of diffuser blowing on the inlet aerodynamics and aeromechanical performance. The test was conducted over a range of freestream speeds (up to 120 knots) and angles-of attack (up to 120 deg). In general, diffuser blowing had a beneficial affect on all performance parameters. The angle-of-attack range for a separation-free flow substantially increased, and the fan face distortion reduced with a corresponding increase in total pressure recovery. Discrete narrow band blade stress peaks which were common to the nonblowing (baseline) configuration were eradicated with diffuser blowing. V.T.

A79-47348 # **New versus existing engines for new helicopter systems - A life cycle cost view.** G. I. Walker (General Electric Co., Aircraft Engine Business Group, Lynn, Mass.). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1316.* 6 p.

The use of life cycle cost analysis as a tool for decision making in system selection with respect to new helicopter system development and acquisition is examined. The tradeoff in choosing an existing engine or a completely new engine as a power plant for a new helicopter is studied. Emphasis is given to the analysis of derivative twin versus new twin engines using parameters for disk loading, rotor solidity ratio, rotor tip speed, and equivalent flat plate areas. C.F.W.

A79-47349 # **The application of multiple swirl modules in the design and development of gas turbine combustors.** B. Jones (Rolls-Royce, Ltd., Combustion Research Dept., Derby, England). *AIAA, SAE, and ASME, Joint Propulsion Conference, 15th, Las Vegas, Nev., June 18-20, 1979, AIAA Paper 79-1196.* 11 p.

The possibility of reducing emissions from gas turbine engines, by means of small swirl modules, is investigated. Attention is given to combustor design variables and the conflicts which arise between factors such as operating cost, engine integrity, short length, and altitude restarting. Design constraints for low emission combustors discussed are: (1) rich primary zone followed by rapid quench, (2) lean primary zone, and (3) fuel staging between two zones each optimized for opposite extremes in the range of operation. Other areas covered are multiple fuel injection modules, and the economic advantages of modular combustors which include simplified test procedure and design modification. In addition, as an example the development of a staged combustor for the Rolls Royce RB.211 engine is described. M.E.P.

A79-47428 # **Nozzles for vectored thrust jet engines (Sopla vozdushno-reaktivnykh dvigatelei s otkloniaemym vektorom tiagi).** K. N. Popov, V. D. Sokolov, and N. I. Khvostov. Moscow, Izdatel'stvo Mashinostroenie, 1979. 144 p. 25 refs. In Russian.

The book deals with the gasdynamic design of nozzles for gasturbine-driven VTOL aircraft. The effectiveness of vectored thrust in vertical takeoff and landing is demonstrated. Some representative powerplant systems for VTOL aircraft are examined. V.P.

A79-47433 # **Fuels, lubricants and other fluids used in aviation (Aviatsionnye goriuche-smazochnye materialy i spetsial'nye zhidkosti).** I. N. Shishkov and V. B. Belov. Moscow, Izdatel'stvo Transport, 1979. 248 p. 18 refs. In Russian.

The properties of fuels, lubricants and other fluids are examined, and their fundamental applications in aviation and ground-based technologies are discussed. Chemical and physical characteristics, production methods and quality control techniques of hydrocarbon fuels for piston and gas turbine engines, including piston engines with spark ignition, piston engines with ignition from compression and jet engines, are considered. The production and properties of motor oils are discussed, with attention given to oils for aircraft piston engines, turbojet engines, turboprop engines, carburetor engines and diesel engines. Consistent greases and solid lubricants are discussed, and cooling, hydraulic, anti-icing and cleaning fluids are examined. A.L.W.

A79-47520 **The inner regions of annular jets.** N. W. M. Ko and W. T. Chan (University of Hong Kong, Hong Kong). *Journal of Fluid Mechanics,* vol. 93, Aug. 14, 1979, p. 549-584. 31 refs.

Further experiments on the detailed study of annular jets are described in which the mean and fluctuating properties in the inner region have been measured. The experiments in the conical jet have shown, besides the jet vortices in the outer mixing region, another train of vortices in the inner region. This train of vortices is due to the wake formed by the boundary layer on the surface of the conical bullet. The experiments in the inner region of the basic annular jet have similar mean velocity profiles to those in the internal recirculating region. Good correlation is found for the location of the vortex center, the location of reattachment, the minimum and maximum mean static pressure and their locations with the non-dimensional available pressure Mo/AiPatm for entrainment behind the interface. A train of wake vortices is generated in the internal recirculating region and a train of jet vortices is found in the inner mixing region. Both types of vortices in the inner region seem to decay fairly rapidly within a distance of one outer diameter Do downstream. The disturbances associated with the wake vortices in the inner region seem to excite the outer mixing region. (Author)

A79-47535 # **Some early experiments in the development of a flying platform for aerodynamic testing.** S. M. Ramachandra (Hindustan Aeronautics, Ltd., Bangalore, India). *Revue Roumaine des Sciences Techniques, Série de Mécanique Appliquée,* vol. 24, Jan.-Feb. 1979, p. 109-117.

The flying aerodynamic platform reported in this paper offers an attractive method of interference free aerodynamic testing using a suitably instrumented airplane or glider as the model carrier. The low cost of glider operation coupled with reasonable operating times and satisfactory model scales makes the flying platform inexpensive for aerodynamic testing and is liable to considerable development. (Author)

A79-47606 **Development of V/STOL aircraft - 1950 to 1970.** J. P. Campbell (Joint Institute for Advancement of Flight Sciences, Hampton, Va.). *American Helicopter Society, Journal,* vol. 24, June 1979, p. 7-16. 14 refs.

In the period from 1950 to 1970 many significant V/STOL aircraft were built and flown and important advances were made in the development of V/STOL technology. This chronological account of V/STOL aircraft starts with the early work on propeller and turbojet vertical-attitude VTOL concepts, and then covers the much more extensive work on horizontal-attitude concepts in separate sections devoted to propeller, turbojet and turbofan, lift-fan, ejector augmentor and rotor V/STOL aircraft. B.J.

A79-47607 **V/STOL Technology - Where do we stand.** R. F. Siewert (U.S. Navy, Naval Air Systems Command, Washington, D.C.). *American Helicopter Society, Journal,* vol. 24, June 1979, p. 17-29. 16 refs.

A broad survey of those aspects of the basic airframe technologies that directly impact V/STOL aircraft configurations is presented. Configurations, aerodynamics, structures, propulsion and flight control are addressed. The dominant problem in developing any V/STOL aircraft is to optimally integrate the propulsion system and the airframe to achieve performance consistent with the aircraft mission requirements. Therefore, focus is on hover and low speed flight characteristics including propulsion induced effects, flight control requirements, and the characteristics of propulsion systems as lifting and/or control devices. Based on this survey, and recognizing that while there are still problems that must be solved, it is concluded that in light of the many technological solutions which exist and are constantly being expanded and improved, V/STOL technology is adequate to permit the development of viable and useful V/STOL aircraft. (Author)

A79-47608 * **Recent V/STOL aircraft designs.** W. H. Deckert (NASA, Ames Research Center, V/STOL Aircraft Technology Div., Moffett Field, Calif.). *American Helicopter Society, Journal,* vol. 24, June 1979, p. 30-37.

The paper reviews the V/STOL aircraft designs pursued by industry from 1971 to 1978, with emphasis on the 1975-1978 period. Consideration is given to those designs pertaining to vertical-attitude and horizontal-attitude V/STOL types. These are divided into such concepts as tilting jet engine, lift/cruise engine, lift engine, lift/cruise fan, ejector augmentor, tilt rotor, stowed rotor, and rotor wing. B.J.

A79-47654 # **Developments in gear analysis and test techniques for helicopter drive systems.** C. Albrecht (Boeing Vertol Co., Philadelphia, Pa.). *American Society of Mechanical Engineers, Design Engineering Conference and Show, Chicago, Ill., May 7-10, 1979, Paper 79-DE-15.* 16 p. 16 refs.

Improvements in helicopter transmission gearing analysis and test techniques have been developed for the high-precision, lightweight gears used on the Heavy Lift, UTTAS and CH-47C and D helicopter drive systems. The use of finite element analyses for performing gear stress and natural frequency calculations: transmission vibration/noise methodology; damage tolerance concepts and failure detection methods are discussed. (Author)

A79-47750 **Lifting-line theory for a swept wing at transonic speeds.** L. P. Cook (California, University, Los Angeles, Calif.). *Quarterly of Applied Mathematics,* vol. 37, July 1979, p. 177-202. 13 refs.

The boundary value problems are derived describing first-order corrections of two-dimensional transonic small disturbance equations to two-dimensional flow about a lifting swept wing at freestream Mach number less than unity. The method of matched asymptotic expansion of the transonic small disturbance equations for x determining the correction is used. The three-dimensional transonic small disturbance theory boundary value problem for a lifting yawed wing is formulated and the methods of Van Dyke and of Cook and Cole for high aspect ratio are examined. C.F.W.

A79-47844 **The principles of hovercraft, powering and propulsion.** *Hovering Craft and Hydrofoil,* vol. 18, June-July 1979, p. 10-14.

The principles, history and development of hovercraft are outlined, together with design aspects, resistances, powering and propulsion. Some types of hovering craft are discussed, as well as the historical development of amphibious and nonamphibious craft, and their sealing arrangements such as skirts and sidewalls. In addition, some basic theory is provided for understanding the hovering principle, and the mechanisms by which this is achieved. Finally, lift and propulsive devices are reviewed, as well as their design aspects, resistances acting, and trends. M.E.P.

A79-47845 **Gas turbines for ACV's and hydrofoils.** *Hovering Craft and Hydrofoil,* vol. 18, June-July 1979, p. 17-20.

Attention is given to the principles of marine gas turbines and their applications in hydrofoils and hovercraft. The turbine gas cycle is discussed along with design features such as single or two shaft machines, heat exchangers, open or closed cycle preheating, and axial or rotary compressors. Fuels are also covered. Finally, applications for naval boost propulsion, merchant ship propulsion and naval ship propulsion are considered. M.E.P.

A79-47847 **Jet propulsion for ACV's and hydrofoils.** *Hovering Craft and Hydrofoil,* vol. 18, June-July 1979, p. 30, 31.

Attention is given to the basic theory and design of waterjet propulsion. Formulas are presented for thrust, waterjet propulsive efficiency, specific speed, and suction specific speed for cavitation. Inlets for waterjets are also discussed, noting three types: (1) ram inlets or scoops, (2) scoop or variable area inlets, and (3) flush inlets (normally on planing hulls). Waterjet applications discussed include the Boeing Jetfoil, the Italian Swordfish, and the American Enterprise. Finally, air jet propulsion is covered, noting that while high velocity turbojets are not suitable for hovercraft speeds and are too noisy, ducting air from the fans to propulsive nozzles at the rear has advantages such as low noise level and the fact that one powerplant serves both lift and propulsion. M.E.P.

A79-47873 # **Experimental investigation of helicopter flight modes on helicopter-generated noise (Ersperimental'nye issledovaniia rezhimov poleta vertoletov na sozdavaemyi imi shum).** B. N. Mel'nikov (Gosudarstvennyi Nauchno-Issledovatel'skii Institut Grazhdanskoi Aviatsii, Moscow, USSR). *Akusticheskii Zhurnal,* vol. 25, May-June 1979, p. 450-453. 5 refs. In Russian.

The establishment of a theoretical relationship between helicopter flight velocity and noise is highly complicated by the complexity of the mechanism of excitation and propagation of helicopter noise and by the multitude of factors that affect the noise. In the experiments described, an attempt is made to establish the noise characteristics and the relationship of velocity to noise for the Mi-2, Mi-6, Mi-8, and Ka-26 helicopters. V.P.

A79-47876 * # **The effects of configuration changes on spin and recovery characteristics of a low-wing general aviation research airplane.** H. P. Stough, III and J. M. Patton, Jr. (NASA, Langley

Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1786.* 13 p. 9 refs.

A fully instrumented, low-wing, single-engine general aviation airplane has been spin tested. Several tail configurations, wing leading-edge modifications, fuselage modifications, moment-of-inertia variations, center-of-gravity positions, and control inputs have been tested to determine their effect on spinning and spin recovery. Results indicate that wing airfoil design can significantly influence airplane spin and recovery characteristics and can overpower the effects of tail design. Results also point out a need to determine limitations of such factors as Reynolds number in model spin test techniques and high angle-of-attack aerodynamics. (Author)

A79-47878 * # **Flight control systems development of highly maneuverable aircraft technology /HiMAT/ vehicle.** K. L. Petersen (NASA, Flight Research Center, Edwards, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1789.* 20 p. 5 refs.

The highly maneuverable aircraft technology (HiMAT) program was conceived to demonstrate advanced technology concepts through scaled-aircraft flight tests using a remotely piloted technique. Closed-loop primary flight control is performed from a ground-based cockpit, utilizing a digital computer and up/down telemetry links. A backup flight control system for emergency operation resides in an onboard computer. The onboard systems are designed to provide fail-operational capabilities and utilize two microcomputers, dual uplink receiver/decoders, and redundant hydraulic actuation and power systems. This paper discusses the design and validation of the primary and backup digital flight control systems as well as the unique pilot and specialized systems interfaces. (Author)

A79-47879 * # **Some results from the use of a control augmentation system to study the developed spin of a light plane.** T. C. O'Bryan, K. E. Glover (NASA, Langley Research Center, Flight Dynamics and Control Div., Hampton, Va.), and T. E. Edwards (U.S. Army, Structures Laboratory, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1790.* 9 p.

A control augmentation system consisting of hydrogen peroxide rockets mounted on the wing tips of a light airplane has been developed and used to study spin recovery characteristics. Recovery from spins that were unrecoverable with aerodynamic controls was accomplished in less than one turn at maximum thrust in about three turns at minimum thrust. The rocket system at maximum thrust produced spin recovery characteristics similar to those obtained using a parachute. An advantage of using the control augmentation system on any airplane being used in a spin test program is its capability to demonstrate configuration effects on stall/spin characteristics at very high angles of attack and clearly determine the existence of all possible spin modes. (Author)

A79-47880 # **Flight testing the circulation control wing.** A. J. Pugliese (Grumman Aerospace Corp., Flight Test Dept., Bethpage, N.Y.) and R. J. Englar (U.S. Naval Material Command, David W. Taylor Naval Ship Research and Development Center, Bethesda, Md.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1791.* 18 p.

The Grumman A-6A was modified and flight tested to demonstrate the high lift and STOL capability of the Circulation Control Wing (CCW) concept, which employs a circular trailing edge blown by engine bleed air. The test program included a ground test series for calibration, adjustment, and checkout of the blowing system, followed by a limited duration flight program to measure blown lift enhancement and resulting STOL improvements. The paper describes the test program, emphasizing flight safety considerations and application of recently developed flight test techniques to accomplish the program's optimistic objectives. Test results are discussed, including the successful demonstration of lift augmentation and significant STOL performance. (Author)

A79-47881 # **Compass Cope airframe design history.** R. B. Brown (Boeing Commercial Airplane Co., Product Development Div., Renton, Wash.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1792.* 10 p.

Preliminary design decisions on the project phase (1971-1973) and flight tests (1973-1974) of the Compass Cope remotely piloted vehicle are discussed. Mission-related decisions are presented along with engine and power plant, wing, landing gear, body, empennage, and flight control design decisions. Wind-tunnel and flight-test results are discussed. It is noted that the podded single-engine airplane arrangement utilized can be considered as a potential standard for future single-engine high-altitude surveillance designs, manned or unmanned. The airframe design features discussed also include a composite and bonded primary structure with maximum use of honeycomb and fiberglass as well as integral wing fuel containment within a honeycomb basic structure. V.T.

A79-47882 # **Manned strategic system concepts 1990-2000.** C. D. Wiler and D. P. Raymer (Rockwell International Corp., North American Aircraft Group, Los Angeles, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1793.* 15 p. Contract No. F33615-77-C-0115.

Manned strategic system concept designs are discussed, requiring the development of new technologies in the areas of aerodynamics, propulsion, structures, controls, and stealth. A total of 34 innovative concepts were prepared using the advanced technologies. Concepts were designed to a strategic 'high-low-low-high' missions, with several exceptions, and can be grouped into four major categories: (1) low-cost simplistic, (2) minimum weight, (3) supersonic penetration, (4) laser defended. The concepts were qualitatively rated to select the best two or three concepts in each category. These remaining candidate concepts were then subjected to a preliminary sizing exercise to select one baseline per category. The baselines were sized, configurated, analyzed, and reconfigurated. V.T.

A79-47883 # **Identifying desirable design features for the C-XX aircraft - A systems approach.** W. T. Mikolowsky, S. G. Thompson, and E. W. Caldwell (Lockheed-Georgia Co., Marietta, Ga.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1796.* 11 p. 14 refs. Contract No. F33615-78-C-0122.

The paper describes Lockheed's approach to the development of information needed to assess pertinent design features of an advanced technology military/commercial transport known as C-XX. The first element is a qualitative assessment that focuses on identifying the most significant features and associated design options, such as basic performance, ground interface, airfield compatibility, cargo compartment, inflight refueling, etc. A quantitative analysis examines the configurational effects of the selected design options as well as their military cost-effectiveness and commercial economics. The results of the analysis were incorporated into the LGA-144-400, the latest version of the baseline aircraft, which serves as a point of departure for the analysis of cargo-compartment height, passenger provisions, service life specification, and other design features. V.T.

A79-47884 # **Recent progress in aircraft sink rate measurement.** G. E. Clarke and K. L. Merson (U.S. Navy, Naval Air Test Center, Patuxent River, Md.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1798.* 5 p.

Efforts to reduce dependency on manually read emulsion film for determination of aircraft sink rate have resulted in test development of faster and more consistent techniques. The two methods undergoing more extensive development are: (1) onboard doppler radar and (2) laser theodolite tracking. These two methods have been tested concurrently with existing sideline and centerline ballistic camera systems with emphasis on accuracy and time correlation of the various methods. The doppler radar appears to give the best instantaneous sink rate information at touchdown although location on the aircraft can affect overall accuracy. The laser theodolite increases the number of significant parameters that can be monitored in real time by the test engineer permitting immediate confirmation of the most significant landing parameters. (Author)

A79-47885 # **An improved method for load survey flight testing.** A. Rosende, Jr. (Lockheed-Georgia Co., Marietta, Ga.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1799.* 5 p.

In the conduct of load survey flight testing, two methods are generally used to obtain inflight load variations: (1) trims, turns and pushdowns, or (2) roller-coaster maneuvers. In either case, maneuver requirements call for smooth, quasi-static load factor variations with minimum variations in airspeed and altitude. The conduct of these maneuvers often exceeds pilot capability to provide the necessary data quality, and substantial re-flying becomes necessary. A new mechanical method has been developed which produces roller-coaster maneuvers with minimum variation in airspeed and altitude. This paper presents the results achieved using this new system. (Author)

A79-47886 # **Dutch roll excitation and recovery techniques on a C-141A Starlifter.** R. E. Hart (USAF, Flight Test Center, Edwards AFB, Calif.) and D. G. Picha (U.S. Air Force Academy, Colorado Springs, Colo.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1801.* 5 p.

The Air Force has experienced several incidents of severe C-141A Starlifter dutch roll problems at cruise altitude. A test program was implemented to develop dutch roll recovery procedures for use by low time C-141A pilots in all weather conditions. The flight test program consisted of evaluating over 100 dutch roll maneuvers. Pilot ratings using Cooper-Harper scale were used to evaluate various recovery techniques. Procedures arrived at can be used safely by low time pilots. C-141A flight restrictions at high cruise altitude/gross weight combinations were lifted as a result. (Author)

A79-47887 * # **Some flight data extraction techniques used on a general aviation spin research aircraft.** S. M. Sliwa (NASA, Langley Research Center, Flight Dynamics and Control Div., Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1802.* 9 p. 11 refs.

Some methods for obtaining flight data from a highly instrumented general aviation spin research aircraft are developed and illustrated. The required correction terms for the measurement of body accelerations, body velocities, and aircraft orientation are presented. In addition, the equations of motion are utilized to derive total aerodynamic coefficients for comparison with model tests and for analysis. Flight test experience is used to evaluate the utility of various instruments and calculation techniques for spin research. (Author)

A79-47888 # **AFFTC parameter identification experience.** D. P. Maunder (USAF, Performance and Flying Qualities Branch, Edwards AFB, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1803.* 6 p. 5 refs.

An overview of the Air Force Flight Test Center experience with automated parameter identification is presented along with the major results of this with respect to accuracy, contributions of otherwise unobtainable information, cost effectiveness, and problems encountered. During the evaluation of several prototype and production aircraft, classic stability and control maneuvers and stability derivative extraction (STABDEX) maneuvers were conducted. It is noted that test planning can effect a reduction in flight test time, while the total flight test time can be reduced nearly 75% by the application of STABDEX techniques. The ability to model relatively small changes in the aircraft's response characteristics due to changes in the aircraft's shape or configuration is outlined. V.T.

A79-47889 # **New materials for future commercial aircraft.** D. T. Lovell and R. V. Carter (Boeing Commercial Airplane Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1804.* 5 p.

New structural graphite-epoxy composites and aluminum alloys will be used on new model commercial airplanes built during the 1980's. The graphite-epoxy composite system will be used for the principal flight control structures; i.e., elevators, rudder, and ailerons, with weight savings exceeding 30% in some components. The new aluminum alloys will be used for primary structures; i.e., upper and lower wing skins and stiffeners with strength improvements from 5% to 12%. The graphite-epoxy composite system will be reviewed with emphasis on design for environmental durability. A review of the aluminum alloy material and durability characteristics will be given. (Author)

A79-47890 # **Design of advanced titanium structures.** C. A. Paez and R. Gordon (Grumman Aerospace Corp., Bethpage, N.Y.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1805.* 12 p. Contract No. F33615-77-3109.

An application of superplastic forming/diffusion bonding (SPF/DB) techniques to a Mach 2.0-class aircraft (ATS/BLAST) is discussed. Consideration is given to high-temperature environment due to aerodynamic and engine heating; loads and dynamic analyses; fracture mechanics analyses of SPF/DB structures; detail design of major components; and concept evaluation. Emphasis is placed on maintainability and reliability assessment and weight and cost analyses of advanced concepts. Optimization techniques, joint details, and design/process/tooling interactions are outlined. Attention is given to potential problem areas and future applications of this new design/fabrication method. V.T.

A79-47891 * # **Design development of an advanced composite aileron.** C. F. Griffin (Lockheed-California Co., Burbank, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1807.* 8 p. Contract No. NAS1-15069.

This paper summarizes the design development of an advanced composite inboard aileron for the L-1011 commercial transport aircraft. Design details of the composite aileron are reported. Results of tests which substantiate the structural integrity of the design are also presented. The composite aileron is a multi-rib assembly with graphite/epoxy tape-syntactic core sandwich covers, a graphite/epoxy tape front spar, and graphite/epoxy fabric ribs. This structure is a direct replacement for the current metal aileron with a weight savings of 28.7 percent (40.3 lb.). Engineering cost estimates indicate that the composite structure will be cost competitive with the metal structure it is replacing. (Author)

A79-47892 # **Simplified analysis spectrum for joints exposed to complex continuously varying stresses.** B. M. Shah (Lockheed-Georgia Co., Marietta, Ga.). *American Institute of Aero-*

nautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1808. 6 p. 9 refs. USAF-supported research.

The stress response of aerospace structures to continuous in-flight turbulence is a complex series of axial/shear stress time-histories which have random phasing relationships. Analytically simplified simulation to obtain durability estimates of 'real-world' experience has been a challenge in-so-far as obtaining reasonably accurate representation. Due to the complexity of this phasing problem no unified analytical simulation spectrum has been test-verified as representative for durability evaluations of the actual experience. An available empirical procedure of defining discrete axial-shear stress phasing relationships is utilized in this paper to develop an equivalent analytical representation spectrum that can be utilized for flight-by-flight durability analyses and tests of structural joints. The essential features of the equivalent spectrum are: axial-shear stress phasing relationships; lo-hi sequence within a mission segment; application of infrequently occurring stresses; and mission segment-to-segment transitions. Test verification in terms of rate of crack growth demonstrates excellent correlation between the real-world axial-shear stress histories and the derived equivalent analytical representative stress spectrum. (Author)

A79-47893 * # **The nonaxisymmetric nozzle - It is for real.** F. J. Capone (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1810.* 18 p. 82 refs.

A review is made of the current status of the nonaxisymmetric nozzle from a technology standpoint. Some of the potential payoffs attributed to this class of nozzles installed on twin-engine high performance fighter aircraft are addressed. These payoffs include a reduction in cruise drag through improved integration and an increase in aircraft maneuverability and agility through the application of thrust vectoring and reversing. Improved takeoff and landing characteristics also are expected through the use of thrust vectoring and reversing. Stealth and survivability aspects of the aircraft can be increased through a reduction of nozzle infrared signature and radar cross section. (Author)

A79-47894 # **Performance evaluation of an air vehicle utilizing non-axisymmetric nozzles.** J. A. Laughrey (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio), D. J. Drape, and P. E. Hiley (McDonnell Aircraft Co., St. Louis, Mo.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1811.* 12 p. 5 refs.

An extensive non-axisymmetric nozzle design and performance data base was utilized to evaluate the performance of a vehicle designed for an air-to-air mission. Performance was evaluated through comparative sizing analysis for selected non-axisymmetric nozzle installations versus a baseline axisymmetric nozzle installation. The non-axisymmetric nozzle/vehicle with a single external expansion ramp was found to be lighter in takeoff gross weight (TOGW) than the axisymmetric baseline. The lighter TOGW was due primarily to the low weight and low installation drag of the non-axisymmetric nozzle, plus the use of thrust vectoring for reduced drag at the transonic maneuver condition used for engine sizing. (Author)

A79-47895 * # **Historical development of worldwide supersonic aircraft.** M. L. Spearman (NASA, Langley Research Center, Aeronautical Systems Div., Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1815.* 15 p.

Aerodynamic problems in the development of supersonic aircraft, their solutions, and innovative design features are presented. Studies of compressibility, introduction of jets, supersonic phenomena, transonic drag and lift, longitudinal and directional stability, dynamic pressure fields, and advent of the supersonic fighter are discussed. The flight research aircraft such as the Bell X-1 and the Douglas-558, the century series models, reconnaissance aircraft, the multimission tactical fighter, and the current generation fighters such as F-16 and F-18 are described. The SCAT program is considered, along with supersonic developments in Great Britain, France, and USSR. It is concluded that the sonic boom still appears to be an inherent problem of supersonic flight that particularly affects overland commercial flight, and efforts continue for increased efficiency for economic and performance gains and increased safety for military and civilian aircraft. A.T.

A79-47896 # **From HiMAT to future fighters.** M. R. Robinson and S. M. Silverman (Rockwell International Corp., North American Aircraft Div., Los Angeles, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1816.* 8 p. 6 refs.

The NATO/U.S. Air Force requirements call for high-performance aircraft, in substantial numbers, and at a low unit cost. The objectives of the HiMAT (Highly Maneuverable Aircraft Technology) program are to investigate and demonstrate in-flight high-risk interdisciplinary technologies as applied to a high-performance fighter design at the lowest possible price. These technologies form the basis for other advances in high-performance aircraft design. Forward swept wing (FSW) is one of the more promising concepts in this category. Several technologies that are common to both programs are outlined: aerodynamics and aeroelastic tailoring, advanced structures, and close-coupled canards. These and control systems and low observables will dictate the specific concepts and combat characteristics that can be attained for future fighters. V.T.

A79-47898 * # **Radar cross section fundamentals for the aircraft designer.** H. A. Stadmore. *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1818.* 10 p. 8 refs. Research supported by the Grumman Aerospace Corp. and NASA.

Various aspects of radar cross-section (RCS) techniques are summarized, with emphasis placed on fundamental electromagnetic phenomena, such as plane and spherical wave formulations, and the definition of RCS is given in the far-field sense. The basic relationship between electronic countermeasures and a signature level is discussed in terms of the detectability range of a target vehicle. Fundamental radar-signature analysis techniques, such as the physical-optics and geometrical-optics approximations, are presented along with examples in terms of aircraft components. Methods of analysis based on the geometrical theory of diffraction are considered and various wave-propagation phenomena are related to local vehicle geometry. Typical vehicle components are also discussed, together with their contribution to total vehicle RCS and their individual signature sensitivities. V.T.

A79-47900 * # **Full-scale wind tunnel study of nacelle shape on cooling drag.** V. R. Corsiglia, J. Katz (NASA, Ames Research Center, Moffett Field, Calif.), and R. A. Kroeger (Michigan, University, Ann Arbor, Mich.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1820.* 10 p. 7 refs.

Tests were made in the NASA-Ames 40- by 80 Foot Wind Tunnel of a wing semispan with a nacelle (no propeller) from a typical, general aviation twin-engine aircraft. Measurements were made of the effect on drag of the cooling air flow through the nacelle. Internal and external nacelle pressures were measured. It was found that the cooling flow accounts for about 13% of the estimated airplane drag and about 42% of the cooling flow drag is associated with the internal flow. It was concluded that improvements could be made by relocating both the inlet and the outlet of the cooling air. (Author)

A79-47901 # **Real time weather display in the general aviation cockpit.** G. M. Kirkpatrick (GMK Consulting Services, North Syracuse, N.Y.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1821.* 4 p.

Weather radar is currently available for installation in many general aviation aircraft including the single engine category. The voice channels of the VOR navigation facilities might be used for narrow-band digital transmission. Airborne radar can be expected to be complementary to the relayed radar charts, since the airborne units are partially able to overcome the limitations created by the curvature of the earth and can provide a closeup view of severe weather for penetration flight paths. The cost of digital storage and processing circuitry has decreased in recent years to the extent that the display, when used with an existing VOR receiver should cost less than an airborne weather radar. S.D.

A79-47902 # **A cheap, effective icing detector for general aviation aircraft.** J. F. Marchman, III (Virginia Polytechnic Institute and State University, Blacksburg, Va.) and D. Manor. *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1823.* 6 p.

A icing detector device that measures near instantaneous ice buildup on aircraft wings is presented and various wind tunnel and flight tests are studied. Existing de-icing techniques and ice detectors such as a differential pressure type sensor, a beta radiation detector, and vibrating rods are examined and it is found that these devices are not only expensive but, due to their mechanical or electrical systems, they are very undependable. A probe, consisting of a streamlined extruded tubing, with a 1 inch width, 2.4 inch chord and 6 inch height, was tested at the VPI wind tunnel and then on a flight in 8000 ft during rime icing conditions. Results showed that the ice detector system employing a pilot-static device was found to be accurate, reliable and inexpensive. C.F.W.

A79-47903 # **Engine-aircraft afterbody interactions - Recommended testing techniques based on YF-17 experience.** A. E. Fanning (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio) and E. J. Lucas (ARO, Inc., Arnold Air Force Station, Tenn.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1829.* 12 p. 8 refs.

The fundamental technical aspects of interactions between propulsion system flows and external aerodynamics are discussed. Installation losses are identified as deviation of these interactions from idealized values. The objectives and approach of an effort to reduce the uncertainties introduced by the methods used to predict these losses are presented. The test techniques used during this effort are presented with data to substantiate their validity. The results of testing two different scale, wind tunnel models are used to define the effects of characteristic Reynolds number and model scale. The techniques used to correct wind tunnel data to free flight conditions are presented and the results compared to flight test data. Comparisons of surface static pressure distributions and integrated axial pressure forces are included. Based on these comparisons, recommendations are made. (Author)

A79-47904 # **Benefits of aerodynamic interaction to the three surface configuration.** J. W. Agnew and J. R. Hess, Jr. (McDonnell Aircraft Co., St. Louis, Mo.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1830.* 9 p.

The three-surface configuration and active flight controls will permit the next generation of fighter aircraft to capitalize on the performance and maneuverability benefits of horizontal canards while retaining the stability and control advantages of horizontal tails. Recent wind tunnel data for a contemporary fighter, with a close-coupled horizontal canard added, are presented with emphasis on demonstrating the beneficial aerodynamic interaction of the canard with the wing, empennage, and other aircraft control surfaces. These data show that a properly configured three-surface configuration can provide significantly increased performance and an effective six-degree-of-freedom maneuvering capability. (Author)

A79-47905 # **Winglet toe out angle optimization for the Gates Learjet Longhorn Wing.** N. E. Conley (Gates Learjet Corp., Wichita, Kan.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1831.* 8 p. 9 refs.

The Gates Learjet Model 28 Longhorn was the first turbojet to be certified with winglets. It has now been joined by the stand-up cabin Model 55 in applying NASA advanced technology to American business jet aircraft. This paper describes the effect of tailoring toe out (incidence) angle for best winglet performance. A winglet with little or no twist must be toed out to reduce separation at the root on the upper surface because of the large inflow angles near the upper surface of the wing at the tip. The need for toe out disappears rapidly with radial distance from the chord of the wing tip due to the reduction in local flow angles to free stream flow angles. Results of wind tunnel testing, computational aerodynamic methods and flight testing will be presented and their relative merits weighed. Some criteria for useful winglet design will be suggested. (Author)

A79-47906 # **All electric subsystems for next generation transport aircraft.** J. W. Phillips (Lockheed Georgia Co., Flight Sciences Div., Marietta, Ga.) and N. E. Wood (AiResearch Manufacturing Company of California, Torrance, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1832.* 12 p.

A technology assessment study conducted to evaluate the applicability of an all-electric airplane concept to transport aircraft is presented. The study compared two all-electric variations of the Lockheed medium advanced transport aircraft (ATA) with the existing ATA that utilizes advanced structures, aerodynamics, and engines, but conventional secondary power systems. The results of reconfiguration tradeoff studies conducted on the primary and secondary flight controls, engine start, environmental control, secondary power generation and distribution, and the landing-gear brakes are considered. Maintainability, reliability, and weight analyses are outlined. V.T.

A79-47907 # **The Beech Model 77 'Skipper' spin program.** M. L. Holcomb (Beech Aircraft Corp., Wichita, Kan.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1835.* 7 p. 7 refs.

An economical 2-place general aviation airplane has been developed for pilot training, including developed spins up to 6 turns. The aerodynamic design of the airplane incorporates many features aimed at providing for adequate spin and spin recovery characteristics. To verify early in the development program that the airplane would have acceptable spin characteristics both free flight radio-control model and spin tunnel tests were employed. This was followed by comprehensive full scale airplane flight tests which resulted in certification for the FAA 6-turn acrobatic spin requirement. (Author)

A79-47908 * # **Exploratory study of the influence of wing leading-edge modifications on the spin characteristics of a low-wing single-engine general aviation airplane.** D. J. DiCarlo and J. L. Johnson, Jr. (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1837.* 15 p. 11 refs.

A wide variety of model and airplane tests were conducted to explore the effects of wing leading-edge modifications on the stalling and spinning characteristics of a low-wing general aviation research airplane configuration. The results presented herein discuss the effects of leading-edge airfoil modifications applied to the full wing span and to partial-span locations. The results obtained in the study indicate that the wing modifications can produce large effects (both favorable or unfavorable) on spin resistance, developed spin characteristics, and spin recovery. (Author)

A79-47909 # **Design of the circulation control wing STOL demonstrator aircraft.** R. J. Englar, R. A. Hemmerly (U.S. Naval Material Command, David W. Taylor Naval Ship Research and Development Center, Bethesda, Md.), W. H. Moore, V. Seredinsky, W. Valckenaere, and J. A. Jackson (Grumman Aerospace Corp., Bethpage, N.Y.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1842.* 12 p. 9 refs.

A testbed aircraft design and modification and a flight demonstration program have been conducted to confirm the short takeoff and landing characteristics of the circulation-control-wing (CCW) concept on an A-6A flight demonstrator. Wind tunnel, engine bleed, and flight tests investigations have verified that the test aircraft can double the lifting capabilities of the A-6A by using existing bleed flow. A trimmed lift coefficient of 3.60 produced a 67-knot airspeed for the demonstrator, and indicated that maximum lift coefficients predicted by tunnel results were obtainable by the manned aircraft. The program's proof-of-concept objectives are accomplished, and the potential payoffs of a CCW-configurated high-performance naval aircraft are identified. S.D.

A79-47910 # **Geometric data transfer.** W. L. Howard (Rockwell International Corp., El Segundo, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1844.* 5 p.

Coordination of an engineering-manufacturing agreement as to data format, procedures, and schedules for geometric data transfer within two separate companies is shown. Consideration is given to the methods used in gaining agreement, examples of problems overcome, and procedures used to document and implement solutions. Sample model drawings were constructed and then redrawn several times in accordance with requirements of design management and manufacturing. Manual drawing release and automated drawing release are discussed with emphasis placed on the use of the CADAM model. V.T.

A79-47911 # **Engineering and manufacturing communication via the computer data base.** E. N. Nilson (United Technologies Corp., Pratt and Whitney Aircraft Group, East Hartford, Conn.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1845.* 8 p. 12 refs.

The most substantial reductions in lead time and cost to be realized across the design/manufacturing interface come from integrated interactive CAD/CAM. The computer data base performs the fundamental communication function. The present status of this technology, the extent of its utilization, its implementation, examples of applications, potential benefits to be derived, implementation problems and solutions, and the developing CAD/CAM technology are the subject of this paper. (Author)

A79-47912 # **CADAM data handling from conceptual design through produce support.** S. J. Smyth (Lockheed-California Co., Burbank, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1846.* 8 p.

The use of interactive computer graphics for data handling in aircraft design, manufacturing, and product support is discussed. The software used is the Lockheed Computer-Graphics Augmented Design and Manufacturing (CADAM) system and the IRAD program CADATA. CADAM provides a common data base of the selected vehicle design for all user disciplines: preliminary design, loft, production design, tool design, numerical control part programming, quality control, and product support. Examples of the use of CADAM and CADATA are given to illustrate the cost savings and reduced time spans achieved. V.T.

A79-47913 * # **The characteristics of a lift cruise fan V/STOL configuration in near proximity to a small deck with finite edge positions.** V. R. Stewart (Rockwell International Corp., Columbus, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1854.* 8 p. NASA-supported research.

Two V/STOL model configurations utilizing lift-cruise-fans for the propulsion system have been tested in the presence of a small landing platform with finite deck edge positions. Results and analysis of these tests are presented. The model was tested at both static (zero velocity) and forward speed conditions with several heights and deck edge positions. Configurations utilizing three fans and four fans were investigated. Incremental forces and moments induced by the various deck edge positions are analyzed as relating to the model height above the ground and the thrust velocity relationships. The test and analysis show the induced forces to be relatively unaffected by deck edge. (Author)

A79-47914 * # **Aerodynamic effects of an attitude control vane on a tilt-nacelle V/STOL propulsion system.** M. D. Betzina (NASA, Ames Research Center, Moffett Field, Calif.) and R. Kita (Grumman Aerospace Corp., Bethpage, N.Y.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1855.* 11 p.

One possible technique for obtaining longitudinal control on a tilt-nacelle V/STOL aircraft is the use of a variable attitude vane assembly mounted in the propulsion system exhaust. Deflecting the vane produces large forces and moments without depending on forward speed of the aircraft. Tests are carried out in the Ames 40 by 80 ft wind tunnel on a large-scale tilt-nacelle V/STOL propulsion system with and without a variable attitude control vane assembly. Aerodynamic characteristics are analyzed in terms of nacelle aerodynamics, vane aerodynamics, and vane-induced effects on the nacelle aerodynamics. It is shown that the aerodynamic forces due to the nacelle without the vane can be a significant part of the total forces produced by the propulsion system. The control vane effectively produces large changes in pitching moment which are accompanied by significant changes in total lift and drag. The vane has a substantial effect on the propulsion-system aerodynamics. Other pertinent results are also given. S.D.

A79-47918 * # **Energy efficient aircraft engines.** R. Chamberlin and B. Miller (NASA, Lewis Research Center, Energy Conservative Engines Office, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1861.* 11 p.

The three engine programs that constitute the propulsion portion of NASA's Aircraft Energy Efficiency Program are described, their status indicated, and anticipated improvements in SFC discussed. The three engine programs are: (1) engine component improvement, directed at current engines, (2) energy efficient engine, directed at new turbofan engines, and (3) advanced turboprops, directed at technology for advanced turboprop-powered aircraft with cruise speeds to Mach 0.8. Unique propulsion system interactive ties to the airframe resulting from engine design features to reduce fuel consumption are discussed. Emphasis is placed on the advanced turboprop since it offers the largest potential fuel savings of the three propulsion programs and also has the strongest interactive ties to the airframe. (Author)

A79-47919 # **Air buoyant vehicles - Energy efficient aircraft.** V. H. Pavlecka (Airships International, Inc., Tustin, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1862.* 7 p.

Energy and overall economic considerations of airplane and two airships in terms of a cost intensity parameter indicate that Metalclad airships can now be constructed and operated with an economic superiority to wide-body jet transports. Comparisons are based on computer printouts of actual flights of 747F and on design studies of MC-80 and MC-100. B.J.

A79-47920 # **Laminar flow stabilization by surface cooling on hydrogen fueled aircraft.** J. G. Theisen (Lockheed-Georgia Co., Marietta, Ga.), G. D. Brewer, and L. R. Miranda (Lockheed-California Co., Burbank, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1863.* 12 p. 30 refs. Research supported by Lockheed-California Independent Research and Development Funds.

The feasibility of delaying the transition from laminar to turbulent flow over aerodynamic surfaces by cooling those surfaces, to decrease friction and increase fuel economy of aircraft, is discussed. For the 'energy crisis', hydrogen is being considered as an alternate fuel, so its cryogenic properties may be used for cooling below the 280 deg R known to stabilize boundary layers. Equations for the stability analysis of a two-dimensional, compressible, laminar boundary layer are presented, including heat transfer and adverse pressure gradient effects which constitute the principal new technological contribution of this study, for near-cruise flight. Preliminary systems analysis for an advanced commercial transport shows drag reductions near 27% and lower direct operating costs (DOC) by over 21%. (Author)

A79-47921 * # **The aerial relay system - An energy-efficient solution to the airport congestion problem.** A. C. Kyser (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1865.* 23 p. 7 refs.

The aerial relay system concept, which was developed as a means of exploiting inflight transfer, utilizing large 'cruise liner' aircraft that fly continuously along their routes and dock periodically with short-haul 'feeder' aircraft for payload exchanges, is discussed. The system employs two distinctly different kinds of aircraft, one for takeoff and landing and one for cruising, with provisions for the routine inflight transfer of passengers, baggage, fuel, etc. The liner design consists of a module of 320 ft span and 80 ft chord with an 800 seat capacity and capable of cruising at 0.75 M, while the feeder is a relatively conventional short-haul transport aircraft with a modified fuselage to accommodate special docking and transportation operations. It is concluded that this concept could alleviate present inadequacies in an extremely cost-effective and fuel-efficient way, and could be expanded indefinitely to become a high-quality, high-capacity national system. C.F.W.

A79-47923 # **F-16 Avionics Intermediate Shop /AIS/ Interim Contractor Support initiatives.** W. A. Moch (General Dynamics Corp., Fort Worth, Tex.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1868.* 7 p.

The paper surveys the F-16 Avionics Interim Contractor Support (AICS) and the Avionics Intermediate Shop (AIS) which it supports. Aspects of the AIS discussed include the maintenance concept, a hardware description, F-16 AIS integration testing, and an F-16 AIS development/production plan. Attention is given to the AICS background and program objectives which address the needs of concurrent development and support in the face of such problems as schedules, avionics configuration changes, changing customer requirements, etc. Other areas covered include the planned phase-in of customer personnel, and the reliability improvement warranty (RIW). M.E.P.

A79-47924 * # **High-performance wings with significant leading-edge thrust at supersonic speeds.** A. W. Robins and H. W. Carlson (NASA, Langley Research Center, High-Speed Aerodynamics Div., Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1871.* 6 p. 11 refs.

A new class of curved-leading-edge wings with which significant levels of leading-edge thrust may be achieved at moderate supersonic speeds is suggested. A recent analysis of the factors limiting such leading-edge thrust has led to a new method for the prediction of attainable leading-edge thrust from subsonic through supersonic speeds for wings of arbitrary planform. Recent supersonic tests of a new wing shape, which largely meets design criteria given by the new prediction method, give evidence of significant levels of leading-edge thrust. The consequent unusually high levels of aerodynamic performance should renew interest in supersonic-cruise vehicle design in general and in cruise-speed selection in particular. (Author)

A79-47925 # **Aerodynamics of spoiler control devices.** M. D. Mack, H. C. Seetharam, W. G. Kuhn, and J. T. Bright (Boeing Commercial Airplane Co., Flight Controls Technology Research Group, Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1873.* 19 p. 28 refs.

Experimental and computational studies of the aerodynamics of spoilers are discussed. Aerodynamic nonlinearities and dead bands are described, scale effect problems shown, and a preliminary design method reviewed. Two-dimensional experimental data for single- and multi-element airfoils with spoilers is presented. Details of the wake behind a spoiler and spoiler induced tail buffet are discussed. Computational results for an airfoil with deflected spoiler are presented. The separation of the turbulent boundary layer ahead of the spoiler's hinge line and reattachment on the face of the spoiler, and calculation of the flow around a multi-element airfoil with a spoiler are discussed. (Author)

A79-47926 # **Boundary layer control on wings using sound and leading edge serrations.** F. G. Collins (Tennessee, University, Tullahoma, Tenn.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1875.* 11 p. 25 refs. NSF Grant No. GK-42133.

Three techniques for improving the lifting characteristics of low speed wings were experimentally examined in a wind tunnel, namely leading edge serrations, external sound, and sound emitted through periodically spaced holes near the wing leading edge. Serrations increased the lift curve slope by 12% for an NACA 0015 airfoil and 22% for an NACA 2412 airfoil (chord Reynolds numbers to 6 x 10 to the 5th). Drag was not measurably increased by the serrations. Sound of certain frequencies emitted from periodically spaced holes could reattach stalled flow and suppress stall-flutter. External sound also improved the airfoil stall characteristics. (Author)

A79-47928 # **Flow patterns and aerodynamic characteristics of wing with strake.** L. Mou-Jie (Peking Institute of Aeronautics and Astronautics, Peking, Communist China). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1877.* 12 p. 14 refs.

Surface oil flow visualizations, force tests and pressure measurements were conducted at low, transonic and supersonic speeds. Four flow types of a wing with strake at low speed have been found. The surface flow is affected and controlled mainly by the formation, development and breakdown of the strake vortices. The differences in flow patterns are reflected in the force and moment results. The lift increment comes from the effect of the strake vortex not only on the inner panel but also on the outer panel. The causes of the nonlinear variation of the pitching moment and ways of reducing it are discussed. The lift increment is decreased with an increase in Mach number at transonic speeds, primarily because the flow over the wing without strake changes from leading-edge separation to leading-edge attached flow with shock-induced separation. An increase in the lift-drag ratio is due to the lift increase at low speed and the drag decrease at supersonic speeds. (Author)

A79-47939 **Predictive guidance for interceptors with time delays.** C. Hecht (Aerospace Corp., Guidance Analysis Dept., El Segundo, Calif.) and A. Troesch (Southern California, University, Los Angeles, Calif.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 88-94. 5 refs. Contract No. F4701-77-C-0078.

Predictive guidance equations for systems with time delays are developed using optimal control theory to obtain interceptor steering gains. Previously, predictive guidance and proportional navigation, which are essentially the same, employed a steering policy based on instantaneous interceptor response. In this paper the time response of the interceptor is approximated by a linear first order time lag, and the optimal steering gain is evaluated using a quadratic penalty function. The optimal control for interception is determined to be a linear function of the predicted position error and the acceleration error. The gains are functions of only the time-to-go and the interceptor time constant. An application with computer simulations is included for interception of a non-maneuvering target. The simulations demonstrate a significant improvement of interceptor performance using the optimum gains in comparison to the conventional gain of proportional navigation. (Author)

A79-47943 **Application of bifurcation analysis and catastrophe theory methodology /BACTM/ to aircraft stability problems at high angles-of-attack.** R. K. Mehra and J. V. Carroll (Scientific Systems, Inc., Cambridge, Mass.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 186-192. 15 refs. Contract No. N00014-76-C-0780.

Aircraft dynamic behavior at high angles of attack is highly nonlinear and, in the past, there has been a lack of suitable techniques for analyzing the global behavior of nonlinear systems. In this paper, an approach based on bifurcation analysis and catastrophe theory methodology (BACTM) has been applied to specific jump, hysteresis and limit cycle phenomena such as roll-coupling, pitch-up, wing rock, buffeting, departure and divergence. Four different aircraft have been considered for comparison purposes, and it has been shown how different types of instabilities and families of limit cycles arise as the control variables are varied. A complete representation of the aircraft equilibrium and bifurcation surfaces is given in a nine-dimensional space consisting of velocity, roll rate, pitch rate, yaw rate, angle-of-attack, sideslip angle, elevator, aileron and rudder deflections. The use of BACTM for understanding spin entry, spin prevention, spin recovery and stability augmentation at high angles of attack are also discussed. (Author)

A79-47957 **Estimation for advanced technology engines.** F. A. Farrar and G. J. Michael (United Technologies Research Center, East Hartford, Conn.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 342-347. 8 refs. Contract No. N00014-76-C-0710.

An estimation algorithm for nonlinear transient operation of multivariable gas turbine engines was developed and evaluated. Kalman methodology and model-mismatch compensation procedures were employed in defining the filtering logic. The estimation algorithm was evaluated by application to noise-corrupted measurement data generated by a nonlinear digital dynamic F100/F401 engine simulation. Estimation of unmeasurable as well as measurable key engine variables from (1) nominal-engine data, (2) degraded-engine data, and (3) engine data with off-nominal noise statistics was evaluated. Results obtained indicate that the nonlinear estimation algorithm provides a viable approach to estimating key engine variables under realistic operating conditions. (Author)

A79-47959 * **Nonlinear decoupled control synthesis for maneuvering aircraft.** S. N. Singh (Santa Maria, Universidade Federal, Santa Maria, Brazil) and A. A. Schy (NASA, Langley Research Center, Flight Dynamics and Control Div., Hampton, Va.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 360-370. 14 refs.

A control law for decoupling roll rate, angle of attack and sideslip in rapid, nonlinear airplane maneuvers is derived. For simplicity, only moments caused by ailerons, rudder and elevator are considered, and control forces are neglected. Simulated responses of the closed loop system, including the control forces, show that the neglected forces have no significant effects and that large, simultaneous lateral and longitudinal maneuvers can be precisely performed. The violent divergences which occur in open-loop maneuvers of this type are eliminated by the decoupling. The control law showed little sensitivity to 20 percent perturbation in three important stability derivatives. (Author)

A79-47960 **Analytic redundancy for flight control sensors on the Lockheed L-1011 aircraft.** E. Y. Shapiro and H. E. Decarli (Lockheed California Co., Burbank, Calif.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 371-376. 5 refs.

The implementation and flight test results of an analytic-redundancy approach employing operational sensors to reconstruct signals of failed sensors is described. This method evolves from the concept of Luenberger Observers. The system is intended for use in a dual or triple redundant environment, and takes maximal advantage of all existing functional and dynamic relationships among the variables sensed by dissimilar sensors. In this paper a brief discussion on the use of Luenberger Observers as a means for the attainment of analytic redundancy is provided. The structure and parameters of the failed sensor signal-reconstructor is developed. Flight test data of the Lockheed L-1011 aircraft are exhibited. (Author)

A79-47961 **The enhancement of aircraft parameter identification using linear transformations.** K. S. Govindaraj and E. G. Rynaski (Calspan Advanced Technology Center, Buffalo, N.Y.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 377-384. Research supported by Calspan Corp.

An approach is developed to identify the equations of motion of an aircraft using linear transformations. The equations of motion are transformed into the phase variable form, the identification is carried out in the phase variable domain and transformed back into the equations of motion form to get the stability and control derivatives. This identification procedure is very useful for the identification of the stability and control derivatives of an aeroelastic airplane. The accuracy of stability and control derivatives obtained through a phase variable transformation is verified by comparing the results of this procedure with the results obtained from the identification in the equations of motion form for the same data on the USAF Total In-Flight Simulator (TIFS). The phase variable method of identification was felt to yield results as accurate as the results obtained from the identification in the equations of motion form. (Author)

A79-47962 * A multiple objective optimization approach to aircraft control systems design. D. Tabak, A. A. Schy, K. G. Johnson (NASA, Langley Research Center, Hampton, Va.), and D. P. Giesy (NASA, Langley Research Center; Vought Corp., Hampton, Va.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 385, 386.

The design of an aircraft lateral control system, subject to several performance criteria and constraints, is considered. While in the previous studies of the same model a single criterion optimization, with other performance requirements expressed as constraints, has been pursued, the current approach involves a multiple criteria optimization. In particular, a Pareto optimal solution is sought. (Author)

A79-47971 Failure detection in signal processing and sensing in flight control systems. R. Onken and N. Stuckenberg (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugführung, Braunschweig, West Germany). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 449-454.

For the signal processing part of a flight control system a definition of the system integrity function is given in order to enable comparative evaluation of different design approaches with respect to the system integrity and mission survival. Two main failure detection methods are analytically investigated, the passive failure detection and the selfdiagnosing active failure detection. For the sensing part of a flight control system a sensor failure detection and elimination concept is presented, based on doubled sensors and deterministic observers. This system equals the fail-operational properties of a triplex-system. (Author)

A79-47987 # Estimation of aircraft target motion using pattern recognition orientation measurements. J. D. Kendrick (USAF, Technical Applications Center, Patrick AFB, Fla.), P. S. Maybeck, and J. G. Reid (USAF, Institute of Technology, Wright-Patterson AFB, Ohio). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 953-959. 16 refs.

A new approach to estimating motion of a highly maneuvering aircraft target in an air-to-air tracking scenario is presented. An interactive filter system is developed which provides an improved estimate of target motion states by conditioning kinematic filter estimates upon target aspect angle data. Pattern recognition techniques used with an electro-optical tracker are presumed to provide this target aspect information. A target orientation filter processes the aspect angle measurements by statistically weighting measured aspect angles with the current best estimate of target kinematics. The aerodynamic lift equation is used to relate approximate angle of attack to target velocity and acceleration. A novel statistical model for aircraft target normal acceleration is also developed to better represent unknown target accelerations. Simulation results of realistic three-dimensional scenarios are presented to evaluate the performance of the interactive filter system. (Author)

A79-47991 * Application of singular perturbation techniques /SPT/ and continuation methods for on-line aircraft trajectory optimization. R. B. Washburn, R. K. Mehra, and S. Sajan (Scientific Systems, Inc., Cambridge, Mass.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 983-990. 13 refs. Contract No. NAS1-15113.

The singular perturbation theory (SPT) approximation of optimal feedback control laws is presented and methods for on-line application of these approximations are discussed. It is demonstrated that SPT control laws break down when the current state is near the terminal target state. The use of continuation methods to improve the accuracy of the SPT approximation and to obtain global solutions of two-point boundary value problems is also discussed. As an illustration, consideration is given to the minimum-time control of a supersonic aircraft for a three-dimensional intercept problem. B.J.

A79-48000 * Digital adaptive control laws for VTOL aircraft. G. L. Hartmann and G. Stein (Honeywell Systems and Research Center, Minneapolis, Minn.). In: 1978 Conference on Decision and Control, 17th, San Diego, Calif., January 10-12, 1979, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1103, 1104. Contract No. NAS1-14921.

Honeywell has designed a digital self-adaptive flight control system for flight test in the VALT Research Aircraft (a modified CH-47). The final design resulted from a comparison of two different adaptive concepts: one based on explicit parameter estimates from a real-time maximum likelihood estimation algorithm and the other based on an implicit model reference adaptive system. The two designs are compared on the basis of performance and complexity. B.J.

A79-48051 A novel technique for obtaining aerodynamic data using simple, free flight trajectory measurements. R. L. Pope and R. E. Dudley (Weapons Research Establishment, Salisbury, Australia). *Aeronautical Journal,* vol. 83, June 1979, p. 224-229. 6 refs.

A free flight testing technique for missiles is presented, together with the results of a preliminary test. The technique consists of firing a projectile across a field and monitoring the trajectory with three ballistic cameras sited downrange. The simplicity and low cost are stressed, noting that the output from the experiments repays the resources used to carry out the trial and data analysis. It is concluded that results from the initial test of the trial technique and the data analysis show that the method is feasible and accurate estimates of aerodynamics parameters can be obtained. M.E.P.

A79-48052 Aircraft longitudinal motion at high incidence. A. W. Babister (Glasgow, University, Glasgow, Scotland). *Aeronautical Journal,* vol. 83, June 1979, p. 230-232.

The paper studies longitudinal symmetric motion of constant speed and height and determines simple control laws for an autopilot which would prevent a superstall occurring. An equation is presented for pitching motion and analysis with fixed elevator and T-tailed aircraft is made. Finally, the prevention of superstalled flight is discussed and it is concluded that a simple linear feedback control can be used to prevent superstalled flight. M.E.P.

A79-48311 # Handbook on aircraft materials and their application technology (Spravochnik po aviatsionnym materialam i tekhnologii ikh primeneniia). V. G. Aleksandrov and B. I. Bazanov. Moscow, Izdatel'stvo Transport, 1979. 263 p. 18 refs. In Russian.

The handbook covers characteristics and properties of steels, nonferrous materials, bearings, plastics, adhesives, elastomeric and textile materials, and leather. Sealing and gasketing materials, fuel filters, varnish coatings, fuel, lubricants, and hydraulic fluids are covered. Various materials used in aircraft and safety methods are described. A.T.

A79-48495 Influence of gas turbine engine combustion chamber geometric parameters on mixture formation characteristics. P. P. Grigorenko, Iu. A. Spiridonov, and A. V. Talantov. *(Aviatsionnaia Tekhnika,* vol. 21, no. 3, 1978, p. 30-37.) *Soviet Aeronautics,* vol. 21, no. 3, 1978, p. 20-24. 6 refs. Translation.

In the experiments described, the mixing of hot gas jets injected into a cross-flow of cold air was studied as a function of some chamber parameters. It is shown that the flow rate increases and the quality of mixing improves when the mixer aperture and number of holes is increased. A diagram is proposed for selecting optimal mixer parameters with respect to the minimization of temperature-field nonuniformity. V.P.

A79-48497 **On the question of selecting the characteristic quantity governing fuel self-ignition in a stream.** V. N. Gruzdev, N. A. Malishevskaia, and M. D. Tavger. *(Aviatsionnaia Tekhnika,* vol. 21, no. 3, 1978, p. 42-45.) *Soviet Aeronautics,* vol. 21, no. 3, 1978, p. 28-30. Translation.

In the experiments described, the self-ignition of kerosene TS-1 in a flow of nonequilibrium combustion products was studied to determine the degree to which the ignition delay characterizes the process as a whole. The ignition time is found to decrease with increasing flow temperature and increasing density of active centers. It is proposed to use the critical flow velocity (which forms the upper bound of the possible range of self-ignition) as the criterion of self-ignition. V.P.

A79-48498 **Experimental study of the gasdynamic characteristics of a stator cascade with cooling air discharge through the vane surface.** O. N. Emin, I. I. Kutysh, and P. I. Shvartsman. *(Aviatsionnaia Tekhnika,* vol. 21, no. 3, 1978, p. 46-53.) *Soviet Aeronautics,* vol. 21, no. 3, 1978, p. 31-36. 8 refs. Translation.

A79-48500 **Determination of turning angle of a jet impinging on a bucket with visor.** L. M. Kotliar, S. G. Margulis, and E. D. Nesterov. *(Aviatsionnaia Tekhnika,* vol. 21, no. 3, 1978, p. 58-62.) *Soviet Aeronautics,* vol. 21, no. 3, 1978, p. 40-43. 6 refs. Translation.

The flow inside a symmetrical target-type thrust reverser is analyzed under the assumption of an imponderable fluid. The reverser ejection angle is calculated by Chaplygin's method of singular points. A technique for determining the ejection angle as a function of the deflector parameters is proposed. V.P.

A79-48501 **Most rational linearization of nonlinear unsteady heat conduction problems.** N. L. Men'shikh. *(Aviatsionnaia Tekhnika,* vol. 21, no. 3, 1978, p. 63-67.) *Soviet Aeronautics,* vol. 21, no. 3, 1978, p. 44-47. 5 refs. Translation.

A proof is obtained for the correspondence between nonlinear and linearized unsteady heat-conduction problems from the point of view of similarity theory. This correspondence is used as a basis to develop a 'most rational' method of linearizing nonlinear unsteady heat conduction problems, owing to a dependence of the thermophysical properties on the temperature and radiant transfer. The method is illustrated by some practical examples. V.P.

A79-48503 **On the influence of relative pitch in the subsonic turbine cascade.** V. G. Nesterenko and G. L. Podvidz. *(Aviatsionnaia Tekhnika,* vol. 21, no. 3, 1978, p. 75-80.) *Soviet Aeronautics,* vol. 21, no. 3, 1978, p. 53-56. 8 refs. Translation.

The influence of varying the pitch/chord ratio from 0.8 to 1.5 on the performance of a subsonic cascade of turbine airfoils is analyzed for large flow angles. The flow of an ideal compressible fluid in the aperture between two blades is calculated and compared with the experiment. Two types of separated flow are identified which may arise at pitch/chord ratios above the critical value. V.P.

A79-48505 **Analysis design of complex systems. II.** T. K. Sirazetdinov and A. I. Bogomolov. *(Aviatsionnaia Tekhnika,* vol. 21, no. 3, 1978, p. 85-91.) *Soviet Aeronautics,* vol. 21, no. 3, 1978, p. 61-65. 16 refs. Translation.

In the present paper, the problem of analytically designing complex systems is formulated and is placed in proper perspective with respect to the general process of systems design. An approach, based on control theory, is proposed to the analytical designing of complex systems. The application of this approach is demonstrated by examples. V.P.

A79-48507 **Experimental study of the turbulent wake downstream of a fan jet.** O. A. Khachaturian. *(Aviatsionnaia Tekhnika,* vol. 21, no. 3, 1978, p. 100-107.) *Soviet Aeronautics,* vol. 21, no. 3, 1978, p. 72-77. 10 refs. Translation.

The velocity and temperature distributions in developing wakes of fan-shaped jets were studied in a cylindrical wind tunnel. It is shown that the wake flow is analogous to the wake behind bluff bodies of revolution. Relations for calculating the temperature and velocity in any wake cross section from the initial parameters of a fan-shaped jet are proposed. V.P.

A79-48517 **Long-life GTE operation based on technical condition.** A. A. Mukhin, A. A. Kovalev, and A. A. Kornoukhov. *(Aviatsionnaia Tekhnika,* vol. 21, no. 3, 1978, p. 153-156.) *Soviet Aeronautics,* vol. 21, no. 3, 1978, p. 116-118. Translation.

The service life of a gas-turbine engine depends primarily on the endurance of the turbine blades, which depends on the gasdynamic and centrifugal stresses, the nonuniformity of the temperature field, the gas temperature, the atmospheric conditions, and seasonal effects. In the present paper, the endurance of first-stage blades prepared from ZhS6KP alloy is analyzed for the actual operating conditions of a modern long-range airliner, involving temperature variations ranging from -55 to +45 C and pressure variations from 725 to 775 torr. Methods of evaluating the technical state of turbine blades are discussed. V.P.

A79-48518 **Use of the method of variable directions for numerical study of the temperature states of a turbine disk with blades.** A. M. Poliakov, V. S. Petrovskii, and V. I. Krichakin. *(Aviatsionnaia Tekhnika,* vol. 21, no. 3, 1978, p. 156-160.) *Soviet Aeronautics,* vol. 21, no. 3, 1978, p. 119-122. Translation.

In the present paper, an economical scheme of integrating over two space variables is applied to the solution of the unsteady-state thermal problem for an axial-flow turbine disk with blades having elongated roots. The problem is reduced to a system of two-dimensional unsteady-state heat equations for the blades and disk. The disk profile is defined by means of arbitrary functions which delimit the contour of the lateral surfaces. By means of linear-fractional transformation, the curvilinear contour of the disk is transformed into a rectangle. The problem then can be solved for coupled rectangular blade and disk regions connected by the boundary conditions. V.P.

A79-48519 **Characteristics of afterburning bypass turbojet engine with oxygen injection into the afterburner chamber.** B. D. Fishbein. *(Aviatsionnaia Tekhnika,* vol. 21, no. 3, 1978, p. 160-164.) *Soviet Aeronautics,* vol. 21, no. 3, 1978, p. 123-126. 6 refs. Translation.

In the present paper, the thermodynamic effectiveness of thrust augmentation by supplying oxygen to the afterburner of a turbojet bypass engine is calculated for various modes of flight. The thermodynamic characteristics of air, air-oxygen mixtures, and combustion products of kerosene in air and in air-oxygen mixtures are tabulated. It is shown that for minimum excess oxidant (air-oxygen) ratio, an oxygen supply of 10 to 20 percent of the rate of airflow results in thrust augmentation by factors of 1.18 to 1.2 at M = 0, and by factors of 1.8 to 2.2 at M = 3.2. The total specific fuel consumption increases by factors of 2.4 to 4.4 at M = 0, and by factors of 2.0 to 2.8 at M = 3.2. V.P.

A79-48572 **Aerodynamic excitation forces of blade vibrations in axial turbomachinery as a result of interference from nearby cascades (Aerodynamische Erregungskräfte von Schaufelschwingungen in axialen Turbomaschinen infolge der Interferenz benachbarter Schaufelgitter).** W. Lienhart. *Ingenieur-Archiv,* vol. 48, no. 4, 1979, p. 239-258. 17 refs. In German.

The paper presents the calculation of the unsteady blade forces and moments caused by the interaction of adjacent cascades by means of an approximation of incompressible plane unsteady potential flow. The results of vibration stimuli for a number of double cascade configurations are presented as examples. Attention is given to the influence of the axial clearance between the cascades, of the profile shape, of the different pitches of adjacent cascades, and of the ratio of peripheral speed to isentropic stage velocity. Finally, a simple formula is given for the influence of axial clearance between the blade rows. M.E.P.

A79-48596 **Multiband antenna.** F. W. Vortmeier (McDonnell Aircraft Co., St. Louis, Mo.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 35-42. Contract No. N62269-77-C-0138.

With the introduction of a new generation of radio communication equipment which is capable of operating at VHF-FM (30-76 MHz), VHF-AM (108-156 MHz) and UHF (225-400 MHz) from a single radio unit, the requirement existed to develop an antenna to match this capability. Such an antenna was developed for conformal mounting on tactical Naval aircraft with the approach being to add capability to an existing antenna. This makes it possible to provide with one antenna the capability formerly provided with two or three antennas. This paper describes the work performed, the successful results obtained and substantiating data. Data measured consisted of impedance measurements on a full scale model, pattern measurements of fourth and fifth scale models, power measurements and gain comparison measurements. (Author)

A79-48597 **Small lightweight electronically steerable cylindrical antenna successfully utilized in an air traffic management system.** J. A. Acoraci (Bendix Corp., Communications Div., Baltimore, Md.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 43-49. Grant No. DAAB07-77-C-2176.

Bendix Communications Division has designed, fabricated and tested a brassboard model lightweight electronic scan interrogator antenna for use in air traffic management. The antenna is a Butler matrix-fed multimode electronically scanned cylindrical array. A brief description of the total system and a detailed technical description of the antenna are presented. S.D.

A79-48598 **Adaptive array tradeoffs for existing airborne UHF radios.** D. A. Sweeney (E-Systems, Inc., St. Petersburg, Fla.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 50-57.

Present-day UHF airborne communications links are susceptible to jamming interference. Frequency hopping, spread spectrum signals, and adaptive antenna arrays are among the methods that can be used to provide antijamming capabilities. The adaptive antenna approach is the only one that can be implemented without replacing or modifying the existing UHF radios. The requirements, tradeoffs, and hardware configurations involved in an adaptive array design are discussed. S.D.

A79-48602 **Preprocessing for advanced image matching techniques.** J. E. Berry and J. K. Yoo (Goodyear Aerospace Corp., Akron, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 86-91. Grant No. DAAK40-77-C-0107.

Preprocessing that enables accurate matching of two images taken by range measuring sensors located at different points in space and at different times is presented. Separation between the sensors results in perspective changes that appear as geometric distortion. There are also variations in image element intensities as a result of changes in position and time. The preprocessing used to remove position dependent distortion and to circumvent the effect of intensity variations are described. This includes descriptions of the sensor data format, the rationale for the preprocessing approach and transformations used to implement the approach. Examples comparing images before and after preprocessing are shown. (Author)

A79-48603 **Synthetic aperture radar map matching for navigation.** E. R. Hiller (Raytheon Co., Missile Systems Div., Bedford, Mass.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 92-100. Contract No. F04701-76-C-0002.

The location of preselected features in synthetic aperture radar (SAR) images by map matching with reference templates can provide fix data for navigation. A procedure for map matching has been developed that encodes the reference feature shape in a binary reference template which is utilized to provide an adaptive normalization and slicing of the radar image, followed by simple binary correlation. The procedure offers a significant reduction in computational complexity compared to traditional cross correlation processing and has the capability to acquire reference features with high probability in the presence of other competing features. Analysis of the theoretical performance characteristics of this map matching procedure is presented. Examples of results obtained with the procedure utilizing SAR imagery are also included. (Author)

A79-48606 **Microcomputer applications in strapdown heading and attitude reference system.** A. Halamandaris and E. N. Jackson (Litton Industries, Guidance and Control Systems Div., Woodland Hills, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 145-151.

Recent developments in LSI technology have made a very dramatic change in the digital system design of an all-attitude strapdown heading and reference system. With the advent of microcomputers it is now possible to design a system with distributed processing techniques. The purpose of this paper is to present the design approach of two microcomputer controlled modules within the Litton Heading Attitude Reference System (HARS). The HARS is a single unit containing inertial sensors, instrument support electronics, BITE electronics, power supply, system I/O electronics and distributed microcomputers. (Author)

A79-48608 # **Microprocessor-based digital autopilot development for the XBQM-106 Mini-RPV.** O. D. Koger, D. E. Tietz, and

G. B. Lamont (USAF, Institute of Technology, Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 157-167. 52 refs.

Contemporary integrated circuit technology permits the employment of microprocessors in the design of small remotely piloted vehicles. The development of a microprocessor based autopilot for the XBQM-106 Mini-Remotely Piloted Vehicles (RPV) is described in this paper. With ultra-low component cost as a primary goal, the autopilot design uses the RCA CDP-1802 microprocessor. The digital autopilot was developed through the breadboard state with performance testing accomplished via hybrid simulation. Aircraft transfer functions were first derived from aerodynamic wind tunnel data. Then a complete control analysis was made of the existing analog autopilot, sensors, actuators, and aircraft dynamics. This was followed by synthesis of the digital control algorithms from the digitization of the analog control laws. Hardware was selected based on system requirements, and software to execute the digital algorithms was developed. The results of testing by hybrid simulation indicates that the performance of the digital autopilot is very comparable to the existing analog autopilot. Sources of minor discrepancies are discussed. (Author)

A79-48609 **A status report on the advanced FIREFLY assessment program.** D. E. Longmire (Northrop Corp., Avionics Systems Analysis Dept., Los Angeles, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 170-175.

FIREFLY studies have shown the potential for significant increases in aircraft effectiveness and survivability offered by integration of the fire and flight control functions during weapons delivery. A modularized characterization of an integrated fire/flight control system eliminates the costly and extensive analysis that has heretofore resulted from conventional, separate, fire and flight control logic. FIREFLY has as its primary goal the design, development and utilization of a digital simulation of such an integrated fire/flight control system that would yield meaningful tactical versatility when used for the analysis and evaluation of a specific aircraft and weapon. (Author)

A79-48610 **Multisensor integration for defensive fire control surveillance.** C. L. Bowman (VERAC, Inc., San Diego, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 176-184. 8 refs. Contract No. F33616-78-C-1576.

This paper develops a multisensor integration (MSI) concept for defensive fire control surveillance. Multisensor, multitarget, maximum likelihood track correlation and minimum variance MSI track filtering algorithms are designed. Due to computational and timing requirements, as well as system reliability and flexibility considerations, sensor-level track files are selected to provide the measurements for MSI algorithms. The benchmark algorithm derivations therefore differ from those standard in the multitarget tracking literature, because of the autocorrelations in the track file errors which arise from the sensor track filters. Candidate suboptimal MSI algorithms are derived in accordance with the sensor characteristics and tracking requirements of a high energy laser (HEL) fire control. (Author)

A79-48614 **Electric power system control techniques.** J. R. Perkins, D. E. Lautner, A. J. Marek (Vought Corp., Dallas, Tex.), and D. Fox (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 237-245. Contract No. F33615-78-C-2018.

This paper presents the Phase I results of a two phase study program which addresses the integration of advanced power system control technologies into a reliable and fault tolerant system. The advanced control technologies integrated include electric engine start, automatic load management, microprocessor control implementations, design techniques for providing 'no-gap' power and an all 'solid state' electric power distribution system. Electric system performance requirements are established and preliminary designs of an integrated 'baseline' control system for single and a multiengine aircraft for the 1990 operational time period are presented. Finally, stability analysis requirements and procedures are established for each of the two designs. (Author)

A79-48615 **Advanced RPV electrical systems.** F. L. Miller (Teledyne Ryan Aeronautical, San Diego, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 246-253.

The paper surveys the possible improvements that can be made in the electrical power systems (EPS) of remotely piloted vehicles (RPV). It is noted that off the shelf hardware, which is commonly used due to cost considerations, is becoming inadequate for the tasks and is causing operational difficulties. Attention is given to the EPS design philosophy and some specific problems such as the lack of adequate generated power, interconnection difficulties, reliability and maintainability problems such as those associated with batteries and high life cycle costs. Several types of RPVs are described such as the HALE RPV, the mini RPV, and the TEDS. Technological improvements considered include: rare earth permanent magnets, flat wire and printed circuit cable, and fiber optics. M.E.P.

A79-48616 **Electrical power system for new-technology transport power-by-wire airplane.** E. T. Reiquam (Boeing Aerospace Co., Seattle, Wash.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 254-261.

A design of the electrical power system for a new-technology aircraft in which the electrical system is the only secondary power system extracting power from the engines is presented. All flight control surface actuation is accomplished by electro-mechanical actuators and hydraulic systems are eliminated. The air conditioning system prime mover is an electric motor that drives a bootstrap air-cycle pack which permits more efficient engine shaft power extraction than less efficient bleed air extraction. The power generation system has quadruple redundancy established for the flight control system. Power for the flight control actuator system is at 270 V dc, and avionics, lighting, engine controls, and instrumentation are powered from 115/200 V 400-Hz, 28 V 400-Hz, and 28 V dc buses. A.T.

A79-48617 **E-4B mission electrical power.** M. E. Kleinmann and A. A. Stewart (Boeing Co., Seattle, Wash.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 262-269.

An overview of the mission power distribution system designed for the E-4B version of the Boeing 747 aircraft is presented. The requirements and criteria established for mission power distribution are given along with a general description of the system, including interfaces with the basic 1200-kVA electrical power generation system. The E-4B power system is characterized by the ability to automatically shed selected mission loads in the event that multiple generator failures require a reduction in load. Mission power distribution control and monitoring is provided at the mission technical control station. From this station 32 dedicated-load and general-purpose mission buses are controlled, and their status monitored. The system also provides 28-V dc; 10-V dc; and 115-V, single-phase, 60-Hz power to mission loads throughout the plane. V.T.

A79-48618 **Digital simulation of a three-phase generator.** P. J. Leong and I. S. Mehdi (Boeing Aerospace Co., Seattle, Wash.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 270-278.

A technique is presented for dynamically modeling a brushless three-phase ac generator on a digital computer. A simplification in the mathematical description of the generator is obtained by using the Park's transformation which defines a new set of variables in terms of the actual winding variables. The model equations are set up in the state-space method and the flux linkages are the state variables. One of the problems encountered in the digital simulation of synchronous generators is the determination of saturation. In this model, a table lookup routine handles the nonlinear saturation effect. The equations describing the generator also cover the rotating exciter. The generator model is part of a complete system simulation of an aircraft generating system. The simulation determines stability and power quality during steady-state and transient operating conditions. (Author)

A79-48620 # **Avionics computer software operation and support cost estimation.** D. V. Ferens and R. L. Harris (USAF, Avionics Laboratory, Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 296-300. 9 refs.

This paper describes many current models and methods available for predicting computer software operational and support costs and discusses the limitations of available models and methods as useful tools. This paper also discusses in detail the Air Force Avionics Laboratory's current effort to develop a model that will help the engineer or cost analyst accurately predict operational and support costs of avionics systems computer software being maintained at Air Force Air Logistics Centers. (Author)

A79-48621 **Built in test of A/D converters - Present approaches and recommendations for improved BIT effectiveness.** R. J. McCabe (Westinghouse Electric Corp., Baltimore, Md.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 301-307.

This paper treats the problems of developing effective BIT approaches for A/D converters to be used in airborne radar systems, and recommends new directions for improving the effectiveness of A/D BIT. Present A/D approaches are comprised of one or more of three basic types of BIT: critical circuit verifications, end-to-end system level tests, and front-to-back hardware level tests. Each of these approaches is described and the merits and shortcomings of each approach are summarized. New requirements for processing of radar target data and the introduction of new hardware technologies motivate a shift toward hardware level A/D BIT. Recommendations for improved BIT effectiveness are given, and include improved test parameters, microprocessor-based measurement techniques, and further development of A/D system modeling techniques. (Author)

A79-48622 **Flight test verification of the ASSET system.** S. T. Donley (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa.) and R. D. Solomon (Grumman Aerospace Corp., Bethpage, N.Y.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 311-318. 8 refs.

The ASSET (Advanced Skewed Sensory Electronic Triad) system flight test configuration consists of two sets of six skewed rate sensors. One set consists of conventional spring-restrained rate gyros, while the other is composed of vibrating beam rate sensors. Flight test results are presented for a redundant arrangement of skewed angular rate sensors and associated failure detection and isolation algorithms designed for digital fly-by-wire control applications. The separation of the sensors in the skewed array demonstrated the concept of survivability through sensor separation. The redundancy data management software demonstrated that computer technology can reliably perform isolation and signal selection which can be processed within the iteration time constraints of aircraft control laws. Specific conclusions are drawn. S.D.

A79-48623 **A microprocessor system for flight control research.** J. C. Seat (USAF, Williams AFB, Ariz.), G. E. Miller, and R. F. Stengel (Princeton University, Princeton, N.J.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 319-326. Contract No. N00014-78-C-0257.

A digital flight control system based on microprocessor technology has been designed, developed, and flight tested in Princeton's Variable-Response Research Aircraft (VRA). The Micro-DFCS works in conjunction with the VRA's existing fly-by-wire control system, and it is programmed to provide command and stability augmentation control laws formulated through modern control theory. The Model 1 Micro-DFCS hardware and software are described, and initial flight test results are presented. (Author)

A79-48625 # **Synthesis of digital flight control tracking systems by the method of entire eigenstructure assignment.** J. J. D'Azzo and T. A. Kennedy (USAF, Institute of Technology, Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 343-347. 12 refs.

The paper is concerned with the use of entire eigenstructure assignment (Moore, 1976; D'Azzo, 1978) in the synthesis of tracking systems which are required to track a command input vector containing piecewise constant signals. The method is demonstrated by application to a digital aircraft flight control system required to produce a constant climb rate at constant velocity. The controllable system is represented in the continuous-time domain by linear multivariable matrix state and output equations. S.D.

A79-48629 **Analysis and evaluation of current MIL-STD-1553 digital avionics architecture as the basis for advanced architectures using MIL-STD-1553B.** C. R. Turner and M. B. McCall (Boeing Aerospace Co., Seattle, Wash.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 426-432.

This paper is presented in two major sections. The first section presents a comparison of current MIL-STD-1553 multiplex systems. These systems are compared as to their application areas, architectures and system control approaches. The second section is a discussion section which presents the conclusions drawn from our study of current systems, as well as presenting areas identified as needing further study. The areas discussed are: problems of MIL-STD-1553(USAF) and MIL-STD-1553A which were solved by -1553B, predicting the future from the past, what advances are needed, and what the payoff is. (Author)

A79-48630 **F/A-18 Hornet display system.** R. A. Juergens (McDonnell Aircraft Co., St. Louis, Mo.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 434-442.

The F/A-18 cockpit display system consists of a Head Up Display (HUD), two Multipurpose Display Indicators (MDIs), and either a Multipurpose Display Repeater Indicator (MDRI) or a Horizontal Situation Display (HSD). The MDI, MDRI, and HUD were developed by Kaiser Electronics while the HSD was developed by Bendix/Ferranti. These four units provide an integrated display system with the functional redundancy necessary to provide a high probability of mission success. Each MDI is able, under aircraft computer direction, to provide all necessary display information to itself and to either the MDRI/HSD, the HUD, or both. With the exception of the optics, the HUD, HSD and MDRI are functionally similar. Internally, the MDIs consist of the MDRI modules plus a processor comprised of an input/output (I/O) section, a central display processor, and two independent but identical symbol generators. This paper discusses the display system organization and details the processor operation. (Author)

A79-48640 **A simple integrated navigation based on multiple DME.** U. Brokof (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugführung, Braunschweig, West Germany). *(Deutsche Gesellschaft für Luft- und Raumfahrt and Deutsche Gesellschaft für Ortung und Navigation, Symposium über Fliegen im Flughafen-Nahbereich, Hamburg, West Germany, Apr. 24-26, 1979, DGLR Paper 79-041.)* In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 591-599. 5 refs. Translation.

A simple integrated navigation system is described, consisting of a dead reckoning system using the intrinsic velocity and the compass heading. The system is supported by range measurements to various DME ground stations by means of a Kalman filter. The state vector contains, besides the elements for dead reckoning, the systematic errors of the ground stations. The operation of the system is discussed in the light of test flight results with an HFB 320. P.T.H.

A79-48641 **Quaternion matching in transfer alignment for SAR motion compensation.** D. J. Schmidt and G. A. Bendor (Westinghouse Electric Corp., Baltimore, Md.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 600-604. 15 refs.

The paper presents the initial results of an on-going study to develop a system for motion compensation in SAR signal processing. In the proposed configuration, a high cost, high performance, low data rate master IMU is located at a convenient vehicle station; also a low cost low performance, high data rate, strapdown slave IMU is located at a remote station. It is noted that despite structural deformation and large slave IMU errors, adequate accuracy is achieved in the slave by Kalmanized transfer alignment with the master. Finally, covariance analysis indicates that accelerometer attitude matches (i.e., quaternion matches) are needed along with other types of matches if slave strapdown inertial sensors of tactical guidance quality are to be used in this application. M.E.P.

A79-48648 **The effect of standardization of avionics software quality assurance.** R. J. Rubey (Softech, Inc., Waltham, Mass.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 656-662.

The paper summarizes existing military standards and Air Force regulations applicable to both inhouse quality assurance (QA) efforts and independent verification and validation (V&V) activities. The need for additional QA and V&V standards are discussed and some potential standards are suggested. An effective software quality assurance plan describing the important parts of a developer's quality assurance activities is described and the major sections of the plan are analyzed including scope, applicable documents, and organization. C.F.W.

A79-48652 **Power hybridization - Key to reducing avionics power supply weight and volume.** R. C. Newton, Jr. and D. G. Frey (Westinghouse Electric Corp., Baltimore, Md.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 698-703.

It is shown that the use of power hybrid packages (PHP) for both linear series regulators and switching power supplies results in large savings in the system power supply weight (over 30 percent) and volume (over 46 percent). The use of PHP technology has other advantages, such as improvements in reliability, producibility, and maintainability. It is apparent that the potential for commonality of the PHP building blocks is large for both linear and switching regulators. In addition, there is evidence to support the prediction that life cycle costs will be significantly reduced. V.P.

A79-48656 **Low cost inertial aiding for NAVSTAR/GPS receivers in naval ship navigation.** V. S. Samant, B. G. Gardner (Orincon Corp., La Jolla, Calif.), and R. Akita (U.S. Navy, Naval Ordnance Systems Command, San Diego, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 726-737.

The paper considers the problem of accurately determining position and velocity of naval ships using GPS signals. An extended Kalman filtering algorithm was adequate for achieving 10 m and 0.2 m/sec accuracies in ship position and velocity in the absence of disturbing sea motion, but this filter is divergent in moderate and stormy sea-state environments. Inertial navigation configurations to measure the ship motion, algorithms for estimating the disturbance motion, and a disturbance motion compensation technique are discussed. The disturbance sea motion estimates are used to compensate GPS measurements to maintain the filter performance within desired limits, and was shown that actual at sea results confirmed the simulation results of velocity error sensitivities due to sea motion. A.T.

A79-48657 **A real-time sequential filtering algorithm for GPS low-dynamics navigation system.** T. N. Upadhyay (Charles Stark Draper Laboratory, Inc., Cambridge, Mass.) and J. N. Damoulakis (Texas Instruments, Inc., Dallas, Tex.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 739-749. 20 refs. Contracts No. F04701-78-0181; No. F33615-78-C-1430.

This paper describes the design, implementation, and performance of a real-time estimation algorithm, referred to in this paper as the Sequential Piecewise Recursive (SPWR) algorithm, for the Global-Positioning System (GPS) low-dynamics navigation system. The SPWR algorithm is based on the extended Kalman filter. It, however, differs from the conventional Kalman filter in that it computes error covariance and filter gains at a slower rate than the state measurement update, and it uses U-D factor formulation to perform covariance computations. Thus, the SPWR algorithm saves real-time processing requirements without appreciable degradation of filter performance, and it alleviates the numerical accuracy problems generally associated with the Kalman filter. Another important feature of the SPWR algorithm is that it incorporates range and range-rate data from each GPS satellite sequential for navigation solution. Numerical results are presented. (Author)

A79-48664 **Radar signal processing development for application of VHSI.** J. D. Grimm and G. L. Bair (Texas Instruments, Inc., Radar and Digital Systems Div., Dallas, Tex.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 796-805.

Advances in component technology leading to the development of very high speed integration promise revolutionary progress in the next decade of radar signal processing. The paper examines mission requirements that place demands on future equipment design. To quantify future signal processing requirements, a baseline is established by describing a current developmental signal processor for an airborne coherent multimode radar. Operational requirements for future processor development are outlined consistent with projected mission capabilities. Signal processor parameters are derived from these operational requirements. Equipment mechanization to meet projected requirements is accomplished by developing architectures that lend themselves to application of revolutionary device technology. (Author)

A79-48665 **Millimeter airborne radar target detection and selection techniques.** L. M. Novak and F. W. Vote (MIT, Lexington, Mass.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 807-817. 12 refs. USAF-DARPA-Army sponsored research.

Results of a study of candidate target detection and selection techniques for use in millimeter airborne radar systems are presented. Improved target and ground clutter models are developed and the implications of these mathematical models on target detection and selection performance is discussed. (Author)

A79-48666 **An analysis of SAPPHIRE image parameters as a function of processing parameters.** R. E. Morden (Goodyear Aerospace Corp., Litchfield Park, Ariz.) and R. L. Withman (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 818-824. Contract No. F33657-74-C-0604.

SAPPHIRE (Synthetic Aperture Precision Processor, HIgh REliability) is a special-purpose digital processor capable of synthetic aperture processing of data from an AN/APD-10 coherent side-looking radar at real-time rates with full resolution. The processor was designed to perform a variety of parameter tradeoff experiments to aid in determining performance requirements for future systems. The paper presents an analysis of clutter return in imagery produced by SAPPHIRE from two passes over a specified site, with special emphasis on an analysis of radar image parameters as a function of processing parameters. The two passes represent a moderate (16 deg) and a relatively low (5 deg) depression angle. The results compare measured clutter histograms with those predicted by theory and also compare two different methods of performing parameter tradeoffs. S.D.

A79-48667 **Verification of operational flight programs by simulation.** C. D. Williams and C. Nemec (Westinghouse Defense and Electronic Systems Center, Baltimore, Md.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 826-828.

Avionics software and their support packages have progressed to the point where verification of onboard computations can be accomplished totally by computer simulation. A test method is proposed which provides dynamic inputs, via the off-line simulation, to a support software package capable of executing onboard code and comparing results of the onboard algorithms with anticipated results. It is now possible to modify and verify onboard computations without the facilities of a software bench. Generation of the test inputs to the support software is achieved by a FORTRAN program that uses a two-tier approach to simulate flight paths for an interceptor and up to 10 maneuverable targets. After simulating the onboard code, the FORTRAN interface routine gathers outputs of the operational flight program and returns to the upper tier. This allows accurate assessment of nonlinearities, parameter uncertainties, and modeling errors. S.D.

A79-48670 **Computer Monitor and Control - A flexible, cost-effective implementation.** J. A. Rey and R. K. Thompson (Northrop Corp., Aircraft Group, Hawthorne, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 840-844.

This paper describes the Performance and Design Requirements Analysis for a test set, often referred to as a Computer Monitor and Control Unit (CMAC) to be used during verification and validation of Operational Flight Programs (OFP) of Tactical Aircraft. Discussed are the requirements for data acquisition, methods of capture and post-processing of acquired data. The intent of this CMAC is to allow the test operator/OFP programmer to set a breakpoint, loop, monitor, trace, and otherwise test the OFP in its hosted environment in real-time without any special test-oriented code within the OFP. A specific case of an OFP host processor (AN/AYK-14) will be discussed and its implementation with a laboratory software development situation. (Author)

A79-48671 **Evolving methods for reducing avionics data in an AISF environment.** C. Bierbaum (USAF, Air Logistics Center, Robins AFB, Ga.), M. Elowitz (TRW Defense and Space Systems Group, Redondo Beach, Calif.), and J. Kennoy, Jr. (TRW Defense and Space Systems Group, Warner Robins, Ga.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 845-852.

The concept and scope of the F-15 data reduction and analysis system (DRAS) are described. Attention is given to the avionics integration support facility (AISF) and its requirement for data reduction, covering such areas as the DSS dynamic simulation system, and flight test support aircraft. The DRAS concept discussion covers the software involved, a timeline summary, timeline analysis, and a parameter listing. Finally, the DRAS state of development is described and the future evolution of the DRAS and the AISF is extrapolated. M.E.P.

A79-48672 # **Microcomputer control of a test facility.** J. A. Carretto, Jr. (USAF, Avionics Laboratory, Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 853-858.

The paper discusses a unique method of placing the data collection and processing equipment of a test facility under the control of a microcomputer. The specific facility is the AF Avionics Laboratory's Mobile Evaluation Laboratory (MEL), a collection of test and data processing equipment used in the evaluation of navigation systems. The paper includes a general physical and functional description of the MEL, its development, and the rationale for reorganizing the system under microcomputer control. The advantages of integrating the microcomputer as the system controller are presented from both the hardware and software viewpoints. The modifications necessary for this are presented in detail. Specific problems encountered, and their solutions are also discussed. (Author)

A79-48676 # **Operational experience with the AN/ARN-131 Omega Navigation Set.** H. W. Underwood and D. W. Keen (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1006-1013.

The paper discusses (1) problems encountered in using the AN/ARN-131 Omega Navigation Set on the C-130 Hercules aircraft, (2) the Omega Task Group efforts, and (3) the subsequent follow-on test and evaluation results. It is found that fixes determined as a result of the Omega Task Group effort were effective. To date the fixes which have been approved for implementation by the Air Force are antenna relocation, minimum/maximum range deselect, 15-deg angular deselect, modal interference deselect, and 5-min wind time constant. B.J.

A79-48677 **The DG-800 - A rugged, high performance heading reference unit.** D. A. Zomick and M. J. Lanni (Bendix Corp., Guidance Systems Div., Teterboro, N.J.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1015-1022.

A directional gyro (DG-800) incorporating a single inertial grade liquid bearing sensor has been designed, fabricated, and tested. The unit is unusually rugged and its hydrostatic bearing and power pivot provide exceptionally good performance for the size of its angular momentum. Considerable interest has been expressed in the concept and the Army has contracted for preproduction units for its CV-HRS program. This paper gives a performance synopsis and discusses design/performance considerations. B.J.

A79-48678 **Expanding the region of convergence for SITAN through improved modelling of terrain nonlinearities.** L. D. Hostetler and R. C. Beckmann (Sandia Laboratories, Albuquerque, N. Mex.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1023-1030. 13 refs. Research supported by the U.S. Department of Energy.

The SITAN (Sandia Inertial Terrain-Aided Navigation) system was originally developed to provide continuous updating of an inertial navigation system by using radar altimeter measurements of the terrain in conjunction with prestored topographic data in an extended Kalman filter. The basic algorithm performs satisfactorily for limited initial position uncertainties, but can diverge when the position uncertainty is so great that terrain linearity assumptions are significantly violated. An improvement to the basic system is described which considerably increases the region of convergence. The improvement is accomplished by modelling the terrain nonlinearities as Gauss-Markov measurement noise whose statistics and frequency content are adaptively varied as the uncertainty region evolves with time. Theoretical development of this modification is given and results of flight test experiments are presented which verify the ability of this modification to significantly increase SITAN's region of convergence. (Author)

A79-48679 **Transfer alignment for precision pointing applications.** J. L. Farrell (Westinghouse Defense and Electronic Systems Center, Baltimore, Md.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1033-1039. 9 refs.

A transfer alignment formulation is presented and illustrated by the nonrigid case with no unobstructed optical path between master and slave IMU, a full validation of the formulation is also presented. The approach is straightforward; only the interpretation requires some sophistication, since the formulation accounts for an extensive array of strapdown errors not often addressed explicitly in other analyses. B.J.

A79-48680 **The alpha-beta-gamma tracking filter in the Z-domain.** R. E. Wilcox (Emerson Electric Co., Electronics and Space Div., St. Louis, Mo.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1042-1046. 14 refs.

The classic linear third order tracking filter also known as the alpha-beta-gamma filter will track an accelerating target with a position error which converges to zero. If this filter is implemented in the digital domain, then solutions for the filter output as a function of time must be carried out in the Z-transform formalism not using the continuous s or Laplace transform approach. This paper studies the linear third order tracking filter in the Z-domain with the objective of deriving and documenting the general solutions for the estimated position, position rate and position acceleration outputs as functions of modeling parameters. An algorithmic outline is presented for calculating the noise bandwidths for the filter outputs and the paper includes a numerical example describing the tracking of an incoming accelerating aircraft. (Author)

A79-48681 **Complex quaternion notation in coordinate transformations.** F. G. Saylor (TRW Defense and Space Systems Group, Redondo Beach, Calif.) and W. A. Jarvinen (USAF, Warner Robins Air Logistics Center, Robins AFB, Ga.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1047-1051. 8 refs.

This paper addresses the use of complex quaternion notation in coordinate system transformations among launch aircraft and simulated missile coordinate systems. Complex quaternion differential equations describing the transformation from the earth to missile coordinate systems are stated. A brief introduction to real quaternions as a lead-in to the use of complex notation and an example of a coordinate transformation using complex quaternions are given. The advantages of using the complex notation over direction cosine techniques are discussed. Complex quaternion solutions to dynamic coordinate system transformations can often reduce time and storage space required for FORTRAN programs when compared to direction cosine methods. (Author)

A79-48682 # **Pave Low III.** J. E. Clifford (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1054-1062.

Various aspects of the Pave Low III program for night/adverse weather rescue are reviewed. The success of the program is attributed to the people and their philosophy. This is followed by a discussion of the hardware, with emphasis on the equipment selection process for the prototype. Detailed subsystem capabilities, integration requirements, and evolved system capabilities/limitations are also discussed. B.J.

A79-48683 # **User requirements for future combat search and rescue vehicles.** D. H. Sattler (USAF, Military Airlift Command, Scott AFB, Ill.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1063-1067.

The mission of a combat rescue vehicle is aircrew recovery in hostile territory in daylight or darkness and under visual or instrument meteorological conditions. In order to accomplish this mission, the vehicle must have superior performance, a high degree of survivability, systems reliability, transportability, and easy maintainability. The aircraft must have equipment which allows operation with search and rescue task force or singly in a convert mode. The aircraft must be designed with threat avoidance as the primary method of operation and with threat defeat secondary. B.J.

A79-48684 # **H-X combat search and rescue avionics study results.** C. L. Zelasco and A. L. Leathan (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1069-1078.

The objective of the present study was to perform the necessary tradeoffs required to define an avionics suite which will satisfy U.S. Air Force requirements for a night/adverse weather combat rescue capability in an H-60 class (medium life helicopter). The results of this study showed the practicality of incorporating this type of capability in an H-60 helicopter. The study team arrived at this conclusion by defining a representative point design for the H-X avionics. This design, which evolved from an iterative tradeoff process, identified specific representative avionics equipments which satisfy the performance requirements. B.J.

A79-48685 **Multifunction CO2 heterodyning laser radar for low level tactical operations.** R. L. Del Boca (U.S. Army, Fort Monmouth, N.J.) and R. J. Mongeon (United Technologies Research Center, East Hartford, Conn.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1079-1088. 8 refs.

Analysis of tactical scenarios indicates that a number of radar requirements are optimally solvable with low power 10.6-micron laser systems. Exploratory development efforts by the U.S. Army and the United Technologies Research Center have been directed at the advancement of the state of the art in airborne CO2 heterodyne laser radar systems. This paper examines the design considerations, hardware configurations, and test results of flyable breadboard models which have demonstrated the feasibility of using CO2 scanning laser systems for wire detection, precision hover, Doppler navigation, and terrain following. B.J.

A79-48686 **Terrain-following radar - Key to low-altitude flight.** A. C. Woodward and J. B. Lagrange (Texas Instruments, Inc., Radar and Digital Systems Div., Dallas, Tex.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1089-1096.

Terrain following radar (TFR) is discussed as a chief factor in aircraft survivability during low-altitude flight. The basic principles of TF techniques applied in current operational radars such as the AN/APQ-126, -146, and -158, are described. Past and current TFR operational environments are compared to examine survivability and cost. Projections are made as to the direction of FTR state of the art to meet operational requirements by the Air Force for fixed- and rotary-wing aircraft. B.J.

A79-48687 **Test implementation through support software - A FIT translator.** G. L. Alker and S. M. Stennett (Westinghouse Defense and Electronic Systems Center, Baltimore, Md.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1098-1104.

The paper considers a hardware environment in which an embedded computer executes fully automated fault isolation tests (FIT) on an airborne radar system. External test equipment is not utilized. Complete FIT of this system requires translation of test designer input into a language that will run on the embedded computer. The information transfer is intricate and prone to error due to weaknessess common to documentation and verbal communication. As a solution to this problem, the paper describes a FIT translator which is easily adapted to a variety of systems. B.J.

A79-48689 **Automatic test software for calibrating strapdown systems.** L. P. Stave (Rockwell International Corp., Autonetics Strategic Systems Div., Anaheim, Calif.) and A. P. Andrews (Rockwell International Science Center, Thousand Oaks, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1111-1116.

An integrated system of software was developed for calibration of the Rockwell N73 Strapdown Inertial Navigation System. The software includes an interactive monitor for interfacing with production personnel, so that use of the software does not require trained or skilled operators. The calibration software also controls and monitors all test equipment, including the MIL-STD-1553A Data Bus which is the primary link to the navigator. The test computer uses the Data Bus to load and execute special-purpose programs in the navigation computer, for diagnosis and calibration of the navigator. The calibration software also performs data management of all calibration and test data, providing traceability for all calibration parameters. This soft-ware system has been evaluated and modified for human factors in the factory environment, and is now in use in production. (Author)

A79-48690 **Automatic test program generation selection.** D. B. Day (Support Systems Associates, Inc., Northport, N.Y.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1117-1121.

This paper examines the use of ATE to test electronic devices and the generation of test programs for digital electronic assemblies. Three methods of generating test programs, using manual, simulation, and automatic stimulus generation programs, are presented. The B-1 and F-16 Automatic Test Program Generation (ATPG) selections are studied in detail, noting the difficulties of the selection processes. The results of these processes for both the B-1 and F-16 favored the D-4 LASAR system becuase of its high (80%) fault detection capability. C.F.W.

A79-48691 **The impact of software in automatic test equipment.** R. G. Slavkin (Westinghouse Electric Corp., Baltimore, Md.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1122-1127.

The paper examines an automated test tool for the evaluation of a radar analog to digital converter (A/D). The present manual test method for the A/D is imprecise in identifying pass/fail criteria because any irregularities in the transfer function of a digital to analog converter cause nonlinearities and tend to distort these measurements. To overcome these problems, automated A/D test equipment utilizing quantative statistical analysis in software is developed. The A/D parameters that must be characterized to insure radar system performance such as the linearity of the A/D transfer function, the 'Random Triangle' test included in the automated test set to measure these parameters, and a noise measurement technique known as the 'RMS Noise' test are discussed. The microcomputer hardware is considered, and it is concluded that automatic equipment software allows ease of data handling, complex calculations, efficiency of manipulation, and detailed analysis of the unit in question. A.T.

A79-48692 **Guidance accuracy considerations for the microwave landing system L-band precision DME.** R. J. Kelly and E. F. C. LaBerge (Bendix Corp., Communications Div., Baltimore, Md.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1130-1141. 26 refs. U.S. Department of Transportation Contract No. FA72WA-2801.

The microwave landing system (MLS) L-band precision distance measuring equipment (PDME) must: (1) satisfy the CTOL Category II decision height and Category III flare maneuver accuracy requirements (100 feet, 2 sigma) when combined with the appropriate elevation data, and (2) for VTOL applications provide accurate range (+ or - 40 feet, 2 sigma) and range information (+ or - 2 knots, 2 sigma) to permit IRF decelerated approaches to within 500-feet range of hover. These specifications must be satisfied in the presence of large signal attenuation caused by ground multipath interference and signal time-of-arrival errors induced by lateral multipath (hangars, etc.). Consideration is given to a consistent accuracy specification suitable for MLS operational requirements and a PDME implementation common for CTOL, STOL, and VTOL. V.T.

A79-48693 **The ATCBI-5 beacon interrogator.** G. L. Vogt (Bendix Corp., Communications Div., Baltimore, Md.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1142-1146.

A new beacon interrogator has recently been introduced into the nation's air traffic control system by the Federal Aviation Administration. The interrogator, the ATCBI-5 is installed at terminal radar sites, enroute radar sites, and enroute beacon only sites. The ATCBI-5 offers significant improvements over previous interrogators, such as improved reliability, higher output power, improved receiver capabilities, compatibility with military interrogations modes, and others. In its first year of operation, this equipment has demonstrated more than double the mean time between equipment outages as compared to its most recent predecessor. (Author)

A79-48694 **Dynamic simulator test and evaluation of a JTIDS relative navigation system.** S. Welt (ITT, ITT Avionics Div., Nutley, N.J.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1162-1169. 5 refs.

The Joint Tactical Information Distribution System (JTIDS) is a spread spectrum command-control-communication system designed to operate in the Lx-Band (960-1215 MHz) and provide the military services with a secure anti-jam communication, navigation and identification capability in the tactical environment of the 1980's. This paper describes the design and implementation of the AN/USM-440 JTIDS Environment Simulator (JES) being developed for the Naval Air Development Center by ITT Avionics Division. The JES is a real time computer controlled dynamic simulator which provides a realistic RF environment and inertial navigation system signals when required which are used to test and evaluate the anti-jam and relative navigation performance of a wide variety of JTIDS user terminals. (Author)

A79-48695 **A deterministic investigation of strapped down navigation system accuracy.** P. Motyka (Charles Stark Draper Laboratory, Inc., Cambridge, Mass.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1172-1178. 5 refs. Contract No. F33615-78-C-1563.

The results of a study which assesses the effects of sensor errors and structural modes upon the accuracy of strapped down navigation systems are presented. These results are significant since the accuracy achieved with state-of-the-art navigation systems is not adequate for present and future high-performance aircraft. The sensors considered are navigation quality laser and two degree-of-freedom gyros and accelerometers. The major sensor errors are considered individually as well as in combination. Time histories of the navigation errors, for a one-hour flight trajectory which includes many features of a typical tactical fighter aircraft profile, are presented and analyzed. (Author)

A79-48696 **Application of instrument rotation in the N73 standard inertial navigation system.** A. P. Truban (Rockwell International Corp., Autonetics Strategic Systems Div., Anaheim, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1179-1185.

Rotation of inertial instruments for reducing the effect of aircraft flight-profile-dependent error sources on strapdown inertial navigation systems is considered. The N73 strapdown inertial navigation system with electrostatic gyros uses instrument rotation; the effect of rotation on electronic characteristics is considered in the mechanization of the rotational technique. The N73 system, the electrostatic gyro, the system mechanization considerations, and system errors are discussed, noting substantial reduction in the system sensitivity to internal and environmental error sources and the achievement of long-term calibration stability. Error sensitivity is discussed, and laboratory and flight test data from the N73 are presented which show the improvement in error sensitivity and calibration stability. A.T.

A79-48697 **Rapid reaction time techniques for a strapdown navigator employing electrostatic gyro technology.** B. E. Bona and R. M. duPlessis (Rockwell International Corp., Autonetics Strategic Systems Div., Anaheim, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1186-1192.

Fast reaction techniques for a strapdown system employing electrostatic gyro technology are described. Induction heating for rotor warmup and accurate gapsetting are used for gyro startup. A scheme for aligning the spin axis and the rotor major principal axis is presented. Gyrocompassing function is accomplished using a staged-gain filter to estimate attitude and drift errors. The filter is designed for rapid detection of large initial errors, especially in heading. The gyrocompass loop is closed through the filter in such a way that the response of the closed loop is precisely as desired. V.T.

A79-48702 **A real time video bandwidth reduction system based on a CCD Hadamard transform device.** D. J. Spencer and J. M. Anderson (TRW Defense and Space Systems Group, Redondo Beach, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1218-1231. 7 refs.

A low-cost video bandwidth compression system, VIDAP, which operates in real time with standard sensors and displays, is described. The VIDAP is based upon the 8 x 8 Hadamard transform and a full frame (512 x 512 x 6) memory and employs a LSI device implemented in digital charge coupled device (DCCD) technology. Compression of the video bandwidth is achieved in three ways: (1) frame reduction, (2) statistical redundancy removal, and (3) spatial fidelity reduction (subsampling). These three factors may be traded off to obtain any given data rate at the expense of temporal or spatial distortion. The system provides multiple synchronization modes for use with either sensor-based or modem-based timing and makes it possible to use small (less than 200 parts), low-power (20 W) transmitters for avionics applications. V.T.

A79-48705 # **Digital sensor simulation at the Defense Mapping Agency Aerospace Center.** M. B. Faintich (U.S. Defense Mapping Agency, Aerospace Center, St. Louis Air Force Station, Mo.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1242-1246.

The primary objective of the digital sensor simulation investigations being conducted at the Defense Mapping Agency Aerospace Center (DMAAC) is to establish an editing and analysis capability for digital culture and terrain data bases. These data bases are being produced by DMAAC to support advanced aircraft simulators by providing an improved low level radar training capability offered by digitally generated radar landmass images. As a result of the technology developed for aircraft simulator support, sensor guidance reference scenes, visual, and microwave scenes are also being digitally generated. Currently, intensive studies are underway to generate synthetic input data bases with apparent resolutions finer than in the original data bases, using supportive data base information. Highly realistic sensor simulations have been generated, and the continuing emphasis is on modeling new sensors as well as improving resolution without increasing data base production costs. (Author)

A79-48711 # **Integrated CNI avionics.** D. G. Botha (USAF, Avionics Laboratory, Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1314-1317. USAF-supported research.

In the context of integrated avionics the concept of multifunction multiband airborne radio system has evolved. This concept recognizes the synergistic relationship between radio navigation and inertial sensor measurements which lead to the designation of an integrated CNI avionics as a subset of integrated avionics. The paper describes a conceptual approach to the airborne CNI function in this higher-level integration context. The findings of a definition phase are discussed, architectural approaches to implementation of the CNI function are described, and further efforts addressing realization of the conceptual goals are postulated. S.D.

A79-48712 **Real time compression of video signals.** D. Ludington (General Electric Co., Aircraft Equipment Div., Utica, N.Y.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1318-1321. USAF-supported research.

The paper deals with a video bandwidth compression system which uses CCDs to implement a two-dimensional cosine transform in real time at a resolution of 512 pixels per TV line. The system is composed of an airborne encoder and a ground-based decoder. The decoder accepts compressed data from the encoder and converts it back into video. A data frame is first assembled in a memory and is then read out to an inverse quantizer and the inverse cosine transform while a parallel memory is being loaded. The output of the transform is a video signal which, after filtering, is available for display on a standard 525-line monitor. V.T.

A79-48713 # **Performance of a pulse-decode circuit in the presence of interference.** G. S. Douple and S. R. Robinson (USAF, Institute of Technology, Wright-Patterson AFB, Ohio). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1328-1333.

The performance of a pulse decode circuit is examined through Monte Carlo simulation for various types of signal interference. The received signals represent environments of many non-coherent correct replies with none dominant, many non-coherent friendly replies with one dominant, and noise jamming with no valid reply present. The performance of the receiver was determined by studying the effects of an envelope detected version of the received signal on the decoder circuit, and the results indicate that many types of deterministic pulse formats will cause the decoder to respond at its maximum decode rate. In terms of random, noise-only types of interference, the decoder is most vulnerable to signals whose bandwidths are at least the overall RF bandwidth of the receiver, but for the signal-plus-noise case the simulation results show that once the interference power reaches a certain value, increases in the power of the valid reply will not improve the decoder performance. A.T.

A79-48715 **JTIDS relative navigation - Architecture, error characteristics and operational benefits.** W. R. Fried (Hughes Aircraft Co., Fullerton, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1344-1349. 7 refs.

The paper examines the relative navigation (RELNAV) function of the joint tactical information distribution system (JTIDS) which provides high-accuracy absolute and relative position information and time synchronization. The RELNAV function is obtained through the addition of software only to the JTIDS terminal's operational computer program. Each member determines his position, velocity, and time offset through sequential passive time-of-arrival measurements with respect to other members, using appropriate source selection algorithms and extrapolation with dead reckoning data by means of a recursive filter mechanization. The basic system architecture, software functions, the error sources, and operational benefits, including the availability of the navigational data in geodetic and arbitrary grid coordinates and operation in a high jamming environment without reliance on critical nodes, are discussed. A.T.

A79-48716 **System configuration and algorithm design of the inertially aided JTIDS Relative Navigation function.** W. R. Fried (Hughes Aircraft Co., Fullerton, Calif.) and R. Loeliger (Intermetrics, Inc., Long Beach, Calif.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979, p. 1350-1356. USAF-sponsored research.

The system configuration for implementing the Relative Navigation (RELNAV) function in the JTIDS Hughes Improved Terminal (HIT) is presented. The integration options for interfacing the LN-31 Inertial Navigation Set with the HIT are discussed and the selected interface is described. The RELNAV operational modes, control and display requirements, and major software functions are discussed. A description is given of the selected RELNAV filter algorithm and the associated timing and sequencing design. The filter extrapolation, the inertial processing and the source selection algorithms are discussed. Some simulation results are presented. (Author)

A79-48717 # **Tactical electronic reconnaissance sensor.** P. W. Post (USAF, Tactical Air Warfare Center, Eglin AFB, Fla.). In: NAECON 1979; Proceedings of the National Aerospace and Electronics Conference, Dayton, Ohio, May 15-17, 1979. Volume 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1979. 8 p.

The ALQ-125 tactical electronic reconnaissance (TEREC) sensor detects, identifies, and locates radar emitters and reports them to ground terminals via narrowband data link. The sensor, which is internally mounted in the RF-4C aircraft, uses left and right side interferometer antenna arrays to determine direction of arrival (DOA) of radar emissions. Locations of tactical emitters such as radars associated with surface-to-air missile systems are computed using triangulation techniques as the aircraft flies along a base leg. The TEREC sensor measures the frequency, pulse repetition interval (PRI), pulse width, and (on a preprogrammed optional basis) scan rate, and compares these with the preprogrammed parameters for up to nine priority emitter types in the airborne computer. All TEREC-collected data is stored on magnetic tape for postflight data reduction using the TEREC portable exploitation processor (T-PEP). (Author)

A79-48849 # **Subsonic and transonic flows on a variable sweep wing (Ecoulements subsoniques et transsoniques sur une aile a flèche variable).** V. Schmitt and F. Manie (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *La Recherche Aérospatiale,* July-Aug. 1979, p. 219-237. 24 refs. In French.

Detailed experiments were performed on models of a variable sweep wing emphasizing in particular flow separation and development of vortex structures in the whole speed range and, in addition, the shape of shock waves at transonic speeds. The results of these tests have been compared with those of calculations made with available codes such as an incompressible panel method for unseparated flows and an unsteady method based on a point discretization of the vortex vector for separated flows. Transonic flows were calculated using different relaxation methods: one based on the perturbation theory, two others on the full potential equation. (Author)

A79-48856 # **The tendency of jet fuels to form deposits on a heated surface (Sklonnost' reaktivnykh topliv k obrazovaniiu otlozhenii na nagretoi poverkhnosti).** E. P. Seregin, V. G. Gorodetskii, N. P. Golenev, and V. N. Prokudin. *Khimiia i Tekhnologiia Topliv i Masel,* no. 8, 1979, p. 17-20. 8 refs. In Russian.

The tendencies of various standard commercial jet fuels to form deposits of oxidation products on heated surfaces are investigated. Temperatures at which deposits start to form, relationships between the amount of test deposit formed and a standard (the thermostability index) and thermal stabilities were determined for the fuels T-1, TS-1, RT and T-6 by means of various procedures. The statistical methods employed (LSART and TSRT-2) are found capable of providing information about total oxidation product formation, but are unable to distinguish thermostability indices, while DTS-1 indicates rates of filter obstruction and only DTS-2 is capable of determining deposit-formation and adhesion parameters. The thermostability indices of the fuels, and thus their tendencies to form deposits on heated engine parts, are found to decrease in the order T-1, TS-1, RT to T-6, and temperatures of deposit initiation to range between 85 and 100 C for T-1 and TS-1, 135 and 180 C for RT and 180 and 190 C for T-6. The fuel deposit formation properties obtained are attributed to relative contents of hetero-organic and oxidizable compounds. A.L.W.

A79-48857 # **Evaluation of the temperature of the initiation of jet fuel decomposition by means of the 'hardness factor' (Otsenka temperatury nachala razlozheniia reaktivnykh topliv po 'faktoru zhestkosti').** A. K. Bukharkin and G. I. Kovalev. *Khimiia i Tekhnologiia Topliv i Masel,* no. 8, 1979, p. 20-22. In Russian.

The application of the pyrolysis 'hardness factor' derived by Linden (1951) as a measure of the extent of cracking in a hydrocarbon and consisting of the product of the temperature and the 0.06th power of the holding time at that temperature, to the calculation of the temperature at which the thermal decomposition of jet fuels begins is examined. A linear correspondance between the 'hardness factor' and the extent of thermal decomposition as measured by the iodine number and the increase in vapor pressure due to cracking is demonstrated for the fuels RT, TS-1, T-8B and T-6. Values of the temperature derived from the 'hardness factor' at the iodine number defined as the point of initial thermal decomposition are shown to agree fairly well with thermal decomposition initiation temperatures calculated from kinetic equations and the dependence of iodine number on temperature. It is concluded that the 'hardness factor' allows the prediction of the extent of thermal decomposition at various temperatures and heating times as well as the computation of thermal decomposition initiation temperatures. A.L.W.

A79-48858 # **Changes in the quality of T-6 fuel upon prolonged storage (Izmenenie kachestva topliva T-6 pri dlitel'nom khranenii).** N. I. Melent'eva, I. V. Malysheva, N. N. Kalitina, and L. N. Savin. *Khimiia i Tekhnologiia Topliv i Masel,* no. 8, 1979, p. 22-24. 7 refs. In Russian.

The values of fuel quality indicators measured at six-month intervals before, during and after the storage of jet fuel T-6 in large steel tanks at elevated pressures are compared. After 20 months of storage, it is found that the acidity, actual tar content, sediment content and dissolved tars exhibit a slight decline in quality, while the remaining technical indicators (density, distillation temperature range, viscosity, aromatic hydrocarbon content, smokeless flame height, iodine number, total sulfur content, ash content, technical impurities and crystallization temperature) remained unchanged. Results of qualification tests, thermal stability tests, corrosion tests and chemical stability tests also indicate that T-6 fuel can be stored for up to two years with no decline in quality. A.L.W.

A79-48859 # **Method of determining mechanical-impurity contents in jet fuels (Metody opredeleniia soderzhaniia mekhanicheskikh primesei v reaktivnykh toplivakh).** V. N. Zrelov, N. G. Postnikova, L. V. Krasnaia, E. N. Zhuldybin, M. V. Sal'nikova, and I. I. Zimina. *Khimiia i Tekhnologiia Topliv i Masel,* no. 8, 1979, p. 51-53. 7 refs. In Russian.

Two methods based on nitrocellulose filtration for determining the contents of mechanical impurities in jet fuels are presented. The graphical-analytical method which determines impurity content from the slope of the relation of the mass of deposit collected on the nitrocellulose column to the volume of fuel passed through the column after the period of tar adsorption, may require up to 15 l of fuel. The improved method, derived from the GOST 10577-63 and ASTM D 2276 standard test and designated GOST 10577-78 or Method B, requires only 5 l of fuel and relies on a coefficient of 0.7 to account for tar accumulation. The results of Method B determinations are shown to agree well with those of the graphical method, and duplicate determinations of jet fuel impurities contents by Method B are shown to differ by no more than 0.06 mg/l, with a mean deviation of 0.02 to 0.03 mg/l. The method, employing on-site filtration by two number 5 filters, is considered suitable for airport as well as laboratory use. A.L.W.

A79-48870 # **A Navy plan for the development of a practical computer-aided programming /CAP/ system for analog circuit test design.** F. Liguori (U.S. Navy, Naval Air Engineering Center, Lakehurst, N.J.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 24-27.

A79-48873 # **E-3A sentry /AWACS/ ATPG.** M. S. Martin (USAF, Software Support Center, Robins, AFB, Ga.). In: AUTOTESTCON '78, International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 39, 40.

The selection of software aids to provide an organic depot capability for certain items of the Air Force E-3A sentry aircraft is

examined. Seventeen automatic test pattern generators (ATPG) of digital type were examined and five, including LOGOS and G- and D-LASAR systems, were selected for further examination. In the analog area, thirteen different circuit analysis programs were studied and it was found that SYSCAP-2 would be the most cost effective.
C.F.W.

A79-48878 # **Air Force modular automatic test equipment development program.** C. M. Wheelock (USAF, Washington, D.C.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 119-121.

The paper examines the Air Force modular automatic test equipment (MATE) development program. It is noted that problem areas with automatic test equipment (ATE) are the proliferation of different configurations, software incompatibilities, erroneous test results, late deliveries of new equipment and high development costs. The MATE family will permit interchangeable modules (hardware and software) to be used at all levels of maintenance, thereby reducing the problem of units passing tests at one level of maintenance and failing at another. Attention is given to the objectives of the MATE program which include reducing the life cycle cost of weapon system support, reduce proliferation of ATE, and improve ATE procurement practices. In conclusion it is stressed that a commitment to supply the necessary resources to the program office must be made by the highest levels of the policy-making machinery. M.E.P.

A79-48883 # **ATE and aircraft mechanical diagnostics.** T. C. Belrose (U.S. Army, Aviation Research and Development Command, St. Louis, Mo.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 176-181. 12 refs.

The Army is committed to fielding a family of automatic test support systems (ATSS) to support all Army materiel. The current plan is to field the AN/USM-410 'third-generation' ATE. The Army has also sponsored a significant amount of work aimed at achieving an 'on condition' maintenance philosophy for major aircraft subsystems by monitoring turbine engine performance, engine mechanical condition, health of various rotating dynamic components, hydraulic systems, and structural integrity of the aircraft. The objective is to investigate the viability of accomplishing the aircraft condition monitoring and diagnostic task using ATE. Significant points are the following: nonintrusive monitoring of aircraft mechanical systems is possible; impressive benefits can be attributed to this approach, but several attempts at fielding such a system have been terminated because of excessive initial investment costs; and mechanical diagnostics is not a simple extension of a measurement capability.
(Author)

A79-48884 **AN/USM-449/V/ ATE for worldwide support of the P3 Orion.** P. M. Knapp (AAI Corp., Baltimore, Md.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 235-241.

The update of the AAI 5500 ATE to the AN/USN-449(V) configuration and the extension of the test program to P-3B and ASN-124 TAC/NAV and P-3C configurations are considered. The AN/USN-449(V) introduced the latest computer configuration, updated peripherals, included ATLAS test language, and added a second test port to the 5500 ATE for dynamic digital testing. The planned installations including Conus sites and Naval Avionics Rework facilities are listed, and communications, data systems, navigation, and update II and III systems are discussed. The test set hardware station stimulus and measurement capabilities are summarized, and integrated logistics support plan, test program set development, including test program information, program printouts, CAD printouts, and patchcard and cable information are listed. The Atlas impact and test program set production are examined, and it is concluded that the support of the P-3 by automatic test equipment permitted transition from prime equipment manufacturer to depot support, and illustrated the ability of a company specializing in integrated logistics support to produce the ATE and test program.
A.T.

A79-48887 # **Can avionic testability requirements be enforced.** R. Brocchi (U.S. Navy, Naval Air Engineering Center, Lakehurst, N.J.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 282-285.

Theoretically avionic testability can be specified, levied contractually, designed and integrated into hardware, and demonstrated. The intent of this paper is not to identify how it is possible to achieve testability but how it is possible to get the maximum testability that is practical by a methodology of enforcement and control from the time the avionics procurement is envisioned through the design, development, and acceptance. The review and concurrence in testability is accomplished through the data submittals from the avionics supplier. Enforcement is directly related to the type of data required, when it is required, the formats specified, and the ability to get exactly what was contractually required. The optimum method of achieving this end is to have support engineering personnel participate through the stages of data preparation, review, and resubmittal. The participation is via concurrent reviews in conjunction with the avionics design review cycle, and by directing the contractor to include specific testability requirements for each UUT on a case by case basis. (Author)

A79-48888 **Avionics design for testability - An aircraft contractor's viewpoint.** J. M. Roche (McDonnell Aircraft Co., St. Louis, Mo.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 286-293.

Designing avionics for testability is the inclusion of design provisions in the avionics to enable test of the performance capability of the avionics, to isolate avionic malfunctions to replaceable elements, and to permit adjustment and alignment of the avionics as may be required. The effective implementation of testability provisions in the design of the Air Vehicle Equipment (AVE) and the Ground Support Equipment (GSE) that comprise the avionics can improve equipment reliability and availability while reducing equipment weight and cost. Accordingly, the operational readiness of the weapon system can be improved by effectively designing the avionics for testability. The aircraft contractor's viewpoint of designing avionics for testability is presented along with the methods and techniques employed by the aircraft contractor to effectively include testability provisions in the avionics. (Author)

A79-48889 **Avionics design for testability - A vendor's viewpoint.** D. C. Byerly (General Electric Co., Binghamton, N.Y.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 294-299. 6 refs.

GE experience with the testability of new avionics systems is reviewed with particular reference to the F-18 program. It is found that testability assessment and enhancement efforts will have minimal adverse impact on the development program for a new avionics system if these efforts are performed at the beginning of the design phase by a separate team of testability/maintainability engineering specialists working in parallel with the system design team. Early generation of test requirement document data submittals provide a highly visible means of measuring and reviewing testability for each UUT in an avionic system. B.J.

A79-48890 **Testability, the key to economical and operationally effective avionic test software.** M. B. Weber (Harris Corp., PRD Electronics Div., Syosset, N.Y.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 300-304.

Testability, in the context of this paper, is defined as the optimum automatic fault detection and isolation capability permitted by the avionic hardware design and economically reflected in the design of the test program set (TPS) for a given automatic test equipment (ATE) system. The paper addresses the major elements of the total avionic/support system (avionic UUT/ATE/TPS, where UUT = unit under test) and the key characteristics of these elements as they relate to and affect the development economics and operational effectiveness of TPSs. The discussion presented reveals how UUT design data derived during the development process of the avionics can be utilized to establish a testability baseline for the UUT/ATE as well as effect-added efficiency in the UUT test software development process. S.D.

A79-48891 **Techniques for fault isolation ambiguity reduction.** R. L. McCollor (Support Systems Associates, Inc., Northport, N.Y.) and N. M. Clark (U.S. Navy, Naval Air Engineering Center, Lakehurst, N.J.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 305-310.

The specification requirements for avionics testability and test access are reviewed, noting that in general, the requirements are not stringent enough to meet the needs of the ATE operator or avionics repair person. Attention is given to some frequent causes of excess PCOF ambiguities and erroneous PCOF's. Means of eliminating such deficiencies in future equipment designs and test programs are described. Finally, recommendations are made for specification revisions and future vendor and contractor responsibilities. M.E.P.

A79-48894 # **F-16 avionics maintenance concept and multinational aspects.** G. L. Vickery (USAF, Systems Command, Washington, D.C.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 336-339.

The paper describes the three level avionics maintenance concept for the F-16, organization, intermediate, and depot. This concept has been tailored to the F-16 weapons system by an iterative process. It is shown that decisions are made based on the best economic approach, yet test capability is retained that allows a reversal in those instances where the phased maturation of the weapons system dictates a change. Finally, it is stressed that since the F-16 will carry the defense forces of many countries into the next century, the development of a workable maintenance concept is a critical element of logistics support planning for ensuring that defense capability. M.E.P.

A79-48895 # **F-16 depot automatic test equipment.** D. B. Day (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 340-345.

General Dynamics Corporation, Fort Worth Division (GD/FW) is currently developing the F-16 depot level Automatic Test Equipment (ATE) system under the direction of the F-16 System Program Office (SPO) located at Wright-Patterson Air Force Base, Ohio. Existing design testers are being extensively utilized through update and improvement modifications, with the vast majority of the development work concentrated in the Test Packages (Interface Test Adapters (ITAs) and test programs). This paper describes the acquisition management techniques used and the various ATE and software development aids selected to date. The test package development effort is described. Our approach to supporting EPROM/PROM ICs is presented. Configuration management is discussed. Finally, a look at the program future is given. (Author)

A79-48896 **A new U.U.T./test station interface.** M. B. Hosking (General Dynamics Corp., Electronics Div., San Diego, Calif.). In: AUTOTESTCON '78; International Automatic Testing Conference, San Diego, Calif., November 28-30, 1978, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1978, p. 346-350.

The modular UUT/test station interface was designed specifically for a combination of LRU and SRU testing. Its advantages include ease of maintenance, long life, simplified field maintenance, proven high reliability, and a substantial reduction in signal degradation due to excessive lengths of interface cabling. Moreover, interface adapter complexity and weight are minimized. B.J.

A79-48945 **Achieving consistency in the production of critical jet engine components by means of press forging.** F. Turner (Cameron Iron Works, Ltd., Livingston, Scotland). In: High temperature alloys for gas turbines; Proceedings of the Conference, Liège, Belgium, September 25-27, 1978. Barking, Essex, England, Applied Science Publishers, Ltd., 1978, p. 893-899.

In recent years, manufacturers of aircraft engine components have placed increased emphasis on quality control and inspection procedures. A major reason for this emphasis is the engine builder's requirement of consistency in the fabrication of components. In the present paper, the ingredients of consistency in manufacture are identified as a combination of good quality control and the nature and reliability of the manufacturing equipment. Two examples of how well consistency has been achieved in an industrial plant, as measured by mechanical property data, are presented. V.P.

A79-49052 * **LDV measurements on propellers.** J. P. Sullivan (Purdue University, West Lafayette, Ind.). In: Laser velocimetry and particle sizing; Proceedings of the Third International Workshop, West Lafayette, Ind., July 11-13, 1978. Washington, D.C., Hemisphere Publishing Corp., 1979, p. 531-534. NASA-supported research.

Laser Doppler velocimeter (LDV) measurements of the flow velocity around high-efficiency propeller blades for high disk loading turboprop propulsion systems are reported. The wind-tunnel flow around sets of eight straight and swept propeller blades with the same twist and chord distributions was measured using a conventional two-color dual scatter LDV system. The measurements of the axial flow velocities a small distance in front of the propeller blade, between the blade row, and downstream of the propeller are shown to provide information necessary for the determination of overall performance, swirl angle distribution, blade loading distributions, local lift and drag coefficients, interference effects, shock location, local induced velocities, wake characteristics and stall pattern. A.L.W.

A79-49054 * # **Effect of tip shape on blade loading characteristics for a two-bladed rotor in hover.** J. D. Ballard, K. L. Orloff (NASA, Ames Research Center, Moffett Field, Calif.), and A. B. Luebs (Gates Learjet Corp., Wichita, Kan.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 9 p. 14 refs. (AHS 79-1)

A laser velocimeter has been used to study the flow surrounding a 2.13-m-diameter, two-bladed, teetering model-scale helicopter rotor operating in the hover condition. The rotor system employed interchangeable blade tips over the outer 25% radius. A conventional rectangular planform and an experimental ogee tip shape were studied. The radial distribution of the blade circulation was obtained by measuring the velocity tangent to a closed rectangular contour around the airfoil section at a number of radial locations. A relationship between local circulation and bound vorticity is invoked to obtain the radial variations in the sectional lifting properties of the blade. The tip vortex-induced velocity was also measured immediately behind the generating blade and immediately before the encounter with the following blade. The mutual influences between blade loading, shed vorticity, and the structure of the encountered vortex are quantified by the results presented and are discussed comparatively for the rectangular and ogee planforms. The experimental loading for the rectangular tip is also compared with predictions of existing rotor analysis. (Author)

A79-49055 **Helicopter performance methodology at Bell Helicopter Textron.** F. D. Harris, J. D. Kocurek, T. T. McLarty, and T. J. Trept, Jr. (Bell Helicopter Textron, Fort Worth, Tex.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 48 p. 23 refs. (AHS 79-2)

Forward flight helicopter performance methodology is reviewed with emphasis placed on the two key aspects of the power required calculation, pitch attitude for trim and rotor aerodynamics. The modeling approach to trim is described along with contrasts among airframe component and rotor forces and moments. It is shown that improved correlation results from a more physical treatment of the blade tip loss model used in combination with unsteady, three-dimensional blade element aerodynamics. The sensitivity of the performance calculation to airfoil data and blade elastic motion are discussed, and the accuracy of simple momentum theory for prediction of power required in low speed flight is outlined. V.T.

A79-49056 **A lifting-surface method for hover/climb airloads.** J. M. Summa and D. R. Clark (Analytical Methods, Inc., Bellevue, Wash.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 12 p. 17 refs. Grant No. DAAJ02-76-C-0069. (AHS 79-3)

The development of a lifting-surface method for hover/climb airloads and its application in the prediction of hovering rotor performance are described. The method includes both a prescribed and a relaxed wake representation. Unique features of wake modeling developed for the method include the wake segmentation, a new far-wake model, and a model of the tip vortex shedding across the blade chord. In addition, new techniques for wake relaxation, such as a numerical method for the calculation of wake velocities due to curved vortex filaments, a more representative core model, and a new method of integration for new wake shapes are discussed. Calculated results demonstrate that the fundamental explanation for discrepancies in hovering rotor airloads predicted by lifting-line and lifting-surface methods is the wake shedding model. Finally, hovering performance correlations for converged relaxed wake calculations with experimental data are analyzed. (Author)

A79-49057 **The influence of sweep on the aerodynamic loading of an oscillating NACA 0012 airfoil.** A. O. Saint Hilaire, F. O. Carta (United Technologies Research Center, East Hartford, Conn.), and W. D. Jepson (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 10 p. 10 refs. (AHS 79-4)

An experimental study was conducted to determine the effect of sweep on the unsteady aerodynamic load characteristics of an NACA 0012 airfoil oscillating in pitch about the quarter chord. The unsteady data for these comparisons were obtained from numerical integrations of the unsteady chord-wise pressure distribution. It was found that sweep delays the onset of dynamic stall and generally reduces the magnitude of the unsteady load variation about the mean response as a function of the pitch displacement. A noteworthy aspect of this research program was the ability to estimate the unsteady drag force using only those contributions due to pressure forces. This approximation is especially valid over the stalled portion of the cycle where the viscous drag contribution is relatively small. (Author)

A79-49058 **An integrated analytical and experimental investigation of helicopter hub drag.** A. H. Logan, R. Marthe (Hughes Helicopters, Culver City, Calif.), D. R. Clark (Analytical Methods, Inc., Bellevue, Wash.), and A. Phelps (U.S. Army, Structures Laboratory, Hampton, Va.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 16 p. 8 refs. (AHS 79-5)

This paper describes an integrated program which uses a viscous wing/body computer code to analyze low drag concepts of a current helicopter. Based on this analysis, full-scale wind tunnel models are fabricated and tested. The resulting experimental data are then compared to predictions and areas of agreement are defined. The viscous wing/body computer code is Program DRAG which includes engine inflow/exhaust modeling and main rotor hub representation. The full-scale experimental model represents the YAH-64 and the testing was conducted in the NASA/Langley V/STOL tunnel. The data presented and discussed indicate that Program DRAG is acceptable for designing hub/pylon modifications. In addition, it is shown that engine air flow has a significant effect on model pylon drag. The development of typical hub/pylon fairings and the importance of sealing are discussed. (Author)

A79-49059 **Helicopter obstacle strike tolerance.** L. T. Burrows (U.S. Army, Applied Technology Laboratory, Fort Eustis, Va.), J. E. Brunken (Bell Helicopter Textron, Fort Worth, Tex.), and B. P. Gupta (Hughes Helicopters, Culver City, Calif.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 11 p. Army-supported research. (AHS 79-7)

Design concepts for improving the tolerance of helicopters to in-flight obstacle strikes are derived for the main rotor, tail rotor, fuselage and landing gear (fixed system), and main rotor hub and controls. Selected concepts are comparatively analyzed based on their functional, operational, and aircraft integration characteristics, and on their strike damage cost-reduction potential. Detailed definition of the in-flight obstacle strike problem provided a sound basis for the derivation and selection of the design concepts having the greatest potential for improving helicopter strike tolerance. Problem definition included determination of the types of obstacles struck and frequency; areas of helicopter struck and frequency; cost of strikes; and diameter and type of trees and wires for which current systems have reasonable strike tolerance. Obstacle strike tolerance design criteria for future systems are proposed, as are suggestions for improving the obstacle strike protection of current systems through retrofit. (Author)

A79-49060 # **A system for interdisciplinary analysis - A key to improved rotorcraft design.** A. W. Kerr (U.S. Army, Research and Technology Laboratories, Moffett Field, Calif.) and J. M. Davis (U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 15 p. 16 refs. (AHS 79-8)

Development of the Second Generation Comprehensive Helicopter Analysis System (2GCHAS) is being initiated by the U.S. Army Research and Technology Laboratories. This system provides the capability to model the total helicopter to predict performance, loads, vibration, aeroelastic stability, stability and control, and acoustics characteristics. This interdisciplinary analysis system is a basic tool required to support the rotorcraft design process. Aspects of this system which affect its application as a design tool are addressed. A primary consideration in the development of the system is the manner in which component parts of the helicopter are combined analytically to represent the total vehicle system. The results of a workshop conducted to discuss formulation of equations and related issues are summarized. Requirements to make the system easy to use are explored, including the manner in which it is applicable through all phases of aircraft design and development from conceptual analysis through flight test and detailed modification support. (Author)

A79-49061 **Composite helicopter tail booms.** H. J. Brown (Fiber Science Corp., Salt Lake City, Utah). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 7 p. (AHS 79-9)

Two different design concepts for helicopter tail booms made from advanced composites are discussed. Cost, structural design and manufacturing factors are presented using the experiences gained from these two tail booms as examples. One tail boom was test flown after extensive static and dynamic testing to prove feasibility. Labor costs using the wet filament winding process plus 1980 material prices for graphic fiber and epoxy resin are presented as justification that production of composite tail booms is reasonable today. (Author)

A79-49062 **Crashworthy armored crewseat for the UH-60A Black Hawk.** S. P. Desjardins, D. H. Laananen, R. L. Taylor (Simula, Inc., Tempe, Ariz.), and R. J. Dummer (Norton Co., Industrial Ceramics Div., Worcester, Mass.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 13 p. 6 refs. (AHS 79-10)

In addition to the typical operational features of adjustment and comfort, the crewseat for the UH-60A Black Hawk has been designed to provide protection from both ballistic fire during operation and crash hazards during accidents. It is the first production seat to be designed entirely in accordance with MIL-S-58095(AV), the Army specification which specifies the degree of crash protection in terms of structural strength and energy absorption as well as the means for evaluation. This paper includes a discussion of the requirements imposed on the seat design, a description of the seat system with emphasis on its unique features, and a presentation of qualification test results. (Author)

A79-49063 **Designing with experimental mechanics.** J. Cernosek (Bell Helicopter Textron, Fort Worth, Tex.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 8 p. (AHS 79-11)

Three-dimensional photoelasticity was modified and developed into a relatively inexpensive tool for accurate stress analysis of complicated helicopter parts. The typical design process of helicopter dynamic components is presented along with model methods of experimental mechanics. The method of aluminum-filled epoxy models, stress freezing three-dimensional photoelasticity, and a new model material based on epoxy resin are discussed. Consideration is given to model casting, curing, and loading and evaluation of stress distribution. The main rotor grip of the 412 model was designed using a three-dimensional photoelastic model to evaluate the stress level. V.T.

A79-49064 **Agricultural helicopters.** H. E. Lemont (Bell Helicopter Textron, Fort Worth, Tex.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 12 p. 5 refs. (AHS 79-60)

Independent investigations, a NASA-funded study on helicopter aerial applications of materials, and flight spraying tests conducted by BHT are discussed. Agricultural (AG) helicopter systems are investigated by computer analysis for parametric effects on swath widths. Standards and productivity indices for a rating system are generated from operational costs, payloads, cruise speeds, and swath widths. Dollar/acre costs are reviewed for establishing Ag helicopter capabilities. The NASA study on the current technology of helicopters, equipment and systems and their inherent limitations form the background for this work. Designs are synthesized from this and other criteria derived in previous studies. These aircraft (three sizes and three missions) are exercised for design potential, cost improvements, and changes in dollars/acre. Advantages of a 'lofted swath' spraying technique and potentials for ultrawide swaths are indicated. Conclusions and recommendations are presented. (Author)

A79-49065 **Meeting the challenge of precise navigation during nap-of-the-earth flight.** S. P. Rogers and K. D. Cross (Anacapa Sciences, Inc., Santa Barbara, Calif.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 9 p. 7 refs. (AHS 79-12)

Navigation during nap-of-the-earth (NOE) flight is one of the most demanding tasks ever required of an aviator. The difficulty imposed by a limited view of surrounding terrain is augmented by the complexity of map interpretation. Nevertheless, aviators are expected to navigate to an accuracy of 100 meters. In order to help meet the challenge of such precise navigation, two major efforts are underway. First, special courses in map interpretation and terrain analysis have been constructed to instruct pilots in these vital skills. The lessons include extensive cinematic simulation exercises to teach the interpretation of symbology, effects of map scale, cartographic practices and other critical information. Second, a research program is being conducted to support the development of a computer-generated topographic display. Such a display is capable of providing enormous advantages over conventional maps. The effectiveness of the system depends greatly upon the research performed to adequately define the display content and format. (Author)

A79-49067 **Multiplex technology applied to helicopters.** L. A. Frazer and J. H. Emery (Bell Helicopter Textron, Fort Worth, Tex.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 8 p. (AHS 79-14)

A multiplex system is an information transfer system that time-shares a single transmission medium with multiple information sources and receivers. The application of the multiplex technology can greatly enhance the helicopter mission performance, providing more versatility in the design and making possible the optimization of the avionics system. The paper familiarizes the reader with multiplex technology concepts and terminology, and introduces the idea of the multiplex system as a tool with which to integrate helicopter subsystems. The application of the multiplex technology to helicopters has been made possible by the advances in electronics technology, primarily in the area of microprocessors and large-scale integration (LSI) techniques. S.D.

A79-49068 **Antennas for the Black Hawk helicopter.** M. L. Parent (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 13 p. (AHS 79-15)

The Black Hawk is the Army's troop transport helicopter for the 1980s and beyond. This helicopter incorporates flush antennas with no protrusions on the bottom to be damaged in rough-area landings. The paper outlines the design and development program for these antennas. Attention is given to a discussion of design objectives, initial antenna designs and installation, the antenna test program, and resulting antenna improvements for production. The design objectives for Black Hawk antenna include compliance with overall performance, mechanical, environmental, EMI, reliability, maintainability, and weight requirements, along with meeting design-to-cost requirements. The final development tasks have been successfully completed and the flush antennas are being delivered to the Army on production Black Hawk helicopters. S.D.

A79-49069 **Advances in decelerating steep approach and landing for helicopter instrument approaches.** P. S. Demko and J. H. Boschma (U.S. Army, Fort Monmouth, N.J.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 13 p. (AHS 79-16)

The instrument decelerating steep approach and landing technique which extended the helicopter capability into instrument meteorological conditions (IMC) domain is considered. This capability permits the helicopter pilot to guide it along a precise steep angle approach course and to perform a normal deceleration to a safe approach termination within a confined landing zone, without visual reference to the outside world. This method uses microwave landing guidance system with precision DME, 4-cue/4-axis flight director (FD) and autopilot (AP) system. The deceleration maneuver, approach profile and rate, the microwave landing system controls and equipment, the decelerating steep approach and landing (DSAL) flight director and controls are discussed, and performance of the IMC DSAL maneuver is illustrated by a flight from 1000 and 200 ft intercept altitudes, along 6 and 12 deg glideslopes by the pilot through the FD, or by the autopilot, to a stable hover over the desired landing point. A.T.

A79-49070 **Helmet mounted display and sight development.** C. J. G. Lewis (Marconi Avionics, Inc., Atlanta, Ga.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 14 p. (AHS 79-17)

Three helmet mounted systems to provide data to the pilot flying head up in nap of the earth (NAP) and at night are examined. The pipelite system avoids the mass, thermal and high voltage disadvantages of mounting a cathode ray tube system directly on the helmet by an airframe cathode ray tube and optics, and data is projected into a coherent fiber optic bundle which brings the light to an optic mounted on the pilot's helmet. The helmet optical position sensing system, HOPS, uses pulsed infrared emitting diodes mounted on the helmet. Their output is detected by airframe mounted, charge coupled devices using V/slit pinhole cameras. The system is free from electromagnetic interference and provides half degree line of sight accuracies. Data for simple sighting and management tasks is provided with a visor projection optics and a high brilliance light emitting diode (LED) addressable matrix with a large viewing aperture. A.T.

A79-49071 * **Experimental measurements of the rotating frequencies and mode shapes of a full scale helicopter rotor in a vacuum and correlations with calculated results.** B. L. Lee (NASA, Langley Research Center, Hampton, Va.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 14 p. 5 refs. (AHS 79-18)

This paper presents results of an experimental program conducted to obtain data which can be used for correlations of rotor blade dynamic analyses. Measurements were made of the rotating frequencies and mode shapes of a representative full-scale, two-bladed helicopter rotor in a vacuum. The blades were cantilevered to the hub. Mode shape data were obtained optically using a system of cameras developed specifically for this purpose. Excitation of the rotor was provided by vertical oscillatory motion of the hub. To compare experimental and analytical results, correlations of some experimental measurements with calculations from an existing blade modes computer program based on a Holzer-Myklestad procedure are presented, and the differences between the results are discussed. The experimental and analytical natural frequencies were generally in good agreement as were the principal components of the modal deflections for the flap and lag modes. The torsion mode shape indicated disagreement between the measured and calculated results in regard to the amount of flap and lag motions present in this mode, while the spanwise variations of the measured and calculated torsional components were in agreement. (Author)

A79-49072 **Dynamics requirements for an Advanced Scout Helicopter /ASH/.** D. P. Schrage and R. A. Wolfe (U.S. Army, Aviation Research and Development Command, St. Louis, Mo.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings.
Washington, D.C., American Helicopter Society, 1979. 8 p. 9 refs. (AHS 79-19)

The paper presents modified detailed requirements specified for recent helicopter development programs and their potential applicability to the requirements for the Advanced Scout Helicopter (ASH) design. The recommended ASH System Specification (SS) requirements for dynamics are considered, and it is shown how they are and should be verified through the Airworthiness Qualification program (AQP). Attention is given to aeroelastic stability, mechanical stability, engine, shaft, and rotor resonances/instabilities, and airframe vibration. A mast-mounted sight (MMS), true nap-of-the-earth (NOE) flight, and maneuverability are outlined along with their effects on the dynamics requirements discussed. V.T.

A79-49073 **Theoretical flap-lag damping with various dynamic inflow models.** D. A. Peters (Washington University, St. Louis, Mo.) and G. H. Gaonkar (Indian Institute of Science, Bangalore, India). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 11 p. 13 refs. (AHS 79-20)

The effects of dynamic inflow perturbations are incorporated into a flap-lag stability analysis of a rigid blade. The concept of equivalent Lock number, previously used to model the effect of quasi-steady inflow for flapping only, is extended to the case of coupled flap-lag motions by the addition of an equivalent profile drag coefficient. Plots of flap and lead-lag damping are presented for various inflow assumptions including: no dynamic inflow, quasi-steady momentum theory, unsteady momentum theory, empirical inflow, and equivalent Lock number and drag coefficient. The results show that dynamic inflow has a large effect on blade damping for the regressing mode. In some instances, this effect can be modeled by the equivalent Lock number and drag coefficient. (Author)

A79-49074 **Evaluation of the practical aspects of vibration reduction using structural optimization techniques.** H. W. Hanson (Bell Helicopter Textron, Fort Worth, Tex.) and N. J. Calapodas (U.S. Army, Aviation Research and Development Command, Fort Eustis, Va.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 13 p. 6 refs. Grant No. DAAK51-78-C-0011. (AHS 79-21)

The results of a practical evaluation of two structural optimization techniques for vibration reduction, the Vincent circle method and the forced response strain energy method, are discussed. An elastic line mathematical model of the AH-1G helicopter was used for initial comparison studies of the two methods and for evaluating the Vincent circle method with respect to mass changes and damping effects. The forced response strain energy method was selected for vibration reduction of a large complex built-up Nastran AH-1G model through structural stiffness optimization. It is noted that while the Vincent circle method is useful in predicting optimum locations of dynamic absorbers for vibration reduction, for more detailed analysis the damp forced response strain energy method has the potential benefit of rapid evaluation and optimization of structural vibratory response. V.T.

A79-49075 **Full scale ground and air resonance testing of the Army-Boeing Vertol Bearingless Main Rotor.** J. A. Staley, R. Gabel (Boeing Vertol Co., Philadelphia, Pa.), and H. I. MacDonald (U.S. Army, Applied Technology Laboratory, Fort Eustis, Va.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 14 p. 10 refs. (AHS 79-23)

This paper presents ground and air resonance test results for full scale tests of the Boeing Vertol-Army Bearingless Main Rotor (BMR) flown on a BO-105 helicopter. The BMR has the advantage of simplicity due to elimination of the pitch bearing and the flap and lag hinges used in articulated rotor designs. This results in potential improvements in performance, reliability and life cycle costs. The aircraft was tested for ground and air resonance damping at conditions which were expected to be critical, including level flight, climbs, descents, maximum power dives, and autorotations; in addition, testing during loads evaluations included banked turns, pull-ups, and push-overs. The aircraft encountered no air resonance mode instabilities during any of these flight conditions. Initial testing disclosed that ground resonance mode damping had to be improved by stiffening the existing landing gear skid. Analytical results are also presented which were used in developing the rotor design and in preparing the flight test procedures. Model rotor test results are also shown which gave an accurate preview of what was to have been expected during full scale flight testing. (Author)

A79-49076 **Spirit helicopter handling qualities design and development.** G. P. Wright and N. Lappos (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 12 p. (AHS 79-24)

The design and development of the Spirit (S-76) helicopter are reviewed. A design and development program included preliminary design, developmental model and wind tunnel testing, computer simulation, and a developmental flight test program. Particular design features, such as a fixed, low horizontal stabilizer, main rotor pitch/flap coupling, pitch bias actuator, mechanical control coupling, and stability augmentation are described. It is shown that the helicopter handling quality design depended heavily on simulation model results. Reliance on simulation resulted in few developmental changes after the first flight. Test data accumulated for the simulation model, and simulation correlation with tests are also presented. V.T.

A79-49077 **Improved method of predicting helicopter control response and gust sensitivity.** F. White and B. B. Blake (Boeing Vertol Co., Philadelphia, Pa.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 12 p. 6 refs. (AHS 79-25)

The paper presents the results of studies performed using recently developed analytical models correlated with flight test data to better understand the effects of rotor and aircraft configuration on flying qualities. Attention is given to low speed control trim change, gust sensitivity and interaxis coupling. A theory is given which has been developed to predict rotor trim changes resulting from nonuniform downwash effects. It is shown that the approach combines fixed wing lifting line theory with simple classical rotor equations and allows rapid estimation of parametric effects and trim changes using simple hand calculations. A computer program is discussed which allows the user to select from a variety of helicopter and control system math models and presents output in either the time or frequency domain. Finally, correlation with flight test data is shown, and results of control cross coupling and gust sensitivity studies are presented. M.E.P.

A79-49078 * # **Piloted simulator investigation of helicopter control systems effects on handling qualities during instrument flight.** R. D. Forrest (FAA, Washington, D.C.), R. T. N. Chen, R. M. Gerdes, T. S. Alderete, and D. R. Gee (NASA, Ames Research Center, Moffett Field, Calif.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 27 p. 12 refs. (AHS 79-26)

An exploratory piloted simulation was conducted to investigate the effects of the characteristics of helicopter flight control systems on instrument flight handling qualities. This joint FAA/NASA study was motivated by the need to improve instrument flight capability. A near-term objective is to assist in updating the airworthiness criteria for helicopter instrument flight. The experiment consisted of variations of single-rotor helicopter types and levels of stability and control augmentation systems (SCAS). These configurations were evaluated during an omnirange approach task under visual and instrument flight conditions. The levels of SCAS design included a simple rate damping system, collective decoupling plus rate damping, and an attitude command system with collective decoupling. A limited evaluation of stick force versus airspeed stability was accomplished. Some problems were experienced with control system mechanization which had a detrimental effect on longitudinal stability. Pilot ratings, pilot commentary, and performance data related to the task are presented. (Author)

A79-49079 **Development of a fly-by-wire elevator for the Bell Helicopter Textron 214ST.** S. W. Ferguson and K. E. Builta (Bell Helicopter Textron, Fort Worth, Tex.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 19 p. (AHS 79-27)

The Bell 214ST helicopter is an extended version of the single-engine Bell 214 and is powered by two General Electric CT7-2 engines. A fly-by-wire (FBW) elevator system is developed for the 214ST helicopter. Considerable insight is gained in handling qualities, testing techniques, and elevator-related aerodynamics during the development of the 214ST FBW elevator. Significant handling qualities improvements, as compared with those available in Bell helicopters using conventional elevator control systems, are demonstrated in pitch attitude control, longitudinal static stability, trim change with power, and damping of long-period longitudinal oscillations. The availability of a pilot-controlled elevator mode during testing provided the opportunity to acquire previously unavailable static and dynamic stability derivative data. Other valuable data allowed further understanding of the airframe-elevator aerodynamic relationship, as well as the aerodynamic characteristics of the elevator pitching moment. S.D.

A79-49080 **Advanced Scout Helicopter flying qualities requirements - How realistic are they.** D. M. Pitt and F. E. Heacock (U.S. Army, Aviation Research and Development Command, St. Louis, Mo.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 14 p. 24 refs. (AHS 79-28)

The proposed mission profile and handling qualities requirements for the Army's Advanced Scout Helicopter (ASH) are examined. The results of the AAH and UTTAS competitive testing are used as a basis to define the state-of-the-art helicopter handling qualities, and what can realistically be expected from the ASH. Results of testing of various Army helicopters in simulated ASH maneuvers are used to justify the ASH postulated handling qualities requirements. Army testing of ASH-type mission equipment and requirements on fielded Army helicopters and their effects on the stability of the known helicopter are used to rationalize expected ASH stability. (Author)

A79-49081 **Handling quality and display requirements for low speed and hover in reduced flight visibility.** R. H. Hoh and I. L. Ashkenas (Systems Technology, Inc., Hawthorne, Calif.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 13 p. 24 refs. (AHS 79-29)

A classification scheme has been developed to account for outside visual cues and cockpit displays in determining the required equivalent system forms for low speed and hover. Tentative criteria are presented in terms of a visibility scale which quantifies environmental conditions for the intended mission in a more fine-grained manner than simply specifying IMC or VMC. There are indications that rate and attitude systems may be used for partial IMC conditions but that a translational rate command (TRC) system is required for low speed and hover in zero visibility. In general, most experiments indicate that advanced displays are not a substitute for augmentation. Tentative limiting conditions are defined for rate and attitude systems, but more data are required to define handling qualities for TRC systems. Since the existing data base is primarily oriented toward command/response characteristics, definition of the limiting conditions for turbulence and large discrete wind shears also requires more data. (Author)

A79-49082 **Role of Numerical Control Design in the computer aided design/manufacturing interface at Sikorsky.** G. O. Pranspill (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 9 p. (AHS 79-30)

The evolution of Numerical Control Design (Engineering) function from its beginnings in graphic lofting/lines layout/master dimensions to its current pivotal position within the aircraft design/manufacturing process is described. The development and application of many sophisticated computerized hardware and software systems currently in operation are outlined. These include interactive graphics, automated drafting and digitizing, demand batch processing and a greatly enhanced APT III system for design/drafting/lofting. The integration of sheet metal layout and template/tool design within the Numerical Control Design function is shown resulting in the output of a wide variety of tool drawings for downstream manufacturing requirements which are illustrated. How these improved interfaces with preliminary and production design and with manufacturing operations and quality assurance coupled with the increased efficiencies of the above systems have resulted in substantial cost and lead time savings in the development of prototype and production aircraft are demonstrated. (Author)

A79-49083 **Model 206L composite litter door.** D. Crist (Bell Helicopter Textron, Fort Worth, Tex.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 11 p. (AHS 79-31)

This paper describes a program to design and manufacture a composite door. The door selected was the litter door of the Bell Model 206L. A new manufacturing process was developed for curing the door in a single cure cycle in a closed cavity tool by using air pressure inside the hollow sections, but without an internal pressure bag. The composite door developed is an all-Kevlar/epoxy design which is cured in a Kevlar/epoxy bond tool. The resulting composite door is 37 percent lighter than the baseline aluminum door. Cost, weight, appearance and manufacturing aspects are discussed and compared to the production aluminum door. (Author)

A79-49084 **Determining the contour of helicopter rotor blades automatically using electro-optical techniques.** A. Pellman (Dreyfus-Pellman Corp., Stamford, Conn.) and T. J. Pojeta (U.S. Army, Aviation Research and Development Command, St. Louis, Mo.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 17 p. Grant No. DAAK50-78-C-0008. (AHS 79-32)

The design of a noncontacting electrooptical system that automatically measures the contour of helicopter blades is presented. An experimental model of an electrooptical range finder was also designed, fabricated, and tested. To test contouring accuracy, measurements were made electrooptically at eighty-seven points on the surface of four sample helicopter rotor blades. In order to check the accuracy of these noncontact electrooptical contour measurements, mechanical-contact gauge measurements were also made on the same sample rotor blades. Contouring test measurements were also made on partially painted translucent fiberglass and black-rubber-coated rotor blades in order to determine how light penetration at the rotor surface and low reflectance would affect contour measurements. V.T.

A79-49085 **Superplastic forming diffusion bonding of titanium helicopter airframe components.** B. A. Burroughs (Rockwell International Corp., Military Aircraft Div., El Segundo, Calif.) and N. J. Mocerino (Hughes Helicopters, Culver City, Calif.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 6 p. (AHS 79-33)

Titanium fabrication combining superplastic forming (SPF) with concurrent diffusion bonding (DB) to reduce fabrication costs and titanium helicopter airframe weight is considered. Superplasticity in titanium which produces large tensile elongations without local thinning is discussed, noting the application of the SPF/DB process for multiple sheet fabrication of the 5 by 8 ft expanded sandwich B-1 aircraft engine access door. The cost and weight savings of this process led to production-type helicopter components for advanced helicopter YAH-64 with a part count reduction up to 30% and proportional cost savings. Three candidates were selected for SPF/DB design evaluation: (1) the aluminum H/C bonded catwalk bridge assembly over the engine driveshaft, (2) the aluminum skin/stringer mechanically fastened engine-nacelle door/work platform, and (3) the primary engine firewall, which is currently a built-up titanium sheet-stiffener assembly with mechanically fastened engine mounts. Further design optimization is expected to increase cost/weight savings, prior to initial production fabrication. A.T.

A79-49086 **Metal-matrix composite structures.** R. L. Pinckney (Boeing Vertol Co., Philadelphia, Pa.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 8 p. 6 refs. Army-supported research. (AHS 79-34)

A design engineering program and fabrication technology development to produce and evaluate complex, high-modulus, fiber-stabilized cast magnesium structure is presented. The introduction of an aluminum oxide, continuous-length, high-modulus fiber and its physical and chemical compatibility with molten aluminum and magnesium alloys made feasible a new direct-casting method of producing high-modulus metal-matrix composite materials. Structural load tests of the CH-47 helicopter main transmission case produced by this method demonstrated that lower deflections under load are achievable. Analysis of the results indicate that better control of component location should provide increased life, reduced vibration and attendant noise. It was shown that new magnesium investment-casting technology can produce void-free composites containing aligned and cross-plied continuous fibers up to 55% by volume, and that direct-cast metal-matrix composite structures can be fabricated and effectively used to stiffen complex helicopter structures. A.T.

A79-49087 **Automatic scanning inspection of composite helicopter structure using an advanced technology fluoroscopic system.** R. H. Porter and B. J. Hunter (Bell Helicopter Textron, Fort Worth, Tex.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 6 p. (AHS 79-35)

This paper discusses the fluoroscope system that was recently installed at Bell Helicopter Textron (BHT). Included are some of the capabilities of the image intensifying tube and the video image processor that enhances the image signal prior to presentation on three different monitors; a high resolution black and white monitor, a pseudo three-dimension image monitor and a color monitor with variable color density slicing features. This fluoroscope system has all of the video image enhancement features incorporated to compensate for the slight losses of sensitivity and resolution still inherent in the image intensifying tubes of today. (Author)

A79-49088 * **Computer-assisted high-speed balancing of T53 and T55 power turbines.** T. J. Pojeta (U.S. Army, Aviation Research and Development Command, St. Louis, Mo.) and T. J. Walter (Mechanical Technology, Inc., Latham, N.Y.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 9 p. 9 refs. NASA-supported research. (AHS 79-36)

Standard overhaul procedures for U.S. Army helicopter engines require operational vibration acceptance testing after rebuild. Engines frequently experience vibrations which exceed allowable overhaul work requirement limits. The rework/retest cycle for these engines constitute a significant cost penalty to the overhaul center. This paper reviews both analytical and test data which indicate bending critical speeds within the operating speed range of the low-speed power turbine rotor as the cause of most test cell rejections. High-speed balancing techniques are applicable and are capable of significantly reducing this reject rate. A complete prototype computer-assisted high-speed balancing system for assembled T53 and T55 power turbine rotors is described. (Author)

A79-49089 **The influence of engine/fuel control design on helicopter dynamics and handling qualities.** W. A. Kuczynski, D. E. Cooper, W. J. Twomey, and J. J. Howlett (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 14 p. 7 refs. (AHS 79-37)

The paper examines the compatibility of the engine/fuel control with helicopter rotor and airframe dynamics in the torsional sense at frequencies below the rotor rotational speed. Consideration is given to the characteristics: torsional stability, transient response (droop) and handling qualities of the helicopter. Studies have shown that the transient response in the rotor speed degree of freedom is affected by the state of the rotor aerodynamics during the condition of high torque demand. It is also shown that the engine/fuel control system can influence the damping in the aircraft handling qualities modes. These interactions are described, drawing upon both flight test experience and analysis. A flight dynamics simulation, GENHEL, is used for this analysis and results are presented which show the potential of using body state feedback to the fuel control to enhance aircraft handling qualities and rotor droop characteristics. M.E.P.

A79-49090 **Rotorshaft torquemeter.** R. B. Bossler, Jr. (Kaman Aerospace Corp., Bloomfield, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 9 p. 8 refs. (AHS 79-38)

This paper discusses the performance benefits and limitations of a rotorshaft torquemeter, surveys some methods of measuring rotorshaft torque and presents some thoughts on using the rotorshaft torque measurement. The performance benefits follow from removing the power penalty imposed by using engine torque measurement to limit rotor torque. Engine torque measurement provides no information on power diversion to accessories or the tail rotor. The greatest performance benefits occur during high-power high-gross-weight hover situations, such as pickup and delivery of heavy sling loads. Four currently-used methods of torque measurement in helicopters are reviewed including hydraulic pressure, toothed wheel phase displacement, material property change and telemetered strain gage systems. The pilots' workload and skill requirement can be reduced by using a rotorshaft torquemeter to produce an audible warning signal, to provide maximum continuous power to the rotor, to accumulate torque/time events and to limit the maximum torque that can be applied. (Author)

A79-49091 **Self-contained grease lubrication systems for aircraft applications.** A. S. Irwin, C. F. Inglee, and J. W. Lenski, Jr. (Boeing Vertol Co., Philadelphia, Pa.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 7 p. (AHS 79-39)

The need for add-on, self-sufficient systems, together with simplified existing helicopter components that are lighter in weight and require less maintenance, create an effort directed toward ingenious concepts. This paper directs attention toward one such add-on, an infrared suppressor and its self-contained bearing/grease lubrication system. Against the requirements for self-contained lubrication systems in helicopter and aircraft bearing support applications, the design principles and concepts, development, and demonstration of grease cavities for antifriction bearings are described. (Author)

A79-49092 **Ground test vehicle testing.** H. D. Jones (U.S. Army, Aviation Research and Development Command, St. Louis, Mo.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 4 p. (AHS 79-40)

The paper discusses the philosophy behind the requirements for GTV (ground test vehicle) testing and objectives and the value of GTV testing. It is shown that not only is the GTV used for the purpose of qualifying certain subsystems, but also to perform investigative or design support tests on a particular subsystem prior to or during flight testing. It is noted that while bench testing only tests the individual components, GTV testing qualifies the components on the system/subsystem level, thus exposing potential problem areas before actual flight tests begin. Finally, it is concluded that GTV testing is an essential part of the total aircraft qualification effort. M.E.P.

A79-49093 **Application of finite-element and holographic techniques in the design of turboshaft engine components.** P. S. Kuo (Avco Corp., Avco Lycoming Stratford Div., Stratford, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 13 p. 7 refs. (AHS 79-41)

A comprehensive finite element method using various types of elements and approaches to model a vast variety of engine components is described. Illustration includes the vibration and stress analyses of the centrifugal impeller, compressor and turbine blades, mechanical gearing and rotor disk assembly. Facilitated by the automated 2D/3D model generators and the graphic presentation of the results, a rapid evaluation of candidate designs is achieved. Holography has been utilized as an effective means to determine the dynamic behavior, the natural frequency and mode shape of the components; it consequently provides a verification for designs when hardware is available. Examples of holograms are given herein to be compared with the theoretical results. (Author)

A79-49094 **Development of a 'no adjustment' turboshaft engine control system.** J. J. Curran and A. M. Levine (General Electric Co., Aircraft Engine Group, Lynn, Mass.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 11 p. (AHS 79-42)

The paper describes the T700-GE-700 gas turbine engine which has been designed to eliminate the need for traditional adjustments and riggings to provide aircraft/engine/control system matching. Attention is given to the adjustments that have been eliminated; these are: topping, ground idle, power turbine speed governing, load sharing, torque computation, power available spindle, load demand spindle, variable geometry rigging, and specific gravity adjustment. Finally, a review of factory and field experience and acceptability of the 'no adjustment' system is presented. M.E.P.

A79-49095 **Certification of composites in civil aircraft.** R. Allen and J. R. Soderquist (FAA, Engineering and Manufacturing Div., Washington, D.C.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 7 p. 5 refs. (AHS 79-43)

Certification of composite structure for use on civil rotary wing aircraft involves showing compliance with Federal Aviation Regulations, FAR 29 for transport rotorcraft and FAR 27 for small rotorcraft, with guidance material provided in the FAA Advisory Circular 20-107. The requirements of primary concern in the civil certification of composite rotary wing structure are discussed in detail. The paper provides examples of civil applications of composites and summarizes the overall in-service performance with these applications. S.D.

A79-49096 **Qualification program of the composite main rotor blade for the Model 214B helicopter.** D. J. Reddy (Bell Helicopter Textron, Fort Worth, Tex.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 9 p. (AHS 79-44)

Extensive fatigue testing of coupons and structural elements and full scale blade testing were accomplished for a composite main rotor blade of the Model 214B helicopter. Data from the coupon and element tests were used to establish S-N curve shapes, environmental effects, and fatigue strength data for such materials as S-glass and E-glass introduced in the blade. Also, a statistical analysis was performed on coupon and element data to find minimum scatter reduction for these materials. The mean S-N curves established by the results of testing the full scale blade fatigue test specimens were reduced for scatter and an additional reduction for environmental effects was taken as indicated by the results of the coupon and structural element tests. It is shown that the coupon tests provided reliable strength values compared with the full scale test data. V.T.

A79-49097 **Operation and test of composite horizontal stabilizer for the Sikorsky Spirit helicopter.** J. D. Ray (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 12 p. (AHS 79-45)

Tests and operation of a composite horizontal stabilizer for the Sikorsky Spirit helicopter are reviewed. Stabilizer materials and construction are described, noting that the skins are Kelvar/epoxy over Nomex honeycomb, with graphite/epoxy spar caps and a Kelvar/epoxy torque tube. Complete assemblies consisting of a stabilizer assembly, stabilizer support fitting, and intermediate gear support fitting were tested. Following accelerated fatigue testing, stabilizers were loaded statically to failure. During 1050 flight-test hours the stabilizer was exposed to a hot, humid climate and extreme cold temperatures. The test results show that the Spirit stabilizer has an unlimited life with high static residual strengths. V.T.

A79-49098 **Design and development of a hybrid composite rotor blade for the circulation control rotor system.** G. A. McCoubrey (Kaman Aerospace Corp., Bloomfield, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 10 p. (AHS 79-46)

The paper presents the design and development of a hybrid composite (graphite and S-glass) circulation control rotor blade (CCR). The CCR system requires rotor blades with a thin slot located on the upper surface near the trailing edge. The blade design characteristics, structural dynamic properties, blade materials, manufacturing process, hybrid composites, and structural testing are discussed. It is shown that by utilizing the additional design freedom provided by the hybrid composite (i.e. fiber orientation, mix ratio, and level of interleaving), it is possible to satisfy strength, bending stiffness, torsional stiffness, weight, and fabrication process constraints. It is concluded that hybrid composite construction permits advances in design optimization for accomodation of engineering and manufacturing constraints. A.T.

A79-49100 **The Sikorsky elastomeric rotor.** R. C. Rybicki (United Technologies Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 14 p. (AHS 79-48)

The paper surveys the development of the Sikorsky elastomeric rotor. Attention is given to improvements made in the design and analyis techniques employed for elastomeric bearings. It is noted that finite element methods have been developed which can handle the large strain, non-linear material, non-axisymmetric loading problems involved. Developments are the resulting improvements are discussed, as well as testing procedures. Finally it is stressed that initial field problems have been minimal. M.E.P.

A79-49101 **Helicopter component environmental vibration testing - The poor man's fatigue test.** S. T. Crews (U.S. Army, Aviation Research and Development Command, St. Louis, Mo.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 8 p. (AHS 79-49)

It is found that the Army can no longer rely on the current version of MIL-STD-810 for helicopter environmental vibration qualification testing of major helicopter equipment. The Systems Development and Qualification Division of AVRADCOM, in conjunction with several manufacturers, has recently developed specific component environmental vibration qualification tests for major pieces of equipment. These tests were derived from the results of preliminary flight testing of these components. B.J.

A79-49102 **Realization of a helicopter-oriented real-time data system for research, experimental, and prototype flight testing.** K. Lunn, C. Hutchinson (Boeing Vertol Co., Philadelphia, Pa.), and J. Obbard (Raytheon Service Co., Boston, Mass.). In: American

Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 13 p. (AHS 79-50)

A real-time data analysis system currently operational in the helicopter flight test industry is considered. The paper discusses the developments over a 20-year period which culminated in a combination of airborne and ground-based data systems for computational analyses to produce plots, tabulations, and summaries for report purposes. The evolution of the STAR (simulation and test analysis in real time) system, appropriate software, and increases in productivity, and the data base which stores calculated engineering values for a flight test program, and allows merging cross-plotting, and fatigue damage calculations to be performed by an engineer operating from a remote terminal, are described. It is concluded that the real-time data system, combined with an airborne data acquisition system, resulted in improved flight test productivity, data quality, and reduced cost, and used as a multipurpose computer, benefits can be attained in simulation, engineering batch, and terminal job entry. A.T.

A79-49103 The circulation control rotor flight demonstrator test program. J. B. Wilkerson (U.S. Naval Material Command, David W. Taylor Naval Ship Research and Development Center, Carderock, Md.), D. R. Barnes, and F. A. Bill (Kaman Aerospace Corp., Bloomfield, Conn.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 15 p. 7 refs. (AHS 79-51)

The circulation control rotor (CCR) technology demonstrator, XH-2/CCR, has undergone many phases of structural, pneumatic, and aerodynamic tests, leading to the flight demonstration. A description of XH-2/CCR is provided with brief descriptions of the major tests conducted. Results of pneumodynamic tests of the compressor and control system are presented. Emphasis is placed on performance results from the whirl stand and from the NASA Ames 40- by 80-foot wind tunnel. Correlation between wind tunnel data and theory is also shown. A good agreement was evident over the flight spectrum for the first full-scale CCR. (Author)

A79-49104 * # Flight investigation of helicopter IFR approaches to oil rigs using airborne weather and mapping radar. J. S. Bull, D. M. Hegarty, J. D. Phillips, W. R. Sturgeon (NASA, Ames Research Center, Moffett Field Calif.), A. W. Hunting, and D. P. Pate (FAA, Flight Standards National Field Office, Oklahoma City, Okla.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 10 p. (AHS 79-52)

Airborne weather and mapping radar is a near-term, economical method of providing 'self-contained' navigation information for approaches to offshore oil rigs and its use has been rapidly expanding in recent years. A joint NASA/FAA flight test investigation of helicopter IFR approaches to offshore oil rigs in the Gulf of Mexico was initiated in June 1978 and conducted under contract to Air Logistics. Approximately 120 approaches were flown in a Bell 212 helicopter by 15 operational pilots during the months of August and September 1978. The purpose of the tests was to collect data to (1) support development of advanced radar flight director concepts by NASA and (2) aid the establishment of Terminal Instrument Procedures (TERPS) criteria by the FAA. The flight test objectives were to develop airborne radar approach procedures, measure tracking errors, determine accpetable weather minimums, and determine pilot acceptability. Data obtained will contribute significantly to improved helicopter airborne radar approach capability and to the support of exploration, development, and utilization of the Nation's offshore oil supplies. (Author)

A79-49105 * Wind tunnel and flight test of the XV-15 Tilt Rotor Research Aircraft. R. L. Marr, S. Blackman (Bell Helicopter Textron, Fort Worth, Tex.), J. A. Weiberg (NASA, Ames Research Center, Moffett Field, Calif.), and L. G. Schroers (U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 12 p. (AHS 79-54)

The XV-15 Tilt Rotor Research Aircraft Project involves design, fabrication, and flight testing of two aircraft. This program is currently in the test phase for concept evaluation and substantiation of design. As part of this evaluation, one of the aircraft was tested in the NASA-Ames 40- by 80-foot wind tunnel. The status of testing to date and some of the results of the wind tunnel and flight tests are presented. (Author)

A79-49106 Analytical and experimental investigation of V-type empennage contribution to directional control in hover and forward flight. C. E. Freeman and W. T. Yeager, Jr. (U.S. Army, Structures Laboratory, Hampton, Va.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 8 p. 12 refs. (AHS 79-56)

Experimental investigations were conducted to determine the source of direction control problems of single main-rotor helicopters operating at low speeds and possible means to alleviate them were examined. Tests proved that the V-type empennage presents significant low speed directional control advantages over conventional tail surface arrangements while providing comparable levels of static stability in both high- and low-speed flights. It was concluded that (1) the aerodynamic characteristics of V-tails are affected by low-aspect-ratios and (2) that the nonsymmetric V-tail surfaces decrease the tail rotor power required at low advance ratios by using the rotor-wake swirl to induce a torque counter to the main rotor torque. C.F.W.

A79-49107 Design, analysis, and testing of a new generation tail rotor. K. W. Harvey and C. W. Hughes (Bell Helicopter Textron, Fort Worth, Tex.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 11 p. 8 refs. (AHS 79-57)

The development of a two-bladed teetering tail rotor without pitch-change bearings is described. The design uses a fiberglass twist-strap flexure to accommodate collective pitch control, and features the elimination of the shear-reaction device for counteracting the pitch link load. The design of the rotor was based on the results of earlier model tests and stability analyses. Wind tunnel tests were conducted with the rotor installed on a flightworthy tailboom. The design concept was demonstrated satisfactorily by testing the tail rotor through the entire flight spectrum of the JetRanger test vehicle. (Author)

A79-49108 Ten years of Aérospatiale experience with the fenestron and conventional tail rotor. R. Mouille (Société Nationale Industrielle Aérospatiale, Marignane, Bouches-du-Rhône, France). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 10 p. (AHS 79-58)

The improvements which have been made during the past few years in the design of both fenestron and conventional tail rotors are reviewed. For conventional tail rotors, novel airfoils and high twist values have resulted in an increase in figure of merit from 0.5 to above 0.7. For fenestron rotors, higher efficiencies have been obtained, owing to improved aerodynamics, resulting from optimization of airfoils and blade twist angles and revised shroud designs. V.P.

A79-49109 Interactional aerodynamics - A new challenge to helicopter technology. P. F. Sheridan (Boeing Vertol Co., Philadelphia, Pa.) and R. P. Smith (U.S. Army, Applied Technology Laboratory, Fort Eustis, Va.). In: American Helicopter Society, Annual National Forum, 35th, Washington, D.C., May 21-23, 1979, Proceedings. Washington, D.C., American Helicopter Society, 1979. 16 p. 5 refs. (AHS 79-59)

The paper describes the field of interactional aerodynamic phenomena, classifies the problems into categories, such as downstream, localized, ground proximity, external interaction, and wing related category, and establishes a matrix of interactions and problems. Specific interactions are analyzed where sufficient data is available. These include the rotor/hub/fuselage/ empennage, rotor/ fuselage, main-rotor/fin/tail-rotor, rotor/ground, rotor/fuselage/ ground, and tail rotor/main/rotor/ground interactions. Evident trends such as flow simulation, are discussed and conclusions drawn regarding significant physical mechanisms. Finally, further research is recommended to expand the data base, to foster theory development, and to develop meaningful design guidelines. M.E.P.

A79-49223 **The DC-9 Super 80 - Much more than a simple stretch.** J. P. Geddes. *Interavia,* vol. 34, Sept. 1979, p. 865-869.

The general characteristics and design features of the DC-9 Super-80 aircraft are presented. The DC-9-80 has a modified wing, a greatly improved powerplant, and a major redesign in the cockpit using the latest avionic technology. Passenger capacities have been increased from 80 to 155 for economy class passengers and other aircraft versions have been designed, powered by two ten ton engines, capable of carrying up to 170 economy class passengers. Fuselage improvements, like the horizontal stabilizer root extension employing an anti-float tab, increase stabilizer effectiveness when the aircraft is in landing configuration. The layout of the instrument panel is given along with diagrams of the wings and flap setting. Other detailed changes in the compressor, the modular design of the fan, and low pressure rotor are noted and an overall performance report is described. C.F.W.

A79-49224 **Lockheed urges hydrogen fuel.** *Interavia,* vol. 34, Sept. 1979, p. 872, 873.

The use of hydrogen as a future aircraft propellant is discussed and some advantages and disadvantages of using methane as another alternate source are examined. Although hydrogen is seen as a dangerous fuel source, its advantages clearly outweigh its disadvantages. First, it is noted that because hydrogen is lighter than air, a fire ignition would tend to roar upward and not expand sideways like a liquid fuel fire. Second, hydrogen burns cleanly and consistently, providing considerable benefits in the design of future power plants. Last, its exhaust consists mainly of water and therefore a hydrogen-fueled engine would create even less air pollution than the cleanest of modern petroleum-burning turbofans. The only disadvantage noted here is the apparent danger because of its high combustibility, and it is concluded that hydrogen may be the best alternative to many present-day energy problems. C.F.W.

A79-49232 **Blown wings from Kiev.** *Air International,* vol. 17, Sept. 1979, p. 140-142, 151.

The Soviet Antonov AN-72 STOL short haul transport aircraft is examined. The aircraft employs a high lift system that resembles the upper surface blowing (USB) system adopted by Boeing for its YC-14 prototypes. Specifications covered include a 16,500 lb payload and a required runway length of 4000 ft. Attention is given to the wing configuration which uses a combination of double-slotted and triple-slotted flaps on the trailing edge and full span leading edge slots. However, it is noted that the primary consideration in locating the engines above the wing was the operation from unimproved runways. Finally, cargo loading arrangements are discussed. M.E.P.

A79-49332 * # **The size and performance effects of high lift system technology on a modern twin engine jet transport.** R. L. Sullivan (Boeing Commercial Airplane Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1795.* 19 p. Contract No. NAS1-14742.

The energy and economic benefits of low-speed aerodynamic system technology applied to a modern 200-passenger, 2000-nmi range, twin engine jet transport are reviewed. Results of a new method to design flap systems at flight Reynolds number are summarized. The study contains the airplane high lift configuration drag characteristics and design selection charts showing the effect of flap technology on the airplane size and performance. The study areas include: wing and flap geometry, climb and descent speed schedules with partial flap deflection, flap system technology, and augmented stability. The results compare the improvements in payload from a hot, high elevation airport. (Author)

A79-49335 # **Application of Lagrange Optimization to the drag polar utilizing experimental data.** J. S. Kohn (Grumman Aerospace Corp., Bethpage, N.Y.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1833.* 15 p. 14 refs.

The Lagrange Optimization, used with linear aerodynamic theory to define optimum aircraft geometry, is shown to have application to the determination of optimum control surface deflections as a function of angle of attack necessary to provide maximum trimmed L/D for a multi-plane aircraft configuration. Linear aerodynamic theory suggests a semi-empirical drag polar equation well suited to the optimization task. The equation is shown to correlate well with experimental data near aircraft cruise conditions. Such correlations are shown for selected aft and forward swept configurations up to 0.9 Mach number both in terms of total drag and drag increments due to control deflections and angle of attack. Optimum trimmed configurations are defined using experimental data and the subject optimization procedure. (Author)

A79-49336 * # **XV-15 flight test results compared with design goals.** K. G. Wernicke (Bell Helicopter Textron, Fort Worth, Tex.) and J. P. Magee (NASA, Ames Research Center; U.S. Army, Aeromechanics Laboratory, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1839.* 11 p. 10 refs.

Aircraft No. 2 is presently in the midst of flight envelope expansion. Noise and safety design goals have been demonstrated; preliminary results indicate that performance and component life goals may also be met. Hovering power indicates a standard hover ceiling of 7,000 feet. After 18.0 hours of flight, a true airspeed of 207 knots has been reached. The goal is a 300-knot cruise speed. So far, XV-15 flight tests indicate no reason why the tilt rotor concept should not fulfill its promise to provide a major step forward in air vehicle flexibility and in rotary wing performance. (Author)

A79-49337 # **Design criteria for airline operation.** W. J. Overend (Delta Air Lines, Inc., Atlanta, Ga.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1849.* 7 p.

This paper provides some of the basic airline concepts of design methodology and illustrates how they may be applied to the selection of a new aircraft for service in the 1980's. Two fundamental criteria for aircraft design are noted: (1) the optimization of passenger transportation and (2) predominance of safety over operating economics. Baseline aircraft, performance capability, and engine selection are considered to give the best possible design for providing the public with an aircraft designed for efficient airline operation. C.F.W.

A79-49338 # **What the FAA would like in airworthiness standards.** C. R. Foster (FAA, Washington, D.C.). *American Institute* *of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1851.* 7 p.

The paper surveys the areas in which the FAA deems future work desirable. These include the development of standards for light transport aircraft used in commuter operations, and for advance types of control configured vehicles. Attention is also given to improved crashworthiness, improved engine capability to resist damage due to ingestion of foreign objects, and the development of standards for operation of helicopters in IFR and icing conditions. Other topics discussed are the development of wet runway stopping criteria, reduction of general aviation accident rate, the development of improved standards for composite and damage tolerant structures, and the development of standards for the verification and validation of digital avionics. M.E.P.

A79-49339 * # **Effect of nozzle spacing on ground interference forces for a two jet V/STOL aircraft.** W. G. Hill, Jr. and R. C. Jenkins (Grumman Aerospace Corp., Bethpage, N.Y.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1856.* 13 p. 20 refs. Contract No. NAS2-10097.

The effect of nozzle spacing on ground interference forces was investigated for a two jet V/STOL aircraft design. The need for information on the effect of jet spacing arises because of the tradeoff between mechanical complexity, which calls for close spacing, and roll control moments, which call for wider spacing. The ground interference forces on a two jet V/STOL aircraft model were measured for a range of nozzle spacings. Interference forces showed a complicated behavior with nozzle spacing, fuselage geometry, and height above ground. For some conditions a slight change in nozzle spacing resulted in a fourfold change in the interference force from 3% to 12% of the basic jet thrust. An understanding of the observed aircraft force behavior was developed using detailed measurements of the upwash flow properties, along with force and pressure measurements on a series of two dimensional fuselage representations. (Author)

A79-49341 # **Wing geometry effects on leading-edge vortices.** R. M. Kulfan (Boeing Commercial Airplane Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aircraft Systems and Technology Meeting, New York, N.Y., Aug. 20-22, 1979, Paper 79-1872.* 38 p. 45 refs.

Leading-edge vortices that form at off-design conditions can profoundly influence the aerodynamic characteristics of highly swept slender wings. A straightforward method that can predict wing geometry effects on the progressive spanwise development of leading-edge vortices is presented. This method, which can account for sweep, camber, twist, airfoil shape, flap deflections, and planform shape, is shown to be a useful tool for aerodynamic design studies. It is shown that suppressing the leading-edge vortex, particularly over the inboard portion of the wing, can cause considerable reduction in drag due to lift. Results of wing geometry parametric studies are shown. (Author)

A79-49343 * # **Evaluation of finite element formulations for transient conduction forced-convection analysis.** E. A. Thornton (Old Dominion University, Norfolk, Va.) and A. R. Wieting (NASA, Langley Research Center, Hampton, Va.). *National Conference on Numerical Methods in Heat Transfer, College Park, Md., Sept. 24-26, 1979, Paper.* 26 p. 13 refs. Grant No. NsG-1321.

Numerical studies clarifying the advantages and disavantages of conventional versus upwind convective finite elements are presented along with lumped versus consistent formulations for practical conduction forced-convection analysis. A finite-element procedure for treatment of negligible capacitance fluid nodes is presented. The procedure is based on procedures used in finite-element structural dynamics to treat nodes with negligible structural mass. Two finite-element programs and a finite-difference lumped-parameter program used in the studies are discussed. Evaluation studies utilizing three convection and two combined conduction-convection problems are then presented and discussed. Additionally, the computational time saving offered by the finite element procedure is considered for a practical combined conduction-convection problem. V.T.

A79-49344 * # **NASA/Princeton digital avionics flight test facility.** D. R. Downing, W. H. Bryant (NASA, Langley Research Center, Flight Electronics Div., Hampton, Va.), and R. F. Stengel (Princeton University, Princeton, N.J.). *Institute of Electrical and Electronics Engineers and American Institute of Aeronautics and Astronautics, Digital Avionics Systems Conference, 3rd, Fort Worth, Tex., Nov. 6-8, 1978, Paper.* 7 p. 10 refs.

This paper describes a general-aviation digital avionics flight-test facility being jointly developed by the Flight Dynamics Laboratory of Princeton University and NASA/Langley Research Center. This facility consists of the Princeton avionics research aircraft (ARA) and NASA/Langley's digital avionics research (DARE) system. The ARA is a fully instrumented five-degree-of-freedom fly-by-wire aircraft. The DARE system contains a state-of-the-art flight computer system and receiving equipment that permits use of the NASA/Wallops Flight Center's position-tracking ground-based display-generation and ground-to-air digital-data-link equipment. The DARE/ARA system will be used for flight evaluation of advanced control, guidance, and display concepts developed as part of NASA/Langley Research Center's general aviation terminal area operations program. (Author)

A79-49345 * # **Characterization of a swept-strut hydrogen fuel-injector for scramjet applications.** G. B. Northam, C. A. Trexler, and G. Y. Anderson (NASA, Langley Research Center, Hampton, Va.). *Joint Army-Navy-NASA-Air Force, Interagency Propulsion Committee Combustion Meeting, 15th, Newport, R.I., Sept. 1978, Paper.* 19 p. 5 refs.

Results of an experimental investigation of a swept-strut hydrogen fuel-injector simulating the center strut of a three strut scramjet module at Mach 6 flight conditions are presented. Detailed wall pressure distributions from over 100 separate tests with overall fuel flow from 0.1 to 1.3 times stoichiometric and test gas stagnation temperature from 1100 to 2400 K were recorded. The distance for pressure rise from the point of injection was found to increase with increasing test stagnation temperature. This trend indicates that chemical kinetics in the immediate region of perpendicular injection are not likely to be the mechanism controlling the onset of pressure rise. A fluid dynamic mechanism is suggested involving separation of the boundary layer downstream of injection which is forced upstream from the trailing edge by pressure rise due to combustion occurring in the base region of the strut. The results obtained indicate that the swept-strut fuel-injector concept can be adapted to a wide range of flight conditions by varying the amount of perpendicular fuel injection. (Author)

A79-49348 **Evaluation of airfield pavement materials based on synthetic polymers.** C. J. Hilado, D. P. Brauer (San Francisco, University, San Francisco, Calif.), and R. C. Corlett (Washington, University, Seattle, Wash.). *(International Conference on Fire Safety, 4th, University of San Francisco, San Francisco, Calif., Jan. 15-19, 1979.) Journal of Fire and Flammability,* vol. 10, July 1979, p. 207-215. Navy-supported research.

Two samples of experimental airfield pavement materials were evaluated for ignition, fire spread, smoke, and toxic gas evolution. The materials consisted of fiberglass-reinforced polyester surface sheets laminated to and supported by a high density polyurethane rigid foam core. Both samples exhibited resistance to ignition and fire spread in this limited study. The effect of these pavement materials on the fire spread of a large pool of burning aircraft fuel would appear to be negligible. (Author)

A79-49376 **Utilization of alternative fuels for transportation; Proceedings of the Symposium, University of Santa Clara, Santa Clara, Calif., June 19-23, 1978.** Symposium sponsored by the U.S.

Department of Energy. Edited by M. Newman and J. Grey (American Institute of Aeronautics and Astronautics, Inc., New York, N.Y.). New York, American Institute of Aeronautics and Astronautics, Inc. (AIAA Aerospace Assessment Series. Volume 2), 1979. 244 p. $15.

This overview of alternative fuel development deals with such issues as energy supply and fuel manufacturing/processing and storage and distribution. Attention is given to fuels for both road vehicles and nonroad vehicles (e.g., aircraft and trains). Finally, discussions on impacts and institutional issues are presented. B.J.

A79-49381 # **Alternative fuels in aviation.** J. G. Borger (Pan American World Airways, Inc., New York, N.Y.). In: Utilization of alternative fuels for transportation; Proceedings of the Symposium, Santa Clara, Calif., June 19-23, 1978. New York, American Institute of Aeronautics and Astronautics, Inc., 1979, p. 129-142.

The state of the art and expected future advances of alternative fuels in aviation are discussed. Consideration is given to uses of liquid hydrogen and methane, broadening of turbine fuel specifications, increased aromatics, decreased flashpoint, increased freeze point, thermal stability, synthetic fuels, and the refinery process. It is noted that major fuel efficiency improvements resulting from the NASA ACEE program probably will not appear before the late 1980s. B.J.

A79-49456 **Numerical solution of the problem of unsteady supersonic flow around the front part of the wings with a detached shock wave.** G. P. Voskresenskii (Akademiia Nauk SSSR, Institut Prikladnoi Matematiki, Moscow, USSR). *Computer Methods in Applied Mechanics and Engineering,* vol. 19, Aug. 1979, p. 257-275. 7 refs.

The object of this paper is to describe a numerical method for the solution of the problem of unsteady supersonic flow around the front part of the wings with a detached shock wave. The velocity vector of the free stream is directed in an arbitrary direction but without flow separation. The problem is formulated for the three-dimensional hyperbolic system of equations of unsteady inviscid chemically reactive gas flow in a mixed subsonic and supersonic domain. It is solved by a finite difference implicit second-order method with the use of the time-dependent stationing principle. A curvilinear coordinate system is introduced in which the numerical domain becomes a simple rectangle. The coordinate system is time-dependent and adapted for the planform of the wing and the free-stream parameters. The planform of the wing and the velocity vector of the free stream may be changed in the time-dependent stationing process. The flow field is computed around the front part of wings which have an elliptical planform and an aspect ratio not greater than 2 for selected freestream Mach numbers betweeen 1.5 and 5. (Author)

A79-49478 **Helicopter noise rules - Are they appropriate and reasonable.** C. R. Cox (Bell Helicopter Textron, Fort Worth, Tex.). *Marconi Review,* vol. 42, 1st Quarter, 1979, p. 16-21.

Consideration is given to proposed governmental regulations concerning helicopter noise and their effects. Problems with the proposed PAA and ICAO standards are shown to stem from two inadequacies: (1) they are patterned after fixed wing regulations with little or no consideration of differences in operation, and (2) the economic impact of implementing these standards has not been adequately assessed in terms of the cost that must be passed on to the individual user. Other areas discussed include the impact on new designs, on derived and existing designs, on safety and reliability, and on the probability of certification. Different approaches are proposed including operational restraints and flight path control. In conclusion it is stressed that inappropriate regulations could result in serious adverse consequences on an industry composed predominantly of small business operators. M.E.P.

A79-49486 # **A design perspective on new technologies for general aviation.** J. B. McCollough (FAA, Aircraft Flight Safety Branch, Washington, D.C.). *Astronautics and Aeronautics,* vol. 17, Sept. 1979, p. 48-53.

Technologies that benefit the design of general aviation aircraft are ranked in terms of safety, performance, utility, and cost. Test criteria in order of importance were: safety, reliability, performance, cost, customer acceptance, efficiency, operational ease and utility, maintenance, weight, and environment. Areas rated were: aerodynamics powerplant, structures, materials, and fabrication, avionics, instrumentation, airframe and system design, and human factors and operations. It is noted that, in many ways, commercial aircraft design is a conservative process, since safety is a first consideration. Among the conclusions is that social and political pressures will also influence the future of the general aviation industry. M.E.P.

A79-49530 * # **Recent applications of theoretical analysis to V/STOL inlet design.** N. O. Stockman (NASA, Lewis Research Center, Cleveland, Ohio). *U.S. Navy, Workshop on V/STOL Aerodynamics, Monterey, Calif., May 16-18, 1979, Paper.* 16 p. 17 refs.

A brief description of the axisymmetric potential flow and boundary layer analysis methods used at the NASA Lewis Research Center, is presented. Application of this method to inlet problems arising from both tilt-nacelle and fixed-nacelle V/STOL aircraft configurations is illustrated. A three-dimensional inlet analysis computer program is described and the preliminary results presented. Finally, a suggested approach to optimum design of inlets for high angle-of-attack operation is discussed. M.E.P.

A79-49541 # **The feasibility of modern dirigibles (Faisabilité des dirigeables modernes).** J. Bouttes and C. La Burthe (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *(Colloque International sur l'Economie et Technologie des Aéronefs Allégés, Paris, France, Mar. 28-30, 1979.) ONERA, TP* no. 1979-93, 1979. 17 p. In French.

Through an analysis of the major constraints on dirigible operation and configuration, a design methodology capable of supporting the development of an optimal airship is obtained. Attention is given to the equilibrium properties of the gas compartment at altitude, means of weight compensation, including mooring, vertical lift engines and aerostatic effects, for various dirigible applications (surveillance, cargo, utility operations), steering and control laws and apparatus. Research on interlocking rotors and the thermal balance of a hot-air balloon presently under way at ONERA is outlined, and a weight distribution optimization loop illustrating the design methodology adopted is presented. The importance of a multidisciplinary integrated approach to dirigible design is also noted. A.L.W.

A79-49543 # **Aerodynamic interaction on a close-coupled canard-wing configuration (Interaction aérodynamique entre un canard proche et une voilure).** Y. Brocard and V. Schmitt (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *(NATO, AGARD, Symposium on Aerodynamic Characteristics of Controls, Naples, Italy, May 14-17, 1979.) ONERA,* TP no. 1979-95, 1979. 12 p. 14 refs. In French. Research supported by the Direction des Recherches, Etudes et Techniques.

Half-model tests were performed on a close-coupled canard-wing configuration in the low speed, pressurized wind tunnel F1 at the new ONERA Center Le Fauga-Mauzac. The main lifting surface is the rectangular cylindrical, wall mounted, half wing AFV-D in a 60 deg back sweep configuration. The chordwise wing section has a 5 percent thickness ratio and a large leading-edge radius. The canard surfaces are similar in shape and section to the main wing. Experimental results are presented in terms of longitudinal aerodynamic characteristics and pressure distribution on the main wing. The effect of canard deflexion and of Reynolds number variation were investigated. (Author)

A79-49554 **Airborne microwave ECM.** D. J. Steer (Royal Aircraft Establishment, Farnborough, Hants., England). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 29-38.

The paper examines techniques currently used in airborne ECM. It covers the philosophy of jamming and gives details of the various types of jammers used against specific radar systems. Jammer transmitters are discussed and a brief survey of the power output of travelling wave tubes (TWT) is included. This leads to an assessment of the jammer powers likely to confront Western radar designers. The general design features of a responsive noise jammer are presented and it is suggested that this type of jammer is the basis of selfscreening (SSJ) escort (EJ) and standoff jamming (SOJ). The paper ends with a brief mention of chaff. (Author)

A79-49555 **Performance of current radar systems in an EW environment.** J. R. Prior and N. Woodward (Royal Signals and Radar Establishment, Malvern, Worcs., England). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 39-50.

The paper will start by considering the more important ECCMs incorporated into radars. It considers the effects of EW against various types of radar systems. Long range early warning (ADGE) radars, airborne early warning, SAM acquisition tracking radars and airborne intercept radars are considered. For each of these systems typical present day characteristics are defined, their vulnerability to the EW threat discussed and the benefits to be obtained from various ECCMs, both technical and operational, are considered. An indication is given of the future trends in the design of such systems where relevant to their operation in ECM and the role of the more modern antijamming aids arising from new technologies is described. (Author)

A79-49565 # **Combined X/Ka-band tracking radar.** L. J. Klaver (Hollandse Signaalapparaten, Hengelo, Netherlands). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 147-156. 6 refs.

The paper surveys the development of the Dutch SIGNAAL combined X/Ka-band tracking radar. Attention is given to the effects of atmospheric conditions, such as rain and sea clutter. It is shown that in this system target detection is performed by a normal search radar, after which the acquisition process is executed with the X-band tracking radar. As soon as video quality permits, target tracking is performed in the Ka-band. Also discussed are the practical problems experienced when tracking low-flying targets by radar and how SIGNAAL overcomes them. M.E.P.

A79-49566 # **The A.I. tracking problem.** B. B. English (Ferranti, Ltd., Hollinwood, Lancs., England). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 157-163. Research supported by the Ministry of Defence (Procurement Executive).

Attention is given to the problems arising from using radar to provide target information to other aircraft subsystems such as the weapons aiming computer. The two main problems considered are (1) aircraft motion which disturbs the radar end of the line of sight, and (2) glint, which introduces noise into the measurement of target behavior. A description is given of an approach which treats aircraft motion and glint as independent problems and is then used to generate a set of desirable servo characteristics. An actual radar system is described along with how well it satisfies the ideal requirements. Finally, possible performance improvements provided by the availability of practical airborne digital computing are covered. M.E.P.

A79-49567 # **A report on the Sperry Dome Radar.** L. Schwartzman and P. M. Liebman (Sperry Rand Corp., Sperry Gyroscope, Great Neck, N.Y.). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 167-176.

The paper describes the Sperry Dome Radar equipment, system operation, and target tracking experiences to-date. The equipment description includes the dome antenna which design provides capability to scan a volume of 3 pi steradians, and provides maximum gain at an angle of 90 deg with respect to the zenith. For shipboard installations this means continuous radar surveillance and tracking for ship roll and pitch as severe as 30 deg. Automatic multitarget tracking over wide scan angles, which has been demonstrated by the Sperry Dome Radar is described. Radar tracking tests have been performed at various levels, namely simulated target injections, simulated target transmissions from external test towers, live skin tracks of targets-of-opportunity and skin tracks of several controlled aircraft. Some of the track test results are presented. (Author)

A79-49568 # **A new three-dimensional surveillance radar.** M. F. Radford (GEC-Marconi Electronics, Ltd., Marconi Research Laboratories, Great Baddow, Essex, England) and A. D. Stevens (Marconi Radar Systems, Ltd., Stanmore, Middx., England). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 193-200. 6 refs. Research supported by the Ministry of Defence (Procurement Executive).

The paper is concerned with a new fully transportable three-dimensional surveillance radar, called Martello, which gives height data with every target plot. It can use its elevation discrimination to separate targets from clutter or from each other. The clutter spectra are narrower, so that the loss of targets in the MTI is minimized. Moreover, a three-dimensional radar is less degraded by jamming, since main beam obscuration is confined to the elevation of the jammer instead of covering the whole elevation sector. The paper shows how the configuration of the Martello radar has been chosen, and describes some of the technological advances incorporated in the design. S.D.

A79-49574 **Recent advances in radome design.** A. M. Munro (Royal Signals and Radar Establishment, Malvern, Worcs., England), B. V. A. Wickenden, F. S. Ward, and P. H. Dowsett (Plessey Materials, Towcester; Plessey Connectors, Ltd., Kingsthorpe, Northants., England). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 246-258.

The paper deals with aberration caused by A-type sandwich radomes whose shapes may be conical or ogival with high fineness ratios. Three methods for reducing radome aberration are presented. The artificial dielectric approach produces a radome whose performance is comparable to that of a solid laminate. The wire-loading technique is capable of making a marked reduction in aberration, although a slight increase in attenuation results. As yet, the asymmetric design has not been used in a practical case. The use of RP12 polyester resin for the construction of laminate radomes gives an improved bandwidth, due to the near-constant permittivity and low loss over a wide temperature range. It is a unique method of constructing high-performance radomes for high-speed aircraft and missiles. S.D.

A79-49580 # **Ellipsoidal modelling of aircraft targets for evaluation of electronic fuzes.** L. Svard and N.-A. Nilsson (L. M. Ericsson Telephone Co., Molndal, Sweden). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 304-309.

This paper describes a computer model for the evaluation of radar proximity fuzes. The target is described by a number of ellipsoids and limiting planes. Cavities are also described by ellipsoids. In this case correction factors are used to adjust the radar cross-section. The contributions from the various ellipsoids are computed by methods of geometrical optics. Shadowing is also considered in this computation. The computer program calculates the received signal with the aid of the radar equation, applies the processing of the fuze and determines the output signal. The output may alternatively be the triggered point in space. A large number of calculations have been performed using this model. The results have been compared with full-scale measurements on a target drone and ultrasonic tank measurements on drone and fighter aircraft models in the X-band. These comparisons show that the standard deviation of the trigger point difference is less than 0.6 m. (Author)

A79-49584 # **Distributed TDMA - An approach to JTIDS phase II.** J. Rubin (ITT, Avionics Div., Nutley, N.J.). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 341-345. Contract No. N62269-76-C-0105.

A distributed TDMA (DTDMA) system for increased performance to meet expanding multiservice future requirements is presented. In addition to existing Tacan and IFF channels, and the TDMA channel, the joint tactical information distribution system (JTIDS)/DTDMA terminals provide multiple demand access channels for A/J digital voice, and command access channels for command and control communications. The DTDMA technique employs low duty cycle pulses, pseudo-randomly distributed in the time-frequency-phase code domain, and because of its flexible channel design, variable information parameters such as message length and rate, access type, and coding requirements are readily achieved. The JTIDS integrated system, the fundamental signal/channel JTIDS architecture, and performance capabilities are discussed. It is concluded that JTIDS/DTDMA can be used for EW computational burden distribution, RPV based active ECM, real-time reconnaissance data collection, and coordination of communications jamming. A.T.

A79-49587 # **Navstar user equipment for civil and military applications.** S. G. Allen, P. J. Hargrave, K. Buckley, J. C. Greenwood, and P. K. Blair (Standard Telecommunication Laboratories, Ltd., Harlow, Essex, England). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 405-409.

High performance and basic Navstar receivers are described along with an experimental receiver. The experimental receiver uses a switching-type code tracking loop and is capable of receiving C/A code spread spectrum signals. Pseudorandom measurement was conducted by comparing the difference between 1023 code epochs of the locally generated code with a one-millisecond epoch derived from the 10 MHz stable reference. Signal strength measurement was made of the received signal-to-noise ratio from the Navstar satellites and compared with predictions. The application of Navstar receivers to both civil and military navigation is discussed. V.T.

A79-49589 # **The servoed modulation FMCW radar altimeters in military applications.** J.-P. Tomasi (Télécommunications Radioélectriques et Téléphoniques, Le Plessis-Robinson, Hauts-de-Seine, France). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 421-425.

A method of receiving and detecting a radar signal, by matching the signal to the receiver and adjusting the modulation of the transmission to the target distance so that the signal is perfectly adapted to the receiver is presented. A FMCW radar altimeter is used to transmit a signal with a frequency modulated by a symmetrical or asymmetrical sawtooth and is then reflected, by the ground, and returns with a delay proportional to the aircraft height. The application of this system for military use is examined for three different altitude ranges: 5000, 10,000 and 70,000 ft and its implementation for fighters, missiles, hydrofoils, and helicopter is reviewed. C.F.W.

A79-49590 # **The application of pulsed 'G' band radio altimeters to modern military aircraft.** R. J. L. Pardoe (Smiths Industries, Ltd., Aviation Div., Basingstoke, Hants., England). In: Military microwaves '78; Proceedings of the First Conference, London, England, October 25-27, 1978. Sevenoaks, Kent, England, Microwave Exhibitions and Publishers, Ltd., 1979, p. 426-430. Research supported by the Ministry of Defence (Procurement Executive).

The paper demonstrates the way an assessment can be made of the slant range accuracy of the pulsed altimeter system. Specifications of the G band radio altimeter reviewed include altitude range, accuracy, track rate, search rate, and maneuverability, and total system weight. In addition, the pulse echo function and video pulse shape are covered. The results of this assessment are shown to agree with Ministry of Defence sponsored trials of equipment in a wide range of military fixed wing and rotary wing aircraft and therefore justify the specified performance. M.E.P.

A79-49604 **Automated tracking for aircraft surveillance radar systems.** R. M. O'Donnell and C. E. Muehe (MIT, Lexington, Mass.). *(NATO, AGARD, Meeting on Strategies for Automatic Tract Initiation, Monterey, Calif., Oct. 16, 17, 1978). IEEE Transactions on Aerospace and Electronic Systems,* vol. AES-15, July 1979, p. 508-517. 17 refs. U.S. Department of Transportation Contracts No. FA72WAI-242; No. FATO-679; Contract No. F19628-78-C-002.

An improved moving target detector (MTD) (a digital signal processor) has been designed, constructed, and tested which successfully rejects all forms of radar clutter while providing reliable detection of all aircraft within the coverage of the radar. The MTD is being tested on both terminal and enroute surveillance radars for the FAA. This processor has been integrated with automatic tracking algorithms to give complete rejection of ground clutter, heavy precipitation, and angels (birds). (Author)

A79-49605 **Small signal compensation of magnetic fields resulting from aircraft maneuvers.** S. H. Bickel (Atlantic Richfield Co., Los Angeles, Calif.). *IEEE Transactions on Aerospace and Electronic Systems,* vol. AES-15, July 1979, p. 518-525. 6 refs. Contract No. N62269-75-C-0210.

It is noted that Tolles and Lawson (1950) identified three permanent, five induced, and eight eddy-current fields as sources of magnetic interference associated with airframe maneuvers. The present paper uses small signal approximations to separate the eddy-current terms and thus decouple the sixteen equations into two sets of eight equations. It is found that a singularity exists in the small signal equations for the permanent and induced terms. It is shown that the ambiguity thus caused among three of the coefficients can be resolved mathematically by resorting to large maneuvers. In addition, flight test data are presented which exhibit a large amount of magnetic hysteresis and it is shown that the magnetic anomality detector (MAD) equipped aircraft will not remain compensated from one flight to the next. Finally, it is found that both optimal frequency filtering and altitude compensation can be used to improve the figure of merit (FOM) resulting from pilot maneuvers. M.E.P.

A79-49608 **Multiradar tracking system using radial velocity measurements.** A. Farina and S. Pardini (Selenia S.p.A., Rome, Italy). *IEEE Transactions on Aerospace and Electronic Systems,* vol. AES-15, July 1979, p. 555-563. 14 refs.

Multiradar tracking using both position and radial velocity measurements is discussed. The measurement of two or more different radial velocity components allows the calculation of rectangular velocity components. The measurement noise of the velocity components is filtered using a Kalman filter in the same way as the Cartesian position components. Before the conversion of velocity components from radial to Cartesian coordinates, the radial velocities are aligned on a time scale to account for the time shift of the radar measurements. In order to compare multiradar tracking system performance with and without radial velocity, some simulation tests have been performed for typical paths. The simulation results show a significant improvement when radial velocity is used for tracking. (Author)

A79-49718 # **An approach for estimating vibration characteristics of nonuniform rotor blades.** K.-W. Lang and S. Nemat-Nasser (Northwestern University, Evanston, Ill.). *AIAA Journal,* vol. 17, Sept. 1979, p. 995-1002. 25 refs. Grants No. DAAG29-77-G-0034; No. DAAG29-78-G-0149.

A method is presented for determining the vibration characteristics of a rotating blade whose cross-sectional dimensions or mechanical properties may vary sharply or even discontinuously along its length. The coupled flapwise bending, chordwise bending, and torsional vibration of the blade is analyzed by the method of the new quotient which is based on a variational statement proposed by Nemat-Nasser. In this approach, the nonuniform blade properties may be approximated by step (piecewise constant) functions. Two illustrative examples are given, and the results are compared with available experimental data and other numerical solutions. The comparison shows that the method of the new quotient yields very good results. (Author)

A79-49806 **Fault diagnosis of gas turbine engines by means of component characteristics determination (Fehlerlokalisierung an Einkreis-TL-Triebwerken durch Bestimmung der Bauteilkenngrössen).** G. Dahl (Branschweig, Technische Universität, Braunschweig; Bodenseewerk Gerätetechnik GmbH, Überlingen, West Germany). *Zeitschrift für Flugwissenschaften und Weltraumforschung,* vol. 3, July-Aug. 1979, p. 216-229. 37 refs. In German.

A method to calculate the component characteristics of single spool jet engine has been developed by using measured engine data. Lacking data are replaced by characteristics of different components of the healthy engine. By comparing the results for these different assumptions the actual conditions of the engine components could be determined. A large number of different faults has been simulated experimentally on a J-65 engine. The application of the present methods led to a correct fault diagnosis in all cases. The method is capable to localize single and multiple faults of arbitrary kind and magnitude. (Author)

A79-49807 **Variables characterizing the wind effects on an aircraft (Grössen zur Beschreibung des Windeinflusses auf das Flugzeug).** R. Brockhaus (Braunschweig, Technische Universität, Braunschweig, West Germany). *Zeitschrift für Flugwissenschaften und Weltraumforschung,* vol. 3, July-Aug. 1979, p. 229-234. 6 refs. In German.

A series of Euler angles between the aerodynamic and the flight path coordinates, very similar to those defined by Krauspe and Klenner, is proposed. These angles allow a very comprehensive description of the wind effect on an aircraft. The present definition has the advantage that the Euler angles are related in a positive sense to the components of the wind velocity vector. In addition, exact and approximate relations are presented between the wind velocity components in the principal coordinate systems and those variables which are measurable on board the aircraft. (Author)

A79-49814 **Aérospatiale AS.350 and AS.355.** J. Boulet (Société Nationale Industrielle Aérospatiale, Division Hélicoptères, Marignane, Bouches-du-Rhône, France). *(Royal Aeronautical Society, Symposium on A New Generation of Civil Helicopters, London, England, Feb. 7, 1979.) Aeronautical Journal,* vol. 83, July 1979, p. 245-249.

The Aérospatiale AS.350 and AS.355 helicopters are surveyed. Attention is given to design features such as the structure made of press stamped parts, and a cabin made up of heat formed polycarbonate shells, the rotor blades and rotor head of fiber glass, showing how the objectives of quality, comfort, performance, and low cost were achieved. Other features discussed include a simplified gearbox, engine availability, the beam type tail rotor. Substantial cost reductions are also shown to have been achieved through the use of high volume production items from the automotive industry, and assembly line production methods. Finally, the introduction of the twin engine AS.355 is noted along with how it differs from the single engine AS.350. M.E.P.

A79-49815 **Design and development of the Agusta A 109 helicopter.** B. Lovera (Costruzioni Aeronautiche Giovanni Agusta S.p.A., Milan, Italy). *(Royal Aeronautical Society, Symposium on A New Generation of Civil Helicopters, London, England, Feb. 7, 1979.) Aeronautical Journal,* vol. 83, July 1979, p. 250-256.

The Agusta A 109 helicopter, considered the forerunner of the generation of civil helicopters introduced in the seventies, is examined. The A 109 design objectives and certification basis are discussed. Attention is also given to performance aspects, safety aspects, and passenger comfort aspects. Operational aspects considered include: helicopter loading, external noise, and IFR capability. In addition, auxiliary installations, climatic tests, and operating costs are covered. Finally, future developments are discussed. M.E.P.

A79-49816 **The Bell Model 222.** J. R. Garrison (Bell Helicopter Textron, Fort Worth, Tex.). *(Royal Aeronautical Society, Symposium on A New Generation of Civil Helicopters, London, England, Feb. 7, 1979.) Aeronautical Journal,* vol. 83, July 1979, p. 257-268.

The design and performance characteristics of the Bell Model 222 are surveyed. Design details covered include the main rotor hub which is designed for reduced maintenance, safety, and long component fatigue lives, the main rotor blade, the tail rotor, and rotor drive system. Attention is also given to the main transmission, the nodal beam's isolation of drivetrain vibrations, the power reserve provided by the twin Lycoming engines, and the impact resistant fuel cells. It is shown that the cockpit has an instrument panel capable of being equipped with an IFR instrumentation array while retaining good visibility for the VFR operator. Finally, flight tests, fatigue tests and noise measurements are described. M.E.P.

A79-49818 **Flight experiments to evaluate the effect of wing-tip sails on fuel consumption and handling characteristics.** J. J. Spillman, H. Y. Ratcliffe, and A. McVitie (Cranfield Institute of Technology, Cranfield, Beds., England). *Aeronautical Journal,* vol. 83, July 1979, p. 279-281.

The results of experiments performed with a Paris MS 760 aircraft modified with wing tip sails to reduce vortex drag are presented. Specifications and test procedures are described and it is shown that fuel flow rate and engine speed are uniquely linked. Attention is given to handling characteristics such as the aircraft's ability to take-off up to 10 knots sooner than without sails. In addition there appeared to be increased damping in roll with the roll rate relatively unaffected. It is concluded that the total drag at lift coefficients above 0.22 is reduced because the lift dependent drag is reduced by 27%. The fuel saving is about 4.5% at a typical lift coefficient of 0.35 rising to almost 11% at a lift coefficient of 0.8. M.E.P.

A79-49866 * # **Active external store flutter suppression in the YF-17 flutter model.** E. Nissim and I. Lottati (Technion - Israel Institute of Technology, Haifa, Israel). *Journal of Guidance and Control,* vol. 2, Sept.-Oct. 1979, p. 395-401. 22 refs. Grant No. NsG-7072.

A single activated trailing-edge (T.E.) control system (spanning 7% of each wing) is applied to the YF-17 flutter model with the object of suppressing the external store flutter of three different store configurations. The control law is derived by the use of the aerodynamic energy concept and its gains are maintained constant for all three configurations. The results obtained show that the activated T.E. control system leads to very significant increases in the flutter dynamic pressures Q(DF) of all three configurations; these increases range between 160-240% increase in Q(DF). These increases in Q(DF) are maintained over a very wide range of flight altitudes and flight velocities. (Author)

A79-49867 * # **On single-degree-of-freedom flutter induced by activated controls.** E. Nissim and I. Lottati (Technion - Israel Institute of Technology, Haifa, Israel). *Journal of Guidance and Control,* vol. 2, Sept.-Oct. 1979, p. 402-406. 8 refs. Grant No. NsG-7373.

It is shown that activation of the trailing-edge control of an airfoil leads to single-degree-of-freedom type instabilities which span over a very wide region of reduced frequencies k, including high values of k (unlike the nonactivated system). These instabilities are shown to be sensitive to changes in pitching axis location, control deflection phase angle, and values of the reduced frequency. These sensitivities of the single-degree-of-freedom system cause the activated airfoil to be potentially sensitive to changes in flight conditions, and may be the source of the many difficulties encountered in suppressing classical multi-degree-of-freedom flutter by means of active controls. The results presented herein relate to zero Mach number and to a 20% trailing-edge control surface. (Author)

A79-49869 * # **Linearization of the boundary-layer equations of the minimum time-to-climb problem.** M. D. Ardema (NASA, Ames Research Center, V/STOL Systems Office, Moffett Field, Calif.). *Journal of Guidance and Control,* vol. 2, Sept.-Oct. 1979, p. 434-436. 6 refs.

Ardema (1974) has formally linearized the two-point boundary value problem arising from a general optimal control problem, and has reviewed the known stability properties of such a linear system. In the present paper, Ardema's results are applied to the minimum time-to-climb problem. The linearized zeroth-order boundary layer equations of the problem are derived and solved. V.P.

A79-49873 # **Comment on 'active flutter control using generalized unsteady aerodynamic theory'.** R. Vepa (National Aeronautical Laboratory, Bangalore, India). *Journal of Guidance and Control,* vol. 2, Sept.-Oct. 1979, p. 446, 447; Reply, p. 447, 448. 7 refs.

A79-49882 # **Solution of a mixed boundary value problem for flow past a thin delta wing (Reshenie smeshannoi kraevoi zadachi obtekaniia tonkogo treugol'nogo kryla).** A. M. Antonova and L. I. Dzvonik (Kievskii Gosudarstvennyi Universitet, Kiev, Ukrainian SSR). *Matematicheskaia Fizika,* no. 25, 1979, p. 74-80. In Russian.

A mapping method is presented for hypersonic flow past a thin delta wing at small angles of attack. A series of transformations makes it possible to formulate a Riemann-Poincare problem for the pressure function. Nontrivial solutions in the form of Fourier series are obtained for the problem along with recursive relations for the flow coefficients, shock profiles, and integral representations for velocity components. B.J.

A79-49904 **A simulation of amphibious hovercraft overturning.** D. M. Waters and R. A. Prasad (Loughborough University of Technology, Loughborough, Leics., England). In: Air cushion technology; Proceedings of the Twelfth Canadian Symposium, Toronto, Canada, September 25-27, 1978. Ottawa, Canadian Aeronautics and Space Institute, 1978, p. 54-74. 13 refs.

The complex motion of an amphibious hovercraft suffering skirt tuck-under, plough-in, and hull contact has been simplified to the beam-on hull contact phase of the roll motion of a craft with a simple flat planing surface at the hull edge. The motion is restricted to two degrees of freedom sideslip and roll, but the nonlinear characteristics are incorporated using the SLAM digital simulation technique. Overturn is assumed if significant roll rate remains after the roll angle has appreciably exceeded that for the deck to submerge (20 to 30 deg). The neutral stability boundary is established as a function of center of gravity height and hull planing surface angle for varying hull thickness/beam, and skirt depth/beam ratios. (Author)

A79-49905 **Performance predictions for open ocean air cushion vehicles and surface effect ships.** J. A. Tremills (Defence Research Establishment Atlantic, Dartmouth, Nova Scotia, Canada). In: Air cushion technology; Proceedings of the Twelfth Canadian Symposium, Toronto, Canada, September 25-27, 1978. Ottawa, Canadian Aeronautics and Space Institute, 1978, p. 75-103. 12 refs.

A79-49906 **Small hovercraft design - Evolution to simplicity.** A. Bliault. In: Air cushion technology; Proceedings of the Twelfth Canadian Symposium, Toronto, Canada, September 25-27, 1978. Ottawa, Canadian Aeronautics and Space Institute, 1978, p. 104-124. 12 refs.

The paper reviews the development of small amphibious ACVs of capacity 0.1 - 2.0 tons from the early 1960s to the present. Changes in structural design, power train and propulsion systems, together with improvements in skirt technology, enable the design of efficient simple craft at present using a single engine and fan for lift and propulsion. The design developments described result in the capability to produce ACVs equivalent to such vehicles as jeeps and landrovers in their rugged reliability, while having the additional ability to traverse water, marshy, and soft sand terrains. The development of simple, rugged, and inexpensive small ACVs is now possible and has begun in Europe. Design data presented illustrate these modern techniques and the craft designs which result from their use. (Author)

A79-49907 **Hovercraft skirt design requirements.** J. E. Rapson (Hovercraft Development, Ltd., Southampton, England). In: Air cushion technology; Proceedings of the Twelfth Canadian Symposium, Toronto, Canada, September 25-27, 1978. Ottawa, Canadian Aeronautics and Space Institute, 1978, p. 125-149. 8 refs.

The reason for using a hovercraft and the duties that it is required to perform are considered as the basis for the work of the hovercraft designer and more particularly, the skirt designer. General skirt requirements are discussed and analyzed in relation to various types of craft. By analyzing the power absorption of several craft, it is shown that a response skirt is of prime importance. The relationship of various skirt configurations is shown and opinions are expressed on their relative performance capabilities. Due to its versatility the open loop and segment system is singled out for special attention and design, and testing techniques are described. Finally the result of work on skirt section stability, nonscooping skirts, and cushion control systems are summarized. (Author)

A79-49909 * **Characteristics of an Air Cushion Landing System incorporating an inelastic trunk.** A. B. Boghani, K. M. Captain (Foster-Miller Associates, Inc., Waltham, Mass.), and D. N. Wormley (MIT, Cambridge, Mass.). In: Air cushion technology; Proceedings of the Twelfth Canadian Symposium, Toronto, Canada, September 25-27, 1978. Ottawa, Canadian Aeronautics and Space Institute, 1978, p. 168-189. 8 refs. Contract No. NAS1-12403.

A series of static and dynamic tests performed on an Air Cushion Landing System (ACLS) incorporating inelastic trunk are described. The tests were performed on an apparatus which had provisions to isolate heave-pitch and roll motion on the prototype cushion. The results of the test show that the sides of the trunk behave differently from the trunk ends. The tests also demonstrate that the current ACLS designs suffer from low heave damping, low roll stiffness and fan stall problems. (Author)

A79-49910 **Road fleet operation of air cushion assisted vehicles - An evaluation of technical and economic problems.** D. Eyre (Saskatchewan Research Council, Saskatoon, Canada) and A. A. Jones (A. A. Jones and Associates, Ltd., La Ronge, Saskatchewan, Canada). In: Air cushion technology; Proceedings of the Twelfth Canadian Symposium, Toronto, Canada, September 25-27, 1978. Ottawa, Canadian Aeronautics and Space Institute, 1978, p. 190-213. 5 refs.

The paper summarizes the results of a detailed evaluation of the economics and technical problems of air-cushion-assisted vehicles in on-road applications, conducted from 1977 to 1978. The results show that air-cushion-assisted vehicles are not economically competitive or technically practicable in fleet operations. This indicates the importance of a paper evaluation prior to the development and application of the technology. It is noted that air-cushion-assisted vehicles cannot compete economically with conventional wheeled vehicles and cannot satisfy the existing braking regulations. The effect on road maintenance is shown to be minimal, and the energy efficiency to be considerably lower than in the conventional vehicles. V.T.

A79-49911 **A combined air-cushion and endless belt transportation system.** D. Train and C. Melançon (Hydro-Quebec, Institute of Research, Varennes, Quebec, Canada). In: Air cushion technology; Proceedings of the Twelfth Canadian Symposium, Toronto, Canada, September 25-27, 1978. Ottawa, Canadian Aeronautics and Space Institute, 1978, p. 214-224.

The paper describes an air-cushion system for the transportation of loads up to 150 T. The system consists of a pallet and an air-cushion assembly of eight 36-in. castors. Each castor is surrounded by a flexible but impermeable endless belt which enables the air-cushions to be used on floor surfaces having discontinuities such as drains, cracks, and recessed rails. This technique also prevents the compressed air from escaping downward when used on semiporous surfaces such as asphalt, gravel, etc. The system was developed in order to eliminate damage to the floor when using a conventional air-cushion system. A major advantage of the new system is that it is less sensitive to irregularities in the floor surface, and the air castors are less prone to puncture due to swarf, screws, etc. V.T.

A79-49912 **Iceater I - Air cushion ice breaker in commercial operations.** W. B. Stocking (Arctic Systems, Ltd., Houston, Tex.). In: Air cushion technology; Proceedings of the Twelfth Canadian Symposium, Toronto, Canada, September 25-27, 1978. Ottawa, Canadian Aeronautics and Space Institute, 1978, p. 237-246.

The paper presents the results of full-scale testing of the Arctic System Limited Air Cushion Craft, Iceater I, which was conducted on Thunder Bay, Ontario, during the winters of 1975-76 and 1976-77. Iceater I was initially developed as an overland transporter and work platform. The craft was also adapted to use over water and in almost all aspects it performed satisfactorily when limited to the special operations and close supervision provided by the test environment. In several other aspects, it was deficient as an over-water or in-water craft. Some of the more important of these aspects are discussed: (1) stability in the floating mode; (2) unwatering/deballasting capability; (3) hovering power plant reliability; (4) craft control and security (including anchoring and landing); (5) hovering system maintenance over water; (6) host ship interfaces; a (7) long-range mobility. V.T.

A79-49915 **Current Canadian developments related to low-speed heavy lift ACV.** R. W. Dyke (Hoverlift Systems, Ltd., Calgary, Alberta, Canada). In: Air cushion technology; Proceedings of the Twelfth Canadian Symposium, Toronto, Canada, September 25-27, 1978. Ottawa, Canadian Aeronautics and Space Institute, 1978, p. 358-378.

A method for determining cushion flows over water and over land is discussed, and a new non-dimensional lift-air coefficient is proposed. Propulsion using winched cables, applied to low-speed ACV ferries, is outlined and developments of surface contacting devices are discussed along with the theoretical and experimental prediction of minimum air flows and over-water drags for cushions containing segmented skirts. Emphasis is placed on the development of a modular structure concept which defines a modular system as consisting of rectangular boxes with triangular perimeter, units that can be assembled together to form a series of craft capable of payloads from about 40 to 300 tons. V.T.

A79-49921 # **Drag reduction by cooling in hydrogen-fueled aircraft.** E. Reshotko (Case Western Reserve University, Cleveland, Ohio). *Journal of Aircraft,* vol. 16, Sept. 1979, p. 584-590. 28 refs.

Drag reductions are possible for cryo-fueled aircraft by using fuel to cool selected aerodynamic surfaces on its way to the engines. This is because cooled laminar boundary layers in air at subsonic and low supersonic speeds are more stable than adiabatic boundary layers and therefore more resistant to transition to turbulent flow. Calculations for M = 0.85 hydrogen-fueled transport show that drag reductions in cruise of about 20% are within reason. The weight of the fuel saved is well in excess of the weight of the required cooling system. These results suggest that the hydrogen fueled aircraft employing surface cooling is quite attractive as an energy conservative aircraft and warrants more detailed study. (Author)

A79-49922 # **Correlation technique for ambient effects on oxides of nitrogen.** R. M. Washam and A. M. Mellor (Purdue University, West Lafayette, Ind.). *Journal of Aircraft,* vol. 16, Sept. 1979, p. 626-631. 19 refs. Research supported by the U.S. Environmental Protection Agency.

Aircraft gas turbine engine testing requires large air flow rates and this is accomplished with ambient air. Daily changes in atmospheric air temperature, pressure, and humidity lead to variations in NOxEI (g NOx/kg fuel). A new scheme is proposed to correlate engine data and minimize this scatter due to changes in ambient conditions. The scheme is derivable from first principles; example calculations are shown for several Pratt and Whitney JT9D engines. The correlation technique is explained in detail, and the resulting scaling relations is discussed. (Author)

A79-49925 # **Comment on 'Flight test of stick force stability in attitude-stabilized aircraft'.** W. O. Breuhaus (Institute for Defense Analyses, Arlington, Va.). *Journal of Aircraft,* vol. 16, Sept. 1979, p. 639, 640; Authors' Reply, p. 640. 6 refs.

A79-49995 **Injuries in air transport emergency evacuations.** D. W. Pollard (FAA, Protection and Survival Laboratory, Oklahoma City, Okla.). *Aviation, Space, and Environmental Medicine,* vol. 50, Sept. 1979, p. 943-947. 7 refs.

Eleven accident histories pertaining to air transport emergency evacuations are reviewed because they are representative of types of evacuations. A twelfth history was selected because the passenger load consisted of trained personnel, and hence is unique. Factors influencing survival in emergency evacuations are presented and described in tabular form: configuration, procedure, environment, and biobehavior. The discussion focuses on the configurational and procedural factors. The environmental factor, while significant in high-impact and/or toxic-agent-producing accidents, is relatively unimportant in less severe accidents. The biobehavioral factors cannot be controlled and are therefore not emphasized in this paper. S.D.

A79-50109 **Lusaka accident report.** J. M. Ramsden. *Flight International,* vol. 116, Aug. 25, 1979, p. 595, 596, 601-607.

A study of the Lusaka accident of a Boeing 707 is examined in detail with emphasis on the detached stabilizer and the cause of its dislodging. Postaccident tests, a total of nine, using theoretically derived loads were examined over a range of four conditions. Other tests including fatigue and failsafe tests were conducted by US and UK agencies and a failsafe design philosophy is discussed. It was concluded that insufficient consideration had been given to the design and certification stage and to the stress distribution of the horizontal stabilizer spar structure following a top chord failure in the region outboard of the closure rib. C.F.W.

A79-50110 **Duct noise radiation through a jet flow.** H. E. Plumblee (Lockheed-Georgia Co., Marietta, Ga.) and P. E. Doak (Southampton, University, Southampton, England). *Journal of Sound and Vibration,* vol. 65, Aug. 22, 1979, p.453-491. 53 refs.

The radiation of internal (or core) noise for aircraft turbojet or turbofan engines is studied analytically. The geometry of a typical engine is simplified for analytical considerations to a hemispherical shell with a jet flow and internal sound emanating through a circular hole on the axis. A linearized theory is used to derive a flow modified spherical wave equation. A forced separation technique is used to produce a modified Legendre equation describing the angular variation of the acoustic radiation field. Then a numerical technique is described for obtaining a general field solution by progressively imposing continuity of pressure across hemispherical shells as the solution is marched from near field to the far field. In a companion paper, numerical results are presented and compared with experimental results from a test configuration identical to that described by the theory. (Author)

A79-50163 **High sink-rate landing testing of Navy aircraft.** G. E. Clarke (U.S. Naval Air Test Center, Patuxent River, Md.). *Society of Flight Test Engineers, Journal,* vol. 1, Jan. 1979, p. 2-9.

Sink-rate measurement systems for Navy aircraft are reviewed including photo-optical systems, the Ryan sink-rate radar, a touchdown rate-of-descent indicator (TRODI), and a laser theodolite. The Ryan radar offers a high potential for development into an accurate measuring system. A near-term effort is being made to improve the data readout available from this radar so that the inherent system accuracy might be realized. Goals are to reduce or eliminate reader variability and to generate report quality data. The long-term solution to accurate sink-rate measurement is a laser theodolite with digitized output fed to an onboard minicomputer capable of real-time computation and display of sink rate and engaging speed. V.T.

A79-50164 **Dynamic test techniques - Concepts and practices.** K. Rawlings, III, J. M. Cooper, and D. L. Hughes. *Society of Flight Test Engineers, Journal,* vol. 1, Jan. 1979, p. 10-20.

The concepts involved in dynamic performance testing represent a philosophy of developing a single, coherent performance model using thrust and drag modeling. It is shown that if all thrust drag interactions, maneuver rates, and instrumentation are taken into consideration, it is possible to generate a lift/drag model which is capable of predicting performance from nearly any maneuver. Although this capability is dependent on the ability to calculate gross thrust adequately, the engines can be calibrated through static thrust runs and the thrust computation procedures verified in flight. The capability of generating a consistent lift/drag model in considerably less time than conventional performance methods is demonstrated. V.T.

A79-50165 **An investigation of the rolling stability derivatives of a T-tail fighter configuration at high angles-of-attack.** W. A. Thor (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). *Society of Flight Test Engineers, Journal,* vol. 1, Jan. 1979, p. 21-25.

The F-104 high-load-factor stability problem was studied with a wind tunnel model. As the angle of attack for the model with a clean wing is increased near the stall, the roll damping drops off abruptly and the yaw due to roll increases negatively (adverse yaw). This characteristic was more pronounced when the wing was in the high-lift configuration of 12 deg leading-edge flap and 13 deg trailing-edge flap, due to the lift-curve slope's decreasing at an earlier angle of attack for the flapped wing. The wing fences, slats, and strakes had a favorable effect on the roll damping and adverse yaw, and they are considered to be the simplest and most effective aerodynamic modification to increase the roll damping at high angles of attack without degrading the longitudinal characteristics. The wing tip end plates decreased the roll damping at angles of attack below stall. V.T.

A79-50166 **Ultrasonic method of gun gas detection.** R. L. Grant (McDonnell Aircraft Co., St. Louis, Mo.). *Society of Flight Test Engineers, Journal,* vol. 1, Jan. 1979, p. 26-32.

Gun-gas sensing systems using ultrasonic sensors are described. Three systems were constructed: two of them employed multiple sensors, whereas the third was a single-sensor prototype system. The control unit, tailored in each case to a particular data system requirement, provided an independent pulse-code-modulated output containing the reduced sensor data and various system status indicators. The single-sensor system was tested in an actual flight environment during the F-15 gunfire program. Data were also collected on sensor performance during ground tests of the 20-mm gun used on the F-15. Conclusive test data supporting the quantitative performance of the sensor were limited to laboratory tests although a limited amount of data exists that indicates a correlation with sampling bottle data taken during actual gunfire. It is noted that the response time of the ultrasonic sensor is significantly faster than that of catalytic sensors. V.T.

A79-50167 **Performance modelling methods.** W. M. Olson (USAF, Flight Test Center, Edwards AFB, Calif.). *Society of Flight Test Engineers, Journal,* vol. 1, May 1979, p. 2-12.

Two different directions a performance program can take are discussed. The first is a program in which accelerations are used to generate acceleration performance, etc. The other extreme is a program in which maneuvers are designed solely to generate drag polars and thrust and fuel flow maps. Five basic performance modeling methods which utilize drag and thrust models are outlined: (1) predicted minimum drag method; (2) predicted thrust method; (3) predicted thrust fuel model; (4) complete reliance on the in-flight thrust calculation; and (5) partial reliance on the in-flight thrust calculation. The preferred program should be designed primarily to generate the model, but 'conventional' maneuvers should be used in this determination. V.T.

A79-50168 **A computer system for identifying aircraft characteristics.** T. J. Galbraith, T. J. Petersen, and C. E. Roth (Boeing Commercial Airplane Co., Renton, Wash.). *Society of Flight Test Engineers, Journal,* vol. 1, May 1979, p. 13-30. 6 refs.

The parameter identification (PI) concept is presented as a mathematical scheme for estimating stability and control derivatives from dynamic flight testing. A parameter identification system composed of six computer programs is described along with a kinematic and sensor-dynamics (KASD) program added to the system for identifying sensor inconsistencies or errors. The PI concept employs the classical six-degree-of-freedom kinematic relations, modeled sensor errors, and an estimator to produce a consistent set of sensor time histories. A flaps-up, lateral-directional flight record for a large subsonic transport aircraft was analyzed to identify the linear stability, control derivatives, and sensor errors. The same record was then processed through KASD. The purpose of this experiment was to determine the impact of more detailed sensor error identification on the estimation of the linear stability and control derivatives. V.T.

A79-50169 **The T & E simulator - A comparison with flight test results.** J. M. Rebel (U.S. Naval Air Test Center, Patuxent River, Md.). *Society of Flight Test Engineers, Journal,* vol. 1, May 1979, p. 31-36.

Development of an automatic carrier landing capability for the F-14A aircraft is presented. The models of the aircraft and automatic carrier landing system (ACLS) were constructed with information that included flight test data. The simulator was then 'tuned.' First, standard aircraft maneuvers, such as pitch and bank steps, were run on the simulator, time histories of these maneuvers were compared with flight test data, and corrections to the models were made. Next, a pilot who had recently flown the aircraft was asked to 'fly' the simulator and comment on its fidelity. Based on comparison of measured aircraft frequency response data, touchdown statistics, and the pilot opinion the F-14 ACLS simulation has been shown to be a valid model that is capable of predicting flight test results. V.T.

A79-50206 **Derivative engines for the 1980s will help limit acquisition and maintenance costs.** J. E. Worsham (General Electric Co., Commercial Engine Div., Cincinnati, Ohio). *ICAO Bulletin,* vol. 34, Apr. 1979, p. 14-17.

It is noted that the projected increase in commercial aviation will lead to greater demand for new aircraft and thus new engines. The industry is shown to be emphasizing derivative engines. Attention is given to the advantages of such development such as rapid maturity of the design resulting in a reduced shop visit rate, and reduced acquisition costs. As an example the CFM56 engine, suitable for re-engineering narrow body aircraft such as the B-707, DC-8, and DC-9, utilizes the core of a high performance engine previously developed for the U.S. Government. It is concluded that meeting costs continues to be a major challenge for the airlines, the aircraft companies, and the engine manufacturers. M.E.P.

A79-50207 **Aircraft engine developments centre on improved performance, higher efficiency.** W. H. Sens (United Technologies Corp., Commercial Products Div., East Hartford, Conn.). *ICAO Bulletin,* vol. 34, Apr. 1979, p. 18-23.

Improvements that can be made to reduce the fuel consumption of current engines are reviewed as well as for new production versions of current engines. In addition, the potential fuel savings with advanced turbofan engines are discussed. Four ways to improve fuel consumption are covered: improvement in component performance, improved maintenance procedures that reduce the amount of engine performance deterioration with operational use, improvement in the power plant cycle, and by designing the engine to be less sensitive to factors causing performance deterioration. Modification to current engines can improve fuel consumption by 5%. It is concluded that the advanced turbofan configuration has the potential of providing a 20% reduction in fuel burned relative to today's designs for a high bypass ratio turbofan for 1990. M.E.P.

A79-50208 * **QCSEE - The key to future short-haul air transport.** C. C. Ciepluch (NASA, Lewis Research Center, Quiet, Clean, Short-Haul Experimental Engine Project Office, Cleveland, Ohio) and W. S. Willis (General Electric Co., Aircraft Engine Group, West Lynn, Mass.). *ICAO Bulletin,* vol. 34, Apr. 1979, p. 24-29.

The paper describes the design and test procedure for the QCSEE (quiet, clean, short-haul experimental engine). The engines designed for the YC-14 and YC-15 STOL aircraft, both use a very low fan pressure ratio to keep jet-flap noise about 3 dB below total system noise. Other noise reducing features discussed are the low tip speed fans and a carefully selected number of fan blades and vanes with adequate spacing between them. Attention is also given to the development of a low emissions combustor, and reduction of fan frame weight, through the use of graphite/epoxy material. The YC-15 engine also employs variable pitch fans to provide thrust reversal, thus saving weight. Finally, it is noted that the tests have proven that the engines could be configurated to meet the needs of a powered lift system without excessively compromising performance or weight. M.E.P.

A79-50209 **Factors controlling stability of swirling flames at diffusers in gas turbines.** V. M. Domkundwar, V. Sriramulu, and M. C. Gupta (Indian Institute of Technology, Madras, India). *Institute of Energy, Journal,* vol. 52, Mar. 1979, p. 17-20. 7 refs.

The paper deals with experimental studies aimed at determining the effect of diffuse angles on flame-stability characteristics and to relate stability data to inlet flow conditions, diffuser angles, and equivalence ratios. The blowoff data obtained for different diffusers show that if diffuser angles are increased, flame stability is improved. The flame-stabilization mechanism is explained by using a recirculation model. It is concluded that the blowoff velocity increases as the diffuser angles increase. V.T.

A79-50236 # **The aeroacoustics of advanced turbopropellers.** D. B. Hanson (United Technologies Corp., Hamilton Standard Div., Windsor Locks, Conn.). *International Union of Theoretical and Applied Mechanics, International Commission on Acoustics, and AIAA, Symposium on Mechanics of Noise Generation Fluid Flows, Göttingen, West Germany, Aug. 28-31, 1979, Paper.* 12 p. 10 refs.

Advanced turbopropellers (prop-fans) are being developed in the United States to improve the fuel economy of future transport aircraft. To study their noise, various noise prediction systems have been developed via the acoustic analogy and a helicoidal source model. A time domain formulation and two frequency domain formulations are presented. Wind tunnel test data are presented to substantiate the theory and to show its limitations. Shadowgraphs and near field microphone signals for straight blades operating at supersonic speeds indicate the presence of detached bow waves that cannot be predicted from the acoustic analogy. Nonlinear effects appear to be confined to a region within two chords of the blade tips and are greatly relieved by blade sweep. It is shown that noise of highly swept blades can be predicted with good accuracy using linear source theory. (Author)

A79-50237 # **Supersonic transport aircraft noise, problems of noise reduction and establishment of standards (Shum sverkhzvukovykh transportnykh samoletov, voprosy ego normirovaniia i snizheniia).** B. N. Mel'nikov. *Itogi Nauki i Tekhniki, Seriia Vozdushnyi Transport,* vol. 7, 1979, p. 5-37. 42 refs. In Russian.

Noise and sonic boom standards for supersonic transport aircraft are presented. Noise characteristics of supersonic transports equipped with different types of high-temperature jet engines are outlined. Research results and comparative analysis of noise characteristics of first-generation supersonic transports are given along with evaluation of the expected noise characteristics of second-generation supersonic transport aircraft. Consideration is given to methods of noise reduction for the second-generation aircraft, including engine improvement, implementation of exhaust systems for jet suppression, and implementation of specific takeoff and approach techniques. V.T.

A79-50240 # **Current status of airport terminal complex development abroad (Sovremennoe sostoianie razvitiia aerovokzal'nykh kompleksov za rubezhom).** V. N. Ivanov and M. G. Piskov. *Itogi Nauki i Tekhniki, Seriia Vozdushnyi Transport,* vol. 7, 1979, p. 159-224. 26 refs. In Russian.

Airport terminal complex development before and after 1970 is considered with attention given to finger, drive-in, gate room, and pipe schemes, parking places, and baggage handling and loading-unloading concepts. Five passenger service system approaches are presented: (1) flight check-in, (2) common check-in, (3) gate check-in, (4) drive-in and drive-to-your-gate, and (5) shuttle. Principles of transportation between airport terminals and aircraft are outlined including busing and plane mate techniques. Airport terminal planning and design, curb space planning, and means of passenger access to aircraft are discussed. Emphasis is placed on the use of mathematical models for calculating airport terminal capacities. V.T.

A79-50306 **A computer program for aircraft identification and derivative extraction.** R. Hector, D. P. Maunder (USAF, Flight Test Center, Edwards AFB, Calif.), and E. M. Cliff (Virginia Polytechnic Institute and State University, Blacksburg, Va.). *Society of Flight Test Engineers, Journal,* vol. 1, Sept. 1979, p. 8-15.

A computer program developed for the investigation of stability, control and performance derivatives of aircraft from flight test data is presented. The program involves the development of a maximum likelihood technique with greater flexibility and accuracy, the development of a new linearized set of equations of motion, and the use of advanced programming technology for minimizing errors and reducing maintenance costs. The design permits operation in both the batch and interactive graphic mode. Attention is given to parameter identification which provides tools for the efficient use of data in the estimation of constants appearing in mathematical models and for aiding in modeling of phenomena. C.F.W.

A79-50307 **Flight testing and simulator flight fidelity.** R. T. Galloway (U.S. Naval Air Test Center, Patuxent River, Md.). *Society of Flight Test Engineers, Journal,* vol. 1, Sept. 1979, p. 22-31. 6 refs.

The paper outlines the role of the NAVAIRTESTCEN in simulator testing, simulator test experience, and fidelity problem areas. The major elements of the Navy test policy are outlined, including assistance in specification preparation, proposal evaluation, participation in in-plant acceptance testing, and adjusting hardware and software to achieve proper flight fidelity. It is shown that the use of NAVAIRTESTCEN flight test expertise has helped to maximize the flight fidelity of recent major aviation training devices within the U.S. Navy and Marine Corps. Furthermore, test experience has shown that meaningful data can be obtained with simple hand-held instrumentation, and that the test pilot must refamiliarize himself with the subtle aircraft characteristics during the evaluation period. C.F.W.

A79-50368 **Combined environment reliability test of the common strategic Doppler system.** J. F. Wagner, III (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In: Learning to use our environment; Proceedings of the Twenty-fifth Annual Technical Meeting, Seattle, Wash., April 30-May 2, 1979. Mount Prospect, Ill., Institute of Environmental Sciences, 1979, p. 574-577. 6 refs.

A recently completed development program for a new common strategic Doppler system made use of preproduction combined environment reliability testing to provide data for the source selection process. This test was used instead of the previously planned MIL-STD-781B reliability tests in order to subject the vendors' equipment to more realistic environmental conditions. This paper will discuss the effectiveness of the combined environment test in the competitive procurement process. (Author)

A79-50375 **Aerodynamics for engineers.** J. J. Bertin (Texas, University, Austin, Tex.) and M. L. Smith (U.S. Air Force Academy, Colorado Springs, Colo.). Englewood Cliffs, N.J., Prentice-Hall, Inc., 1979. 424 p. 123 refs. $28.

The book contains an introductory-level discussion of basic fluid mechanics and thermodynamics. The contents are divided among three major areas: flow fields for which the density may be assumed constant; flow fields for which the variations in density are important; and topics with general application both to incompressible and compressible aerodynamics. Discussions of the effects of viscosity, compressibility, shock-boundary layer interactions, turbulence, and other practical aspects of contemporary aerodynamic theory and design are also presented. Attention is given to characteristic parameters for airfoil and wing aerodynamics, two-dimensional incompressible flows around thin airfoils and about wings of finite span, and subsonic and transonic flows. V.T.

A79-50421 # **Gas turbines for flight vehicle engines: Theory, design, and calculation /Third review and enlarged edition/ (Gazovye turbiny dvigatelei letatel'nykh apparatov: Teoriia, konstruktsiia i raschet /Third revised and enlarged edition/).** V. I. Lokai, M. K. Maksutova, and V. A. Strunkin. Moscow, Izdatel'stvo Mashinostroenie, 1979. 448 p. 42 refs. In Russian.

The book deals with the theory, calculation and projection methods, and designs of gas turbines used in aircraft gas-turbine and liquid rocket engines as well as in auxiliary aircraft power plants. Consideration is given to the physics of gas flows in channels as well as the thermo- and gas dynamics of turbines. Emphasis is placed on problems of cooling gas turbines. A classification of cooling systems for gas turbines is given along with calculation methods for different parts of gas turbines. Losses in gas turbines, gas turbine characteristics, and operational processes parameters under cooling conditions are evaluated. Typical designs of the major components and units of gas turbines are presented along with strength and vibrational test methods for disks, blades, and shafts. V.T.

A79-50427 **The Swedish approach to escape system testing.** G. Niss (Saab-Scania AB, Linkoping, Sweden). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 1-1 to 1-12.

The paper deals with methods of obtaining maximum safety in current fighter aircraft escape systems and producing reliable test results. The test aircraft, a modified night fighter version of the Lansen; seat and dummy pilot installation; and the test site where most tests are performed at 500 ft and higher above the ground and in the 270 to 1150 km/h speed range are described. Seat and dummy acceleration during the drive phase, the effect of wind blast on pilot and equipment and effectiveness of the restraint system are evaluated, and initial stability of the man-seat combination, stabilizer chute, the separation between the seat and the pilot, clearance between the dummy-parachute combination and the seat are discussed. Parachute deployment sequence, the trajectory from ejection point till the dummy is in a fully deployed parachute, and inspection of dummy, dress, and equipment are described, and it is concluded that changes required at high speed must be based on full scale flight testing. A.T.

A79-50428 **An evaluation of sidestick force/deflection characteristics on aircraft handling qualities.** S. B. Smith and C. M. Miller (USAF, Flight Test Center, Edwards AFB, Calif.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 2-1 to 2-17. 9 refs.

A study of a variable force and motion sidestick controller programmed to simulate the handling characteristics of a high-performance stability fighter aircraft is presented. Precision air-to-air tracking of a target aircraft during level and windup turns, gross acquisition and tracking involving large pilot inputs, and landings were evaluated. The ratio of stick force to stick deflection and the ratio of stick force to aircraft response, and the effect of sidestick controller pre-filter characteristics were investigated. It was concluded that for very small displacements the range of stick force/response gradients is restricted, that there is a region of moderate stick displacement where performance is insensitive to variations in force/response gradients, and that moderate stick motion coupled with light to moderate stick force gradients results in the best tracking performance. A.T.

A79-50429 **Separation testing of large weapons from the B-1 bomber.** R. E. Little (Rockwell International Corp., El Segundo, Calif.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978.
Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 4-1 to 4-14.

This paper covers the flight test techniques and data analysis methods in use on the weapon separation test program for the B-1. Weapon trajectory test results together with prediction methods are shown, and the importance of estimating methods and test instrumentation is discussed. Weapon launch and trajectory parameters are covered with comparisons taken from analytical wind tunnel and flight test results. Weapon accuracy error budgets are presented in relation to current capabilities of space positioning equipment, and aircraft/weapon accuracy requirements. (Author)

A79-50430 **INACT - Interactive test data analysis.** D. R. Halwes (Bell Helicopter Textron, Fort Worth, Tex.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 6-1 to 6-18.

The capability of interactive test data analysis (INACT) for high speed data programs is based on new mini-computers. INACT was developed to provide flight test engineers an on-line computer access during flight and laboratory vibration testing, and to command data acquisition, analysis, and display on a graphics terminal in a telemetry or the vibration control room. INACT can analyze up to 8 channels of analog data from telemetry during flight testing, analog tape playback, or during ground vibration testing. Input command form and conventions, examples of data analysis, and the use of INACT for flight testing are discussed, and it is concluded that INACT provides capabilities for data acquisition, time history displays, harmonic analysis, spectral analysis, damping estimation using the complex exponential approximation, and transfer function computation. A.T.

A79-50432 * **Estimation of longitudinal aircraft characteristics using parameter identification techniques.** R. C. Wingrove (NASA, Ames Research Center, Aircraft Guidance and Navigation Branch, Moffett Field, Calif.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 9-1 to 9-24. 22 refs.

This study compares the results from different parameter identification methods used to determine longitudinal aircraft characteristics from flight data. In general, these comparisons have found that the estimated short-period dynamics (natural frequency, damping, transfer functions) are only weakly affected by the type of identification method, however, the estimated aerodynamic coefficients may be strongly affected by the type of identification method. The estimated values for aerodynamic coefficients were found to depend upon the type of math model and type of test data used with each of the identification methods. The use of fairly complete math models and the use of long data lengths, combining both steady and nonsteady motion, are shown to provide aerodynamic coefficient values that compare favorably with the results from other testing methods such as steady-state flight and full-scale wind-tunnel experiments. (Author)

A79-50433 * **Considerations in the analysis of flight test maneuvers.** K. W. Iliff, R. E. Maine, and T. D. Montgomery (NASA, Flight Research Center, Edwards AFB, Calif.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 10-1 to 10-36. 13 refs.

This paper discusses the application of a maximum likelihood estimator to dynamic flight-test data. The information presented is based on the experience in the past twelve years at the NASA Dryden Flight Research Center of estimating stability and control derivatives from over 3,000 maneuvers from 32 aircraft. The overall approach to the analysis of dynamic flight-test data is discussed. Detailed requirements for data and instrumentation are discussed and several examples of the types of problems that may be encountered are presented. (Author)

A79-50434 **AFFTC parameter identification experience.** D. P. Maunder (USAF, Performance and Flying Qualities Branch, Edwards AFB, Calif.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 11-1 to 11-18. 5 refs.

The AFFTC experience with parameter identification and results of this application with respect to accuracy, contributions of otherwise unobtainable information, and cost effectiveness are presented. Parameter identification techniques in aircraft flight testing obtain aerodynamic, structural, and performance characteristics to assess control system performance and establish design criteria. The technique was used to provide mathematical description of aircraft stability and control characteristics such as improved verification of performance criteria and improved dependability of extrapolated flight characteristics. Parameter identification experience including test optimization, accuracy, flight test parameter identification comparisons with wind tunnel, and parameter identification and configuration effects are discussed. It is concluded that parameter identification provided reduction and optimization of flight test programs, better verification of performance criteria, enhanced system development, and optimization of vehicle performance. A.T.

A79-50435 **Flight test technology development - A preview of DyMoTech.** J. W. Hicks (USAF, Flight Test Center, Edwards AFB, Calif.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978.
Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 12-1 to 12-11. 8 refs.

The scope of dynamic modeling technology (DyMoTech) for instrumentation systems, flight test maneuvers, and performance modeling techniques is presented. The purpose of DyMoTech is to develop dynamic flight test techniques and modeling to define the aircraft performance characteristics, and to conduct an inflight comparison of four methods of extracting flightpath accelerations simultaneously from separate measurement systems on the test aircraft. Four instrumentation systems will be compared during takeoff and landing, climbs, level accelerations, wind-up turns, and split-S maneuvers. It is concluded that DyMoTech seeks to develop a total approach to dynamic flight testing to save flight test time and program cost, provide a more complete definition of the performance envelope, and greater model utility and versatility in which it can predict both standard-day and non-standard day performance data, flight manual preparation, mission analysis, and performance simulation. A.T.

A79-50436 **Evaluation of the radar altimeter reference method for determining altitude system positioning errors.** J. D. Dinkel (Grumman Aerospace Corp., Calverton, N.Y.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 13-1 to 13-18.

The radar altimeter reference method for determining altitude system position errors which can reduce the number of flights required to calibrate a system, manpower and supporting equipment is presented. The method has the advantages of instrumentation and equipment in the test aircraft, coverage over a wide range of Mach numbers and attack angles. In addition, it is independent of wind speed and air temperature measurements, has high data productivity per maneuver and flight, and its telemetry compatible system enables determination of answers in real time. The radar altimeter reference method consists of runway flyover, atmosphere calibration, and altitude pressure system calibration. The radar altimeter and pneumatic altimeter, the flight test method, software, and test procedures were evaluated, and computer software was developed. It was concluded that the radar altimeter reference method provides a viable means for determining altitude system position errors. A.T.

A79-50437 **ARIA takeoff performance flight test program.** H. A. Lebovitz (USAF, Directorate of Flight Test Engineering, Wright-Patterson AFB, Ohio). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 15-1 to 15-13.

The verification and subsequent testing to reduce the impact of the extended takeoff roll on the advanced range instrumented aircraft (ARIA) is presented. Two EC-135N ARIA aircraft experienced a takeoff ground roll greater than predicted by the flight manual. Since in the event of an engine failure at or near the critical engine failure speed, the aircraft would be incapable of aborting the takeoff or continuing it, a hazard report was prepared recommending action to verify the takeoff performance. The verification test indicated that the extended ground roll is due to an interaction of the enlarged nose radome and the ground resulting in a large increase in drag. Ground/radome interaction tests were made, and it was concluded that the EC-135N aircraft exhibit an extended ground run 15% greater than predicted, aircraft subsystems were functioning properly, and the extended ground run appears to be due to a ground/radome interaction. A.T.

A79-50438 **The evolution of the high-angle-of-attack features of the F-16 flight control system.** C. K. Clark, J. E. Walker, and J. K. Buckner (General Dynamics Corp., Fort Worth, Tex.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 17-1 to 17-21.

'Eyes-out-of-the-cockpit' air combat maneuvering achieved through the use of angle-of-attack and structural-load-limiting features of the flight control system is presented. Spin-tunnel results revealed a fast-flat spin mode that required an unacceptable number of turns to recover, and a no-spin condition resulted when flaperons were deflected to roll in the direction of the spin. A yaw-rate limiter was designed that automatically prevented spins by positioning the flaperon and rudder in the direction defined by the spin tunnel to prevent the spin. Flight testing showed that departures may develop from high angle-of-attack sideslips and rolling maneuvers. A rudder fadeout was designed which prevented yaw departures from full-rudder side-slips, a roll-rate command limiter was installed, pitch-axis modifications were made in the flight control system, and a rudder-pedal command limiter was designed. It was concluded that these systems improved the high angle-of-attack handling qualities of the F-16 and allow the pilot to fly 'eye-out-of-the-cockpit' air-combat maneuvering with maximum command inputs and without fear of departure. A.T.

A79-50439 **Evaluation of selected class III requirements of MIL-F-8785B /ASG/, 'Flying Qualities of Piloted Airplanes'.** C. C. Withers (Lockheed-Georgia Co., Marietta, Ga.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 19-1 to 19-18. 5 refs.

A comparison of the requirements of the military specification 'Flying Qualities of Piloted Airplanes' with flight test results from the C-5A, L-1011, C-141A, and YC-141B aircraft is presented. A study of the C-5A flight results showed that this specification was too stringent in seven sections which were compared with flight test results in this investigation: phugoid stability, short-period response, elevator control force gradient, lateral directional damping, roll mode time constant, sideslip excursions, and roll control effectiveness. It was shown that: (1) sections dealing with lateral control, roll mode, sideslip excursions, and roll control effectiveness are too stringent for Level 1 conditons; (2) phugoid stability, short period response, and control forces in maneuvering flight warrant adjustment in Level 1 requirement boundaries; and (3) the lateral directional damping section is too restrictive for Level 2 conditions. A.T.

A79-50440 * **A simplified gross thrust computing technique for an afterburning turbofan engine.** M. J. Hamer (Computing Devices Co., Ottawa, Canada) and F. J. Kurtenbach (NASA, Flight Research Center, Propulsion Controls Branch, Edwards AFB, Calif.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 22-1 to 22-20. 8 refs. Research sponsored by the United States/Canada Defence Production Sharing Program.

A simplified gross thrust computing technique extended to the F100-PW-100 afterburning turbofan engine is described. The technique uses measured total and static pressures in the engine tailpipe and ambient static pressure to compute gross thrust. Empirically evaluated calibration factors account for three-dimensional effects, the effects of friction and mass transfer, and the effects of simplifying assumptions for solving the equations. Instrumentation requirements and the sensitivity of computed thrust to transducer errors are presented. NASA altitude facility tests on F100 engines (computed thrust versus measured thrust) are presented, and calibration factors obtained on one engine are shown to be applicable to the second engine by comparing the computed gross thrust. It is concluded that this thrust method is potentially suitable for flight test application and engine maintenance on production engines with a minimum amount of instrumentation. A.T.

A79-50441 **J85-CAN-15 compressor stall and flameout investigation.** W. L. Macmillan (Department of National Defence, Directorate of Aeronautical Engineering and Simulators, Ottawa, Canada), R. M. McGimpsey (Aerospace Engineering Test Establishment, CFB Cold Lake, Alberta, Canada), and K. D. Nelson. In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 23-1 to 23-16.

An investigation of the J85-CAN-15 compressor inlet temperature sensing system to prevent compressor stall and flameout during flight operations is presented. Engine testing and stall analysis which demonstrated the compressor inlet temperature sensitivity of the engine, the flight test program to determine engine and sensing system performance, and flight test techniques are described showing that there were errors in the T2 sensing system. It was shown that the compressor inlet temperature (T2) sensing systems on the J85-CAN-15 operate at temperatures warmer than the compressor inlet total temperature (CIT), that the T2 cutback does not occur in accordance with that predicted by the engine CFTO's, T2 cutback can be observed on cockpit instruments, insulating the T2 duct did not significantly reduce the T2 sensing system error, and engine anti-ice provides an effective means of reducing compressor discharge pressure during afterburner initiation. A.T.

A79-50444 **Testing the F-18 at the U.S. Naval Air Test Center.** J. L. Dunn (U.S. Naval Air Test Center, Patuxent River, Md.). In: Why flight test; Proceedings of the Ninth Annual Symposium, Arlington, Tex., October 4-6, 1978. Lancaster, Calif., Society of Flight Test Engineers, 1978, p. 26-1 to 26-11.

The U.S. Navy is procuring the F-18 as a replacement for the F-4 and A-7 aircraft starting in 1983. The F-18 evolved from the

YF-17 prototype which was a part of the U.S. Air Force Light Weight Fighter Competition in 1974. F-18 design advancements include control-by-wire digital flight control system, cockpit designed for one man operability, state-of-the-art avionics integration by software/multiplex techniques, and a high use of composite materials. From the Navy viewpoint, the unique aspect of the F-18 Full Scale Development (FSD) program is that it will be principal sited at the Naval Air Test Center (NAVAIRTESTCEN), Patuxent River, Maryland. Present plans for the FSD program are based on 11 test aircraft and 3100 test flights with first flight scheduled for late September 1978. NAVAIRTESTCEN involvement to date has consisted of participation in the design review process, Navy Integrated Test and Evaluation Working Group, Aircrew Systems Advisory Panel, and participation in simulation evaluations in St. Louis. The on-site preparation phase has consisted of establishing a management plan, ensuring that adequate facilities, support aircraft, airspace, and data and instrumentation systems are available. (Author)

A79-50499 # **Airport power supply (Elektrosnabzhenie aeroportov).** I. S. Gladysh and P. L. Andreev. Moscow, Izdatel'stvo Transport, 1979. 248 p. In Russian.

The book deals with the basic principles and instrumentation of airport power supply. Characteristics of power consumers and techniques for reducing power consumption are discussed. General problems of power supply are considered, including electric network design, methods of design-power selecting, and determining wire and cable cross sections in accordance with heating and voltage-loss requirements. The electric power equipment and relay protection devices for airport transformers and power stations are described along with their design and circuitry. Attention is given to automatics and telemechanics of electric power networks, methods for calculating short-circuit current and selecting power, relay protection, and grounding equipment. The electrotechnic laboratory (ETL-1M) is also described. V.T.

A79-50606 **Radiation from quarter-wavelength monopoles on finite cylindrical, conical, and rocket-shaped conducting bodies.** M. N. I. Fahmy (Cairo University, Cairo, Egypt; Riyadh, University, Riyadh, Saudi Arabia) and A. Z. Botros (Cairo University, Cairo, Egypt). *IEEE Transactions on Antennas and Propagation,* vol. AP-27, Sept. 1979, p. 615-623. 14 refs.

A theoretical-numerical technique, based on Maue's integral equation, is applied for the determination of radiation patterns of airborne antennas comprising one or more quarter-wavelength monopoles, straight or bent, on finite cylindrical, conical, and rocket-shaped conducting airframes. The induced surface currents on the conducting body are first determined whence the total radiation fields are obtained. In the cases of a single monopole on a conducting body, the surface currents and radiation patterns are studied in view of varying the geometrical parameters of the body as well as the position and relative orientation of the monopole. For the case of two diametrically opposite monopoles on a finite cylinder, the effect of varying the relative phasing is studied. A physical interpretation of the variation with various parameters of the surface currents and the radiation fields is endeavored wherever feasible, and important results are concluded. Experimental investigation of radiation from one of the theoretically treated models, namely that of a bent monopole on a finite frustum of a cone, showed excellent agreement with computed results. This establishes the validity of the theoretical-numerical technique as well as the computed radiation patterns for various cases. (Author)

A79-50920 **Aeronautical information data subsystems /AIDS/.** F. W. Fischer (Studiengemeinschaft für Flugsicherung, Westerngrund, West Germany). *The Controller,* vol. 18, Sept. 1979, p. 30-33.

The aeronautical information data subsystem (AIDS) is presented as a means to help alleviate the problems facing air traffic control at present. The method employs a data base that interlinks radar, flight plan and progress, and information data, and is also capable of simultaneous retrieval for multiple users. It is suggested that this system be implemented as the third vital data category in order to close the air traffic control data processing function loop. Such an implementation would improve air safety by increased responsiveness of the air traffic services to pilots requests for operational flight information availability of vital and important system data to air traffic controllers, and other air navigation services operators. C.F.W.

A79-50921 **Modern systems for air traffic control.** P. A. Jorgensen (Selenia SpA, Rome, Italy). *(International Federation of Air Traffic Controllers' Associations, Annual Conference, 18th, Brussels, Belgium, Apr. 23-27, 1979.) The Controller,* vol. 18, Sept. 1979, p. 35-37.

The paper deals with air traffic systems and equipment which can conveniently be put into operation, within a reasonable amount of time in order to upgrade present flaws. Attention is given to distributed intelligence, where the various tasks and functions can clearly be defined and divided to be performed by dedicated computers, each placed where the task or function may best be performed. The typical system structure of a computer and its radar links is shown, depicting the interface between the radar data processor and the display processor, radar head processor, and flight data processor. With this system, it is found that error detection capability is better than 80% within aircraft identification range, and the number of false alarms can be kept to 10 to the minus 8th. C.F.W.

A79-50925 # **Laser velocimeter applied to the study of circular distorsion effects in a low speed compressor.** J. Labbe (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *(Symposium on Measuring Techniques in Transonic and Supersonic Cascade Flow, Leatherhead, Surrey, England, Mar. 22, 23, 1979.) ONERA, TP* no. 1979-30, 1979. 20 p.

In order to investigate the capabilities of laser velocimetry for the study of perturbations due to circular distorsions in an axial compressor, preliminary experiments have been performed on a low speed compressor. The instrument used is a back-scattered Doppler velocimeter designed by ONERA. It is equipped with a 1400 mW argon ion laser used in its green line. Signals, picked up by synchronous sampling, are recorded by a frequency counter. Velocity (average 15 m/sec) and turbulence components are computed off-line. Three locations were investigated, namely upstream, in the mid-interblade channels and downstream of the impeller. Results obtained by LDV show deformations of the velocity vector and are in good agreement with average values deduced from previous experiments performed with pressure probe techniques. (Author)

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STAR ENTRIES

N79-30138*# Rail Co., Baltimore, Md.
MAINTENANCE COST STUDY OF ROTARY WING AIRCRAFT, PHASE 2 Interim Report
Aug. 1979 34 p
(Contract NAS2-9143)
(NASA-CR-152291) Avail: NTIS HC A03/MF A01 CSCL 02A

The Navy's maintenance and materials management data base was used in a study to determine the feasibility of predicting unscheduled maintenance costs for the dynamic systems of military rotary wing aircraft. The major operational and design variables were identified and the direct maintenance man hours per flight hour were obtained by step-wise multiple regression analysis. Five nonmilitary helicopter users were contacted to supply data on which variables were important factors in civil applications. These uses included offshore oil exploration and support, police and fire department rescue and enforcement, logging and heavy equipment movement, and U.S. Army military operations. The equations developed were highly effective in predicting unscheduled direct maintenance man hours per flying hours for military aircraft, but less effective for commercial or public service helicopters, probably because of the longer mission durations and the much higher utilization of civil users. A.R.H.

N79-30139*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
PERFORMANCE EVALUATION METHOD FOR DISSIMILAR AIRCRAFT DESIGNS
Harold J. Walker Sep. 1979 72 p refs
(NASA-RP-1042; H-1064) Avail: NTIS HC A04/MF A01 CSCL 02A

A rationale is presented for using the square of the wingspan rather than the wing reference area as a basis for nondimensional comparisons of the aerodynamic and performance characteristics of aircraft that differ substantially in planform and loading. Working relationships are developed and illustrated through application to several categories of aircraft covering a range of Mach numbers from 0.60 to 2.00. For each application, direct comparisons of drag polars, lift-to-drag ratios, and maneuverability are shown for both nondimensional systems. The inaccuracies that may arise in the determination of aerodynamic efficiency based on reference area are noted. Span loading is introduced independently in comparing the combined effects of loading and aerodynamic efficiency on overall performance. Performance comparisons are made for the NACA research aircraft, lifting bodies, century-series fighter aircraft, F-111A aircraft with conventional and supercritical wings, and a group of supersonic aircraft including the B-58 and XB-70 bomber aircraft. An idealized configuration is included in each category to serve as a standard for comparing overall efficiency. Author

N79-30140# Administrative Sciences Corp., Alexandria, Va.
NAVAL AIRCRAFT OPERATING AND SUPPORT COST-ESTIMATING MODEL, FY 1977 REVISION
Feb. 1979 199 p refs Revised
(Contract N00014-77-C-0180)
(AD-A068175; ASC-R-120; ASC-R-116-Rev) Avail: NTIS HC A09/MF A01 CSCL 05/1

In fiscal year 1974, Administrative Science Corp. developed a parametric cost-estimating model which has been updated and documented several times and used to support numerous Defense Systems Acquisition Review Council (DSARC) reviews as well as other cost reviews. This report provides a detailed documentation of the cost-estimating relationships (CER's) developed from FY-77 data. In addition, the report has been significantly enhanced in order to serve as a handbook and training aid for Op-96D aircraft analysts. For each cost element in the structure, this report provides: (1) a definition; (2) discussion of the definition and other aspects of how, where, and why these costs are incurred, points of contact including organizational codes and telephone numbers, historical data, and sources for planning data; (3) cost-estimating relationship, including all computational procedures, regression statistics for the CER, and the data base; (4) an alternative CER (in many cases) with the same detail as above; and, (5) an example calculation. GRA

N79-30141# Information Spectrum, Inc., Warminster, Pa.
MAINTENANCE IMPROVEMENT: AN ANALYSIS APPROACH INCLUDING INFERENTIAL TECHNICAL DATA Final Report, 27 Dec. 1977 - 15 Mar. 1979
Milton Clyman, Philip S. Grenetz, and Raymond R. Mellott
15 Mar. 1979 322 p
(Contract MDA903-78-C-0176)
(AD-A068382; ISI-W-7958-02C) Avail: NTIS HC A14/MF A01 CSCL 01/3

Tables of input information and output data which were used in assessment of the economic impact (cost and downtime) of potentially avoidable maintenance actions are presented for the F-14A fire control, A-7E and S-3A bombing navigation, and the S-3A landing gear. A.R.H.

N79-30143*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
UPPER-SURFACE MODIFICATIONS FOR C SUB I MAX IMPROVEMENT OF SELECTED NASA 6-SERIES AIRFOILS
C. A. Szelazek and Raymond M. Hicks Aug. 1979 79 p refs
Prepared in cooperation with Computer Information Systems, Cupertino, Calif.
(NASA-TM-78603; A-7889) Avail: NTIS HC A05/MF A01 CSCL 01A

The thickness of the upper surface of 64 airfoils was increased from the leading edge to the position of maximum thickness. The modifications were generated using a numerical optimization routine coupled with an aerodynamic analysis code. The type of modification presented can be used for aircraft design or for the retrofit of current aircraft to improve the stall characteristics and climb performance. The coordinates of the modified airfoils are presented with plots of the forward 45% of the profiles and pressure distributions for both the modified and unmodified sections at an angle of attack of 14 degrees. K.L.

N79-30145*# Bihrle Applied Research, Inc., Jericho, N. Y.
ROTARY BALANCE DATA FOR A TYPICAL SINGLE-ENGINE GENERAL AVIATION DESIGN FOR AN ANGLE-OF-ATTACK RANGE OF 8 DEG TO 90 DEG. 1: HIGH-WING MODEL B
William Bihrle, Jr. and Randy S. Hultberg Sep. 1979 497 p refs
(Contract NAS1-14849)
(NASA-CR-3097) Avail: NTIS HC A21/MF A01 CSCL 01A

Aerodynamic characteristics obtained in a rotational flow environment utilizing a rotary balance located in a spin tunnel are presented in plotted form for a 1/6.5 scale, single engine, high wing, general aviation airplane model. The configurations tested included the basic airplane, various wing leading-edge devices, tail designs, and rudder control settings as well as airplane components. Data are presented without analysis for an angle of attack range of 8 deg to 90 deg and clockwise and counter-clockwise rotations covering an omega b/2V range from 0 to 0.85. Author

N79-30147*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
FLOW VISUALIZATION STUDIES OF A GENERAL RESEARCH FIGHTER MODEL EMPLOYING A STRAKE-WING CONCEPT AT SUBSONIC SPEEDS

James M. Luckring Aug. 1979 93 p
(NASA-TM-80057; L-12673) Avail: NTIS HC A05/MF A01 CSCL 01A

A systematic wind tunnel study was conducted in the Langley high-speed 7 by 10 foot tunnel to document, by oil-flow photographs, the surface flow patterns for configurations incorporating strake-wing geometries indicative of current and proposed maneuvering aircraft. The configurations employed combinations of strakes with reflexed planforms having exposed spans of 10 percent, 20 percent, and 30 percent of the reference wing span and wings with trapezoidal planforms having leading-edge sweep angles of approximately 30 deg, 44 deg, and 60 deg. Tests were conducted at Mach numbers of 0.3 and 0.5 and at angles of attack ranging from approximately 5 deg to 30 deg in 5 deg increments at 0 deg sideslip. The configurations incorporating the strake-wing geometries exhibited more organized flow patterns with smaller asymmetries to higher angles of attack than the corresponding configurations incorporating the wing-alone geometries did. Author

N79-30148# Northrop Corp., Hawthorne, Calif. Aircraft Group.

ANALYSIS OF WIND TUNNEL DATA PERTAINING TO HIGH ANGLE OF ATTACK AERODYNAMICS. VOLUME 1: TECHNICAL DISCUSSION AND ANALYSIS OF RESULTS Progress Report, Jun. 1977 - Apr. 1978

Jack W. Headley Jul. 1978 180 p 2 Vol.
(Contract F33615-77-C-3062; AF Proj. 2404)
(AD-A069646; NOR-78-69-Vol-1; AFFDL-TR-78-94-Vol-1)
Avail: NTIS HC A09/MF A01 CSCL 20/4

This report provides a technical discussion and analysis of wind tunnel data obtained from tests conducted on a family of Northrop fighter aircraft. These tests were performed mainly in the Northrop Low Speed Wind Tunnel, and cover the time period between 1966 and 1976. This report concentrates on data in the stall post-stall region, and for convenience is provided in two sections. This volume presents the results of the analysis of wind tunnel data which concentrates on the high angle of attack regime, and on three major aircraft components. These components are the nose and forebody, the wing leading edge extension, and the vertical tail. The effects of geometric changes in these components on the aircrafts' high angle of attack aerodynamics are analysed. Wherever possible design guidelines which identify the sensitivity of aerodynamic characteristics to geometric parameter variations are presented. Geometric changes or effects which were configuration dependent are also discussed. The second volume, Volume 2: 'Data base,' contains summaries of the wind tunnel tests which were selected to provide data for the analysis. GRA

N79-30149# Northrop Corp., Hawthorne, Calif. Aircraft Group.

ANALYSIS OF WIND TUNNEL DATA PERTAINING TO HIGH ANGLE OF ATTACK AERODYNAMICS. VOLUME 2: DATA BASE Progress Report, Jun. 1977 - Apr. 1978

Jack W. Headley Jul. 1978 571 p refs 2 Vol.
(Contract F33615-77-C-3062; AF Proj. 2404)
(AD-A069647; NOR-78-69-Vol-2; AFFDL-TR-78-94-Vol-2)
Avail: NTIS HC A24/MF A01 CSCL 20/4

This volume presents, in summary form, the geometric and aerodynamic data used as a basis for the design guidelines presented in Volume 1. The summaries have been divided into eight sections, the first seven being the low speed tests, which include almost all the configuration development studies and most of the high AOA testing. Data summaries for the transonic and supersonic testing form the eighth and last section. Because of the considerable quantity of data available from all the testing (some test reports containing as much as thirteen volumes), it is not practical to include the summaries in all the basic aerodynamic data available. In general, only the main aerodynamic effects are presented or summarized, and for more detailed information on a particular configuration, reference should be made to the actual wind tunnel report. All the data summaries are presented in a similar way, and include the following information: a data sheet including the test report title, a summary of the report, and the test conditions; a general three view of a representative test model configuration; detailed sketches of the pertinent configurations changes; and the relevant aerodynamic data. GRA

N79-30151# Naval Ship Research and Development Center, Bethesda, Md. Aviation and Surface Effects Dept.

A FLOW FIELD STUDY FOR TOP MOUNTED INLETS ON FIGHTER AIRCRAFT CONFIGURATIONS Final Report, Oct. 1977 - Sep. 1978

Steven W. Prince Jan. 1979 61 p refs
(F41421000)
(AD-A069732; DTNSRDC/ASED-79/03) Avail: NTIS HC A04/MF A01 CSCL 20/4

A flow visualization study was conducted for top mounted inlets on fighter aircraft. A generic fighter model was tested at low speed in a wind tunnel with a tuft grid mounted on the upper fuselage. Tuft patterns were photographed in four longitudinal positions from 0 to 39 deg angle of attack and from 0 to 30 deg sideslip. Various configurations were tested with a high or low delta wing, two leading edge extensions and two canards. The results indicate that the downwash from leading edge extensions or canards can produce fairly smooth and straight flow to high angles of attack and moderate angles of sideslip for an inlet mounted on the upper fuselage surface. GRA

N79-30161# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Aerodynamik.

THEORETICAL ESTIMATION OF NONLINEAR LONGITUDINAL CHARACTERISTICS OF WINGS WITH SMALL AND MODERATE ASPECT RATIO BY THE VORTEX-LATTICE METHOD IN INCOMPRESSIBLE FLOW

Wolfgang Schroeder Sep. 1978 82 p refs In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-585)
(DLR-FB-78-26) Avail: NTIS HC A05/MF A01; DFVLR, Cologne DM 31,80

A nonlinear vortex-lattice method is described applying a force-free condition to the vortex sheet giving the trailing, side- and leading edges, respectively. In extensive test runs various influences on the numerical stability of the iterative rolling-up process were studied such as the force-free condition of the wake, the number of horseshoe vortices, the panel distribution along span and chord, the representation of the wakes by chains of straight vortex elements of different length and number, and the introduction of an artificial friction parameter. Because of numerical difficulties the slender delta wing itself could not be treated completely. These numerical difficulties resulting from the singular behavior of line vortices are described and ways of overcoming them are suggested. Author (ESA)

N79-30162# National Technical Information Service, Springfield, Va.

LIGHTER THAN AIR VEHICLES. CITATIONS FROM THE NTIS DATA BASE Progress Report, 1964 - Mar. 1979

Guy E. Habercom, Jr. May 1979 256 p Supersedes NTIS/PS-78/0409; NTIS/PS-77/0374
(NTIS/PS-79/0471/7; NTIS/PS-78/0409; NTIS/PS-77/0374)
Avail: NTIS HC $28.00/MF $28.00 CSCL 01C

Designs and applications of balloons, dirigibles, and airships are investigated in this Government sponsored research. Passenger or cargo transport, timbering, tethering, and fabric selection are discussed. Meteorological balloons are excluded. This updated bibliography contains 250 abstracts, 16 of which are new entries to the previous edition. GRA

N79-30163# National Technical Information Service, Springfield, Va.

LIGHTER THAN AIR VEHICLES. CITATIONS FROM THE ENGINEERING INDEX DATA BASE Progress Report, 1970 - Apr. 1979

Guy E. Habercom, Jr. May 1979 88 p Supersedes NTIS/PS-78/0410; NTIS/PS-77/0375
(NTIS/PS-79/0472/5; NTIS/PS-78/0410; NTIS/PS-77/0375)
Avail: NTIS HC $28.00/MF $28.00 CSCL 01C

Design and applications of balloons, dirigibles, and airships are investigated. Passenger or cargo transport, timbering, tethering, and fabric selection are discussed. Meteorological balloons are excluded. This updated bibliography contains 82 abstracts, 8 of which are new entries to the previous edition. GRA

N79-30164 Fordham Univ., New York, N. Y.
FINANCING THE CAPITAL REQUIREMENTS OF THE US AIRLINE INDUSTRY IN THE 1980'S Ph.D. Thesis
Robert William Mandell 1979 245 p
Avail: Univ. Microfilms Order No. 7918290
The study presented estimated capital requirements from the close of this decade to the close of the maximum fleet replacement cycle in 1994, under alternative assumptions. It also forecasted internally generated funds and reasonable amounts of additional debt which can be summoned to meet those needs. It was concluded that in order for the industry to approach meeting the projected levels of demand for air travel, the following measures are imminently required: (1) liberalization of the investment tax credit with respect to the purchase of new aircraft; (2) swift deregulation of the industry; and (3) permit mergers between airlines with complementary route structures.
Dissert. Abstr.

N79-30165*# Lightning Technologies, Inc., Pittsfield, Mass.
THE FEASIBILITY OF INFLIGHT MEASUREMENT OF LIGHTNING STRIKE PARAMETERS
K. E. Crouch and J. A. Plumer Oct. 1978 91 p refs
(Contract NAS1-15216)
(NASA-CR-158981) Avail: NTIS HC A05/MF A01 CSCL 01C
The appearance of nonmetallic structural materials and microelectronics in aircraft design has resulted in a need for better knowledge of hazardous environments such as lightning and the effects these environments have on the aircraft. This feasibility study was performed to determine the lightning parameters in the greatest need of clarification and the performance requirements of equipment necessary to sense and record these parameters on an instrumented flight research aircraft. It was found that electric field rate of change, lightning currents, and induced voltages in aircraft wiring are the parameters of greatest importance. Flat-plate electric field sensors and resistive current shunts are proposed for electric field and current sensors, to provide direct measurements of these parameters. Six bit analog-to-digital signal conversion at a 5 nanosecond sampling rate, short-term storage of 85000 bits and long term storage of 5 x 10 to the 7th power bits of electric field, current and induced voltage data on the airplane are proposed, with readout and further analysis to be accomplished on the ground. A NASA F-106B was found to be suitable for use as the research aircraft because it has a minimum number of possible lightning attachment points, space for the necessary instrumentation, and appears to meet operational requirements. Safety considerations are also presented. F.O.S.

N79-30167# National Transportation Safety Board, Washington, D. C. Bureau of Technology.
SPECIAL INVESTIGATION REPORT: WING FAILURE OF BOEING 747-131 NEAR MADRID, SPAIN, 9 MAY 1976
6 Oct. 1978 41 p refs
(NTSB-AAR-78-12) Avail: NTIS HC A03/MF A01
On May 9, 1976, an Imperial Iranian Air Force Boeing 747-131 crashed as it approached Madrid, Spain. Witnesses observed lightning strike the aircraft followed by fire, explosion, and separation of the left wing. The report includes fire pattern studies, structural failure descriptions, trajectory analysis, fuel flammability calculations, gust loading analysis, and an analytical treatment of several hypotheses. G.Y.

N79-30168 Committee on Commerce, Science, and Transportation (U. S. Senate).
INTERNATIONAL AIR TRANSPORTATION COMPETITION ACT OF 1978
Washington GPO 1978 285 p refs Hearings on S. 3363 before the Subcomm. on Aviation of the Comm. on Commerce, Sci., and Transportation, 95th Congr., 2d Sess., 22-24 Aug. 1978
(GPO-34-912) Avail: Subcomm. on Aviation.
Testimony was given and arguments were heard to amend the Federal Aviation Act of 1958 in order to promote competition in International Air Transportation, provide greater opportunities for United States air carriers, create a structure and establish goals for developing United States International Aviation negotiating policy, and for other purposes. M.M.M.

N79-30169# Technology/Scientific Services, Inc., Dayton, Ohio.
ATMOSPHERIC ELECTRICITY HAZARD (AEH) Final Report, 11 Jul. - 30 Sep. 1978
Arturo V. Serrano Dec. 1978 168 p refs
(Contract F33601-78-D-0042; AF Proj. 2202)
(AD-A069338; T/SSI-0140-01; AFFDL-TR-78-164) Avail: NTIS HC A08/MF A01 CSCL 01/3
A literature survey relating to the survivability of aircraft transparencies and electrical circuits embedded within them was performed. The types of materials used in transparencies and their edge construction were identified, the electrical properties of interest were defined along with test methods in use or available, the availability of electrical properties for the materials of interest was determined, the physiological hazards were documented, and analytical methods for evaluation of transparency systems were identified. As a result of this study it was concluded that the electrical parameters of interest are affected by temperature, frequency and exposure and that data for the materials of interest are not generally available over the ranges of interest for these parameters. It was also concluded that insufficient information is currently available for evaluation of the physiological hazards. Finally, analytical models for evaluation of transparency systems in an electromagnetic environment were found available that could be used to analyze transparency designs. However, these methods need to be computerized and validated. Recommendations are made to eliminate existing data gaps by tests and analyses. GRA

N79-30173*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
RADIO-CONTROLLED MODEL DESIGN AND TESTING TECHNIQUES FOR STALL/SPIN EVALUATION OF GENERAL-AVIATION AIRCRAFT
Sanger M. Burk, Jr. and Calvin F. Wilson, Jr. (Piper Aircraft Corp., Lock Haven, Penn.) 1975 63 p refs Presented at the 1975 SAE Natl. Business Aircraft Meeting, Wichita, Kansas, 8-11 Apr. 1975
(NASA-TM-80510) Avail: NTIS HC A04/MF A01 CSCL 01C
A relatively inexpensive radio-controlled model stall/spin test technique was developed. Operational experiences using the technique are presented. A discussion of model construction techniques, spin-recovery parachute system, data recording system, and movie camera tracking system is included. Also discussed are a method of measuring moments of inertia, scaling of engine thrust, cost and time required to conduct a program, and examples of the results obtained from the flight tests. K.L.

N79-30174 Committee on Armed Services (U. S. House).
ENFORCER AIRCRAFT
Washington GPO 1978 154 p refs Hearing before the Research and Development Subcomm. of the Comm. on Armed Services, 95th Congr., 2d Sess., 22 Jun. 1978
(GPO-32-569; HASC-95-86) Avail: Research and Development Subcomm.
The utility of a privately developed Enforcer-type aircraft as a tank killer in either the battlefield interdiction or close air support is assessed with emphasis on lethality and vulnerability. Characteristics are compared to those of the A-10 aircraft.
A.R.H.

N79-30175*# Foster-Miller Associates, Inc., Waltham, Mass.
HEAVE-PITCH-ROLL ANALYSIS AND TESTING OF AIR CUSHION LANDING SYSTEMS Final Report

A. B. Boghani, K. M. Captain, and D. N. Wormley Feb. 1978 205 p refs
(Contract NAS1-12403)
(NASA-CR-2917) Avail: NTIS HC A10/MF A01 CSCL 01C

The analyical tools (analysis and computer simulation) needed to explain and predict the dynamic operation of air cushion landing systems (ACLS) is described. The following tasks were performed: the development of improved analytical models for the fan and the trunk; formulation of a heave pitch roll analysis for the complete ACLS; development of a general purpose computer simulation to evaluate landing and taxi performance of an ACLS eouipped aircraft; and the verification and refinement of the analysis by comparison with test data obtained through lab testing of a prototype cushion. Demonstration of simulation capabilities through typical landing and taxi simulation of an ACLS aircraft are given. Initial results show that fan dynamics have a major effect on system performance. Comparison with lab test data (zero forward speed) indicates that the analysis can predict most of the key static and dynamic parameters (pressure, deflection, acceleration, etc.) within a margin of a 10 to 25 percent. A.W.H.

N79-30176*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
SIMILITUDE REQUIREMENTS AND SCALING RELATIONSHIPS AS APPLIED TO MODEL TESTING
Chester H. Wolowicz, James S. Brown, Jr., and William P. Gilbert Aug. 1979 64 p refs Prepared jointly with NASA. Langley Res. Center
(NASA-TP-1435; H-1022) Avail: NTIS HC A04/MF A01 CSCL 01C

The similitude requirements for the most general test conditions are presented. These similitude requirements are considered in relation to the scaling relationships, test technique, test conditions (including supersonic flow), and test objectives. Particular emphasis is placed on satisfying the various similitude requirements for incompressible and compressible flow conditions. For free flying models tests, the test velocities for incompressible flow are scaled from Froude number similitude requirements and those for compressible flow are scaled from Mach number similitude requirements. The limitations of various test techniques are indicated, with emphasis on the free flying model. A.W.H.

N79-30177# Army Aviation Engineering Flight Activity, Edwards AFB, Calif.
AH-1G HELICOPTER, 19-ROUND LIGHTWEIGHT AIRBORNE LAUNCHER JETTISON ENVELOPE DETERMINATION Final Report
Gary L. Skinner and Frederick S. Doten Mar. 1979 30 p refs
(AD-A069828; USAAEFA-78-10) Avail: NTIS HC A03/MF A01 CSCL 19/7

The United States Army Aviation Engineering Flight Activity conducted a limited evaluation of a 19-round prototype launcher to determine a safe jettison envelope for the 19-round lightweight airborne rocket launcher. The evaluation was conducted from 25 May 1978 to 6 June 1978 at Edwards Air Force Base, California. Ten flights using an AH-1G helicopter were conducted totaling 3.5 flight hours. This evaluation defined a safe jettison envelope in coordinated (ball-centered) level flight to 120 knots calibrated airspeed (KCAS) and in autorotation at 70 KCAS. Establishment of a jettison envelope equivalent to that of the M159 and M200 launcher will require 75 7-round and 75 19-round lightweight airborne rocket launchers and 744 2.75-inch Model M229 rockets. Five reliability and maintainability launcher shortcomings were identified during the evaluation of the prototype launcher. GRA

N79-30178# Army Aviation Engineering Flight Activity, Edwards AFB, Calif.
AIRWORTHINESS AND FLIGHT CHARACTERISTICS TEST, OV-1C TAKEOFF PERFORMANCE Final Report, 11 Apr. - 19 Jul. 1978
Raymond B. Smith, George M. Yamakawa, John R. Niemann, Joseph C. Watts, and Jerry R. Guin May 1979 33 p
(AD-A069827; USAAEFA-78-07) Avail: NTIS HC A03/MF A01 CSCL 01/2

The United States Army Aviation Engineering Flight Activity conducted takeoff performance tests on an OV-1C aircraft, serial number 67-18918, from 11 April through 19 July 1978. The aircraft was tested at Edwards Air Force Base (field elevation 2273 feet) and South Lake Tahoe, California (field elevation 6262 feet). Twelve flights totaling 6.9 productive flight hours were conducted. Takeoff performance tests were conducted on the OV-1C to substantiate the performance data currently incorporated in the operator's manual. Tests were conducted using two normal takeoff techniques and a minimum run takeoff technique at each of three gross weights. All takeoffs were made from hard, dry, paved level runways. Test results show that the estimated data for normal takeoff is satisfactory but the data for the minimum run technique in the operator's manual is optimistic. GRA

N79-30179# Textron Bell Helicopter, Fort Worth, Tex.
HELICOPTER OBSTACLE STRIKE TOLERANCE CONCEPTS ANALYSIS Final Report, Sep. 1977 - Jun. 1978
Bharat P. Gupta Apr. 1979 183 p refs
(Contract DAAJ02-77-C-0049; DA Proj. 1L2-62209-AH-76)
(AD-A069877; BHT-699-099-096; USARTL-TR-78-46) Avail: NTIS HC A09/MF A01 CSCL 01/3

A large number of obstacle strikes have occurred during Army helicopter combat missions and nap-of-the-earth (NOE) training missions. Obstacle strike tolerance becomes particularly important for NOE flights in areas containing many obstacles, such as western Europe. This report defines the obstacle strike problem, particularly for tree and wire strikes. Only a small percentage of obstacle strikes produce accidents, but these accidents account for a high proportion of helicopter damage costs. Tree strikes are more common than wire strikes, but the wire strikes are more likely to cause accidents. Generally, the main and tail rotors are most commonly struck, but a high proportion of wire strikes also occur on the fuselage. Helicopter obstacle strike tolerance designs for rotors, fuselage, and controls are analyzed and the most promising concepts are selected for both existing and future helicopter systems. In addition, obstacle strike tolerance design criteria are defined. GRA

N79-30180# Sikorsky Aircraft, Stratford, Conn.
HELICOPTER DRIVE SYSTEM R AND M DESIGN GUIDE Final Report
K. R. Cormier Apr. 1979 91 p ref
(Contract DAAJ02-76-C-0047; DA Proj. 1L2-62209-AH-76)
(AD-A069835; SER-50997; USARTL-TR-78-50) Avail: NTIS HC A05/MF A01 CSCL 01/3

This report is a reliability and maintainability design guide for helicopter drive systems. While not containing 'how to' design information, the guide points out those areas of design which can be troublesome in the reliability and maintainability of helicopter drive systems. Besides containing information on the various drive system components, a management section is included that outlines some practices which design managers may employ to insure that reliability and maintainability are given proper emphasis during a design program. The final section is devoted to a step-by-step procedure for hazard function analysis, which may be used to predict the reliability of a gearbox during the design stage. GRA

N79-30181# United Technologies Corp., Stratford, Conn.
HELICOPTER DRIVE SYSTEM R AND M DESIGN GUIDE Final Report
K. R. Cormier and B. Trustee Apr. 1979 138 p refs
(Contract DAAJ02-76-C-0047; DA Proj. 1L2-62209-AH-76)
(AD-A069691; SER-510012; USARTL-TR-78-51) Avail: NTIS HC A07/MF A01 CSCL 01/3

This report covers the investigations conducted during the Helicopter Drive System R and M Design Guide program. The report discusses the present state of transmission reliability and how reliability and maintainability are dealt with during the design and development of a helicopter drive system. Other topics discussed include the effect of quality control on drive system reliability, drive system maintainability problems, diagnostics, and the likely effect of advanced design concepts on the reliability and maintainability of future drive systems. Two different types of reliability prediction techniques, hazard function analysis and probabilistic design, are discussed, and the strengths and weaknesses of each are outlined. Test planning and maintainability analysis are included as separate appendices. GRA

N79-30182# Sandia Labs., Albuquerque, N. Mex.
DRIFTDOWN CALCULATIONS FOR THE FH/227D AIRCRAFT
L. A. Bertram Feb. 1979 79 p refs
(Contract EY-76-C-04-0789)
(SAND-78-1807) Avail: NTIS HC A05/MF A01

Two codes are described: USIM, which simulates FH-227D flights with an enroute engine loss, and UNDRIFT, which locates the maximum takeoff weights satisfying driftdown terrain clearance and landing weight limits as well as falling within the climb capability of the aircraft. These codes are presented in a form suitable for use at a remote terminal using the NOS timesharing system for the Sandia CDC 6600 computer and user instructions and examples are given. Some weaknesses in the FAA-approved driftdown analysis procedure are noted and discussed, but it is the approved procedure which is implemented in the codes. DOE

N79-30183# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Inst. fuer Dynamik der Flugsysteme.
INVESTIGATIONS ON THE DESIGN OF ACTIVE VIBRATION ISOLATION SYSTEMS FOR HELICOPTERS WITH RIGID AND ELASTIC MODELING OF THE FUSELAGE
Gerd Schulz Mar. 1978 72 p refs In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-556)
(DLR-FB-78-04) Avail: NTIS HC A04/MF A01; DFVLR, Cologne DM 25,70

Different methods for the design of controllers for active vibration isolation on helicopters are investigated. Based on the special structure of the controller, compensation for the rotor blade harmonic disturbance vibrations is achieved, guaranteeing good trim behavior during maneuvers. For the first controller design, done for a rigid helicopter fuselage with a modified Riccati design, different sensor configurations are investigated. A possibility for sensitivity reduction for rotor speed variations is shown. For the second controller design for an elastic helicopter fuselage the modified Riccati design, the design by means of Nyquist plots and pole assignment are investigated, especially with respect to the applicability for higher order systems. Author (ESA)

N79-30184# McDonnell Aircraft Co., St. Louis, Mo.
RESEARCH ON VISUAL DISPLAY INTEGRATION FOR ADVANCED FIGHTER AIRCRAFT Final Technical Report, 13 Jul. 1977 - 13 Aug. 1978
George S. Mills, Marshall A. Grayson, Susan L. Loy, and Richard A. Jauer, Jr. Wright-Patterson AFB, Ohio AMRL Nov. 1978 162 p refs
(Contract F33615-77-C-0536; AF Proj. 7184)
(AD-A069605; MDC-A5425; AMRL-TR-78-97) Avail: NTIS HC A08/MF A01 CSCL 01/3

This 'Visual Display Integration' study was conducted to determine the display integration options projected available for inclusion in an attack/fighter aircraft crew station design in the 1985-1990 time. A second objective was the definition of an evaluation framework that would permit evaluation of the selected display options during future related studies. Summarizing the results, it is clearly evident that the CRT, as Option 1, will retain its preeminence as the multifunction display unit for 1985-1990. Option 2 is the flat-panel plasma display, Option 3 is the flat-panel liquid crystal display, and Option 4 is the electroluminescent thin-film-transistor display. It was concluded that man-in-the loop simulations provide the best opportunity for evaluating these display options in future related work. GRA

N79-30185*# Pratt and Whitney Aircraft Group, East Hartford, Conn.
AERODYNAMIC AND ACOUSTIC INVESTIGATION OF INVERTED VELOCITY PROFILE COANNULAR EXHAUST NOZZLE MODELS AND DEVELOPMENT OF AERODYNAMIC AND ACOUSTIC PREDICTION PROCEDURES, COMPREHENSIVE DATA REPORT, VOLUME 1
Richard S. Larson, Douglas P. Nelson, and Bradley S. Stevens Jun. 1979 312 p 2 Vol.
(Contract NAS3-20061)
(NASA-CR-159515; PWA-5550-16-Vol-1) Avail: NTIS HC A14/MF A01 CSCL 21E

The experimental data necessary to establish aerodynamic and acoustic prediction systems for coannular exhaust nozzles with inverted velocity profiles are presented in graphical form. R.E.S.

N79-30186*# Pratt and Whitney Aircraft Group, East Hartford, Conn.
AERODYNAMIC AND ACOUSTIC INVESTIGATION OF INVERTED VELOCITY PROFILE COANNULAR EXHAUST NOZZLE MODELS AND DEVELOPMENT OF AERODYNAMIC AND ACOUSTIC PREDICTION PROCEDURES, COMPREHENSIVE DATA REPORT, VOLUME 2
Richard S. Larson, Douglas P. Nelson, and Bradley S. Stevens Jun. 1979 225 p refs
(Contract NAS3-20061)
(NASA-CR-159516; PWA-5550-17-Vol-2) Avail: NTIS HC A10/MF A01 CSCL 21E

The experimental data necessary to establish aerodynamic and acoustic prediction systems for coannular exhaust nozzles with inverted velocity profiles are presented in tabular form. The acoustic data are corrected to a 'theoretical day' and scaled to full engine size. R.E.S.

N79-30187*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
EFFECT OF STEADY-STATE TEMPERATURE DISTORTION AND COMBINED DISTORTION ON INLET FLOW TO A TURBOFAN ENGINE
Ronald H. Soeder and George A. Bobula Aug. 1979 43 p refs
(NASA-TM-79237; E-143) Avail: NTIS HC A03/MF A01 CSCL 21E

Flow angle, static pressure, total temperature and total pressure were measured in the inlet duct upstream of a turbofan engine operating with temperature distortion or combined pressure-temperature distortion. Such measurements are useful in the evaluation of analytical models of inlet distortion. A rotating gaseous-hydrogen burner and a circumferential 180 degrees-extent screen configuration mounted on a rotatable assembly generated the distortions. Reynolds number index was maintained at 0.5 and engine corrected low-rotor speeds were held at 6000 and 8600 rpm. The measurements showed that at the entrance to the engine, flow angle was largest in the hub region. As flow approached the engine, yaw angle (circumferential variation) increased and pitch angle (radial variation) decreased. The magnitude of static-pressure distortion measured along the inlet-duct and extended bullet nose walls increased exponentially as flow approached the engine. Author

N79-30188*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A SUMMARY OF NASA/AIR FORCE FULL SCALE ENGINE RESEARCH PROGRAMS USING THE F100 ENGINE
W. J. Deskin (Pratt and Whitney Aircraft Group, West Palm Beach, Fla.) and H. G. Hurrell 1979 24 p refs Presented at 15th Joint Propulsion Conf., Las Vegas, Nev., 18-20 Jun. 1979; Sponsored by AIAA, Am. Soc. of Mech. Engr.
(NASA-TM-79267; E-183) Avail: NTIS HC A02/MF A01 CSCL 21E

A full scale engine research (FSER) program conducted with the F100 engine is presented. The program mechanism is described and the F100 test vehicles utilized are illustrated. Technology items were addressed in the areas of swirl augmentation, flutter phenomenon, advanced electronic control logic theory, strain gage technology and distortion sensitivity. The associated test programs are described. The FSER approach utilizes existing state of the art engine hardware to evaluate advanced technology concepts and problem areas. Aerodynamic phenomenon previously not considered by design systems were identified and incorporated into industry design tools. A.W.H.

N79-30189*# Pratt and Whitney Aircraft Group, East Hartford, Conn. Commercial Products Div.
ENERGY EFFICIENT ENGINE FLIGHT PROPULSION SYSTEM PRELIMINARY ANALYSIS AND DESIGN REPORT Progress Report, Mar. 1978 - Feb. 1979
W. B. Gardner Apr. 1979 480 p refs
(Contract NAS3-20646)
(NASA-CR-159487; PWA-5594-49) Avail: NTIS HC A21/MF A01 CSCL 21E

A flight propulsion system preliminary design was established that meets the program goals of at least a 12 percent reduction in thrust specific fuel consumption, at least a five percent reduction in direct operating cost, and one-half the performance deterioration rate of the most efficient current commercial engines. The engine provides a high probability of meeting the 1978 noise rule goal. Smoke and gaseous emissions defined by the EPA proposed standards for engines newly certified after 1 January 1981 are met with the exception of NOx, despite incorporation of all known NOx reduction technology. F.O.S.

N79-30190# Michigan Univ., Ann Arbor. Dept. of Aerospace Engineering.
CRITICAL ASSESSMENT OF EMISSIONS FROM AIRCRAFT PISTON ENGINES Final Report, Jun. 1974 - May 1978
W. Mirsky, J. A. Nicholls, R. Pace, R. Ponsonby, and D. E. Geister Jun. 1979 163 p refs
(Contract DOT-FA74NA-1102)
(AD-A071002; FAA-RD-78-82; FAA-NA-78-166) Avail: NTIS HC A08/MF A01 CSCL 21/7

A comprehensive mathematical analysis for evaluating the measured emissions from piston type general aviation aircraft engines is presented and discussed. The analysis is used to calculate the fuel-air ratio, molecular weight of the exhaust products, and water correction factor. A sensitivity analysis is presented which shows the effects of emission measurement errors on calculated fuel-air ratio. The test facility is briefly described and the associated emissions instrumentation is discussed in detail. The experimental results obtained in this facility on the AVCO-Lycoming LIO-320 engine are presented. This includes baseline and lean-out emissions data and the influence of sampling probe location in the exhaust pipe. The influence of leaks in the exhaust system or emissions console are investigated and evaluated in terms of the mathematical model. A.W.H.

N79-30191*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
PERFORMANCE OF TWO-STAGE FAN WITH A FIRST-STAGE ROTOR REDESIGNED TO ACCOUNT FOR THE PRESENCE OF A PART-SPAN DAMPER
William T. Gorrell and Donald C. Yrasek Sep. 1979 72 p refs
(NASA-TP-1483; E-9786; AVRADCOM-TR-79-10) Avail: NTIS HC A04/MF A01 CSCL 21E

The NASA two-stage fan was tested with a redesigned first-stage rotor. The redesign included a new design approach to account for the presence of a part-span damper. At design speed the fan achieved a peak efficiency of 0.803, which is 1.9 percentage points higher than the original design. The peak efficiencies of the first stage and first rotor were 0.789 and 0.821, respectively. An improvement in efficiency of up to 5 percentage points in the damper region was achieved over the original large damper version. The stall margin, based on flow conditions at peak efficiency, was 10 percent at design speed. Author

N79-30192# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abt. Technische Akustik.
NOISE GENERATION BY JET-ENGINE EXHAUST DEFLECTION
Burkhard Gehlhar, Werner Dobrzynski, and Bernhard Fuhrken Sep. 1978 56 p refs In German; ENGLISH summary Report will be also announced as translation (ESA-TT-553)
(DLR-FB-78-21) Avail: NTIS HC A04/MF A01; DFVLR, Cologne DM 23,30

Noise radiation by jet-engine exhaust-flow-interaction with blast deflectors was investigated by means of model-experiments of scale 0.1; the investigations pertained to a specific deflector configuration. Noise spectra and directivity characteristics for various power-settings and configuration changes were determined and used for the prediction of noise generation by full-scale configuration. The investigation shows that the particular deflected gives rise to higher noise levels than those of the corresponding engine noise alone, when the distance between exhaust nozzle and deflector is loss than 10 nozzle-diameters. Author (ESA)

N79-30193*# Massachusetts Inst. of Tech., Cambridge. Lab. for Information and Decision Systems.
VTOL CONTROLS FOR SHIPBOARD LANDING M.S. Thesis
Christopher Graham McMuldroch Aug. 1979 198 p refs
(Contract NGL-22-009-124)
(NASA-CR-162140; LIDS-TH-928) Avail: NTIS HC A09/MF A01 CSCL 01C

The problem of landing a VTOL aircraft on a small ship in rough seas using an automatic controller is examined. The controller design uses the linear quadratic Gaussian results of modern control theory. Linear time invariant dynamic models are developed for the aircraft, ship, and wave motions. A hover controller commands the aircraft to track position and orientation of the ship deck using only low levels of control power. Commands for this task are generated by the solution of the steady state linear quadratic gaussian regulator problem. Analytical performance and control requirement tradeoffs are obtained. A landing controller commands the aircraft from stationary hover along a smooth, low control effort trajectory, to a touchdown on a predicted crest of ship motion. The design problem is formulated and solved as an approximate finite-time linear quadratic stochastic regulator. Performance and control results are found by Monte Carlo simulations. K.L.

N79-30194*# Scientific Systems, Inc., Cambridge, Mass.
A STUDY OF THE APPLICATION OF SINGULAR PERTURBATION THEORY Final Report
Raman K. Mehra, Robert B. Washburn, Salim Sajan, and James V. Carroll Aug. 1979 339 p refs
(Contract NAS1-15113)
(NASA-CR-3167) Avail: NTIS HC A15/MF A01 CSCL 01C

A hierarchical real time algorithm for optimal three dimensional control of aircraft is described. Systematic methods are developed for real time computation of nonlinear feedback controls by means of singular perturbation theory. The results are applied to a six state, three control variable, point mass model of an F-4 aircraft. Nonlinear feedback laws are presented for computing the optimal control of throttle, bank angle, and angle of attack. Real Time capability is assessed on a TI 9900 microcomputer. The breakdown of the singular perturbation approximation near the terminal point is examined Continuation methods are examined to obtain exact optimal trajectories starting from the singular perturbation solutions. A.W.H.

N79-30195# Rockwell International Corp., Columbus, Ohio. Aircraft Div.
FLUIDICS: FEASIBILITY STUDY ELECTRO/HYDRAULIC/ FLUIDIC DIRECT DRIVE SERVO VALVE Final Report, 11 Apr. - 29 Dec. 1978
Louis P. Biafore and Bernie Holland Washington NASC Mar. 1979 74 p refs
(Contract N62269-78-C-0176; WF41400000)
(AD-A069798; NR78H-126; NADC-78-033-60) Avail: NTIS HC A04/MF A01 CSCL 13/7

The feasibility of providing a fluidic back-up control for the Navy's Advanced flight control actuation system (AFCAS) was investigated and potential design concepts were evaluated. A prelim. spec. for an electro/hydraulic/fluidic direct drive servo valve was proposed. Technical data and supplier hardware was reviewed. A design concept for an electro/hydraulic/fluidic servo control valve was selected and a prelim. design drawing was prepared. The study confirms the feasibility of providing a fluidic back-up for the AFCAS direct drive servo valve. GRA

N79-30196# Boeing Vertol Co., Philadelphia, Pa.
EVALUATION OF PYLON FOCUSING FOR REDUCED HELICOPTER VIBRATION Final Report, Aug. 1977 - May 1978
R. Gabel and D. Reed Apr. 1979 96 p refs
(Contract DAAJ02-77-C-0034; DA Proj. 1L2-62209-AH-76)
(AD-A069712; D210-11390-1; USARTL-TR-79-6) Avail: NTIS HC A05/MF A01 CSCL 01/3

A wind tunnel model test program was conducted to investigate the effectiveness of a focused isolation system in reducing the transmission of rotor-induced vibratory loads for a four-bladed hingeless rotor. The model consisted of a four-bladed hingeless rotor and a simulated transmission mounted on a focal isolation system having pitch and roll degrees of freedom. Analytical considerations indicate that there is no single focus which will simultaneously isolate both hub moments and inplane loads. For the four-bladed hingeless rotor with large vibratory hub moments, the optimum focus lies close to the combined rotor/transmission center of gravity. Model test results indicated two configurations with reasonable moment isolation. One was an upward focus near the combined rotor/transmission center of gravity. The second, which had an effective downward focus, produced high lateral and longitudinal loads. GRA

N79-30197# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Inst. fuer Dynamik der Flugsysteme.
AN IN-FLIGHT CONTROLLER INSENSITIVE TO PARAMETERS VARIATION
Gerhard Kreisselmeier and Reinhold Steinhauser May 1978 80 p refs In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-565)
(DLR-FB-78-07) Avail: NTIS HC A05/MF A01; DFVLR, Cologne DM 30,30

A design method, based on a systematic approach to aircraft attitude control parameters, was developed and tried on the design of a pitch controller for the Do28D Skyservant aircraft. The method takes into consideration the entire range of in-flight requirements posed by the guidance characteristics of the aircraft, including appropriate response (damping) to air turbulence. The controller is independent of radical changes in flight conditions and thus responds to the special problem of low speed elevator control as a harmonic progression of the elevator deflection angle. The influence of an onboard computer on flight behavior is examined and flight test results are compared with computer simulation results. Author (ESA)

N79-30198# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
THE GUIDANCE AND CONTROL OF HELICOPTERS AND V/STOL AIRCRAFT AT NIGHT AND IN POOR VISIBILITY
May 1979 237 p refs Partly in ENGLISH and FRENCH Papers presented at the Guidance and Control Panel Symp., The Hague, 9-12 Oct. 1978
(AGARD-CP-258; ISBN-92-835-0238-8) Avail: NTIS HC A11/MF A01

The following topics are discussed: (1) operational requirements; (2) controls and displays; (3) forward looking sensors; (4) man/machine aspects; (5) landing operations and systems; and (6) system implementation.

N79-30199# Army Training and Doctrine Command, Fort Monroe, Va.
ADDING THE CHALLENGE OF NAP-OF-THE-EARTH
Joseph C. Tirre *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 5 p
Avail: NTIS HC A11/MF A01

In an attempt to defy the law of physics as it pertains to having two or more bodies occupy the same space at the same time, NAP-of-the Earth (NOE) was developed. The problems of night, weather, and NOE flying discussed include: (1) navigation; (2) communication; (3) aircraft control; (4) wire detection; and (5) target acquisition/engagement. S.E.S.

N79-30200# Smiths Industries Ltd., Cheltenham (England).
THE DEVELOPMENT AND IN-FLIGHT EVALUATION OF A TRIPLEX DIGITAL AUTOSTABILIZATION SYSTEM FOR A HELICOPTER
J. Meadows and P. Robinson (RAE, Farnborough, Engl.) *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 22 p refs

Avail: NTIS HC A11/MF A01

The program and the triplex autostabilization system and its installation in the aircraft were reviewed. The final stages of development, with particular emphasis on the major contribution afforded by a comprehensive systems rig, both to the hardware and software development program are discussed. The results of in-flight evaluation program including performance under fault-free and simulated runaway conditions. A number of problem areas encountered during the initial phases of the flight trials and means to overcome these are presented. S.E.S.

N79-30201# Marconi-Elliott Avionic Systems Ltd., Rochester (England).
SOME ASPECTS OF THE DESIGN AND DEVELOPMENT OF THE MARITIME AUTOPILOT MODES FOR THE WESTLAND LYNX HELICOPTER
K. S. Snelling and M. V. Cook (Cranfield Inst. of Technol.) *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 18 p refs

Avail: NTIS HC A11/MF A01

The stability augmentation system and the transistion autopilot mode were reviewed. The requirement for Sea State filtering of the height control signal is discussed. The design and development of the Cable Angle and Cable Height hold autopilot modes that together provide sonar modes for stabilizing the position of a dunking sonar. S.E.S.

N79-30202*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
DESIGN AND TESTING OF A REDUNDANT SKEWED INERTIAL SENSOR COMPLEX FOR INTEGRATED NAVIGATION AND FLIGHT CONTROL
R. E. Ebner (Litton Systems, Inc., Woodland Hills, Calif.) and W. E. Howell *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 13 p refs
Avail: NTIS HC A11/MF A01 CSCL 01C

Requirements for a redundant strapdown inertial sensor complex applied to V/STOL aircraft as developed by NASA are presented. Flight test data of a redundant, skewed axis strapdown inertial system are given, demonstrating the feasibility of the primary design aspects. This data consisted of parity equation responses through various flight conditions, showing residual noise levels on redundant gyro and accelerometer comparisons as a measure of minimum failure-level detectability, plus failure isolation and navigation performance through several simulated instrument failures. S.E.S.

N79-30203# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
SCAN CONVERTER AND RASTER DISPLAY CONTROLLER FOR NIGHT VISION DISPLAY SYSTEMS
H. W. Killian and W. Voswinckel *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 10 p

Avail: NTIS HC A11/MF A01

A modular Raster Display System and its functional modules are described. Digital scan conversion of images of electro-optical sensors and digital storage of images with several gray tones are allowed. With the help of the digital symbol generator digital information is converted into adequate symbology which again can be superimposed on the sensor image. Superposition of two sensor images is performed with the same equipment. Some technical features are discussed which exceed the common modes of current display systems and may help to support missions of military helicopters flying low level at poor visibility conditions. S.E.S.

N79-30204# Army Avionics Research and Development Activity, Fort Monmouth, N. J.
APPLICATIONS OF PATTERN RECOGNITION SYSTEMS FOR DAY/NIGHT PRECISION AIRCRAFT CONTROL
Alfred Kleider *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 7 p refs
Avail: NTIS HC A11/MF A01

The philosophical and practical foundations for the utilization of advanced technological developments in lasers and Charge Coupled Devices (CCD) to provide light weight, low cost solutions to theise problems in day/night operations are explored. The special case of weather limited visibility is presented and projected operational parameters are discussed relative to near term availability of infrared devices (IRCCD). The concept of feature extraction is explored using the complimentary one dimensional characteristics of wire/wire-like obstacles and a 1728 linear CCD Array as the foundation of the Wire Obstacle Warning System (WOWS) presently in development. In this instance the appropriate geometrical, optical, and electronic capatibilities were combined to provide a real time automatic pattern recognition system for Nap-of-the-Earth (NOE) helicopter operations. S.E.S.

N79-30205# Army Avionics Research and Development Activity, Fort Monmouth, N. J.
HETERODYNING CO2 LASER RADAR FOR AIRBORNE APPLICATIONS
R. L. DelBoca and R. J. Mongeon (United Technol. Res. Center) *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 17 p refs

Avail: NTIS HC A11/MF A01

The design considerations, hardware configuration, and test results of flyable breadboard models are discussed which have demonstrated the feasibility of employing CO2 scanning laser systems for wire detection, precision hover, Doppler navigation, and terrain following. S.E.S.

N79-30206# Standard Elektrik Lorenz A.G., Stuttgart (West Germany).
A SELF CONTAINED COLLISION AVOIDANCE SYSTEM FOR HELICOPTERS
S. Bloch, G. Hoefgen, and D. zurHeiden *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 6 p refs

Avail: NTIS HC A11/MF A01

A proposed solution to the problem of obstacle detection and collision warning pertaining to the operation of helicopters at low altitude and within a formation is described. A simple yet effective algorithm is used in order to assess the collision hazard posed by stationary obstacles as well as other helicopters in the proximity of the protected aircraft. The raw data needed (range and closing speed) is provided by a 35 GHz versatile low-cost FM/CW-radar that was originally developed for the protection of road vehicles. With the exception of the antenna assembly only minor modifications are needed in order to make this radar fit the requirements of an airborne anti-collision system. Author

N79-30207# Ferranti Ltd., Edinburgh (Scotland). Radar Group.
A HELICOPTER HIGH DEFINITION ROTOR BLADE RADAR
C. M. Steward *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 10 p ref

Avail: NTIS HC A11/MF A01

By installing a radar aerial within the rotor blade, a sensor having unique capabilities for the operation of helicopters in darkness or bad weather can be provided. A description of such a system is given outlining the factors affecting the choice of the principal radar parameters and their interaction with the helicopter rotor design. Examples of the high definition pictures from the display are shown with the appropriate section of map for comparison and some suggestions are made on operational roles where such a radar system would have particular advantages. Author

N79-30208# Naval Air Development Center, Warminster, Pa.
DESIGN PROCEDURE FOR AIRCREW STATION LABELING SELECTION AND ABBREVIATION
Patrick M. Curran and Norman E. Lane *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 16 p refs

Avail: NTIS HC A11/MF A01

Methods are described of preparing the functional statements of what, where, when, and how the operator should act upon gathering information on a characteristic of a system/subsystem or component. The usage of common labeling of associated controls and displays is presented as well as specific procedures for abbreviating display/control labels. M.M.M.

N79-30209# Royal Aircraft Establishment, Farnborough (England). Flight Systems Dept.
SUBJECTIVE ASSESSMENT OF A HELICOPTER APPROACH SYSTEM FOR IFR CONDITIONS
H. Howells *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 7 p refs
Avail: NTIS HC A11/MF A01

The contribution of subjective assessment techniques used in the flight evaluation of 3 azimuth approach guidance laws presented on crosspointers of electromechanical instruments in a fully stabilized helicopter is outlined. The pilots were instructed to confine their attention to monitoring the instruments within the cockpit as a safety pilot was carried. The use of subjective assessment techniques, in conjunction with the interpretation of radar plots and comments of an airborne trials observer, provide a type of information not obtainable from other sources. The technique, although used here on electromechanical instruments, would be equally applicable to an assessment of electro-optical displays. M.M.M.

N79-30210# Army Avionics Research and Development Activity, Fort Monmouth, N. J.
THE IMPACT OF A MULTI-FUNCTION PROGRAMMABLE CONTROL DISPLAY UNIT IN AFFECTING A REDUCTION OF PILOT WORKLOAD
Bernard S. Gurman *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 8 p refs

Avail: NTIS HC A11/MF A01

Three digitally-addressed Multi-Legend Display Switches (MLD/S) which employ different mechanizations, and the incorporating of these MLD/S's in a multi-purpose, programmable Control Display Unit (CDU) are described. Several programs are cited which logically led to the development of the Multi-Legend Display Switches and the CDU. These programs and that possible applications are presented. Developments that lead to the reduction of pilot workload and improve overall pilot/vehicle performance are pointed out. M.M.M.

N79-30211# GIE ISPENA, Paris (France).
THE EQUIPMENT-SYSTEM INTERFACE IN AN ANTITANK HELICOPTER AT NIGHT [ETUDE D'INTERFACE EQUIPAGE SYSTEME DANS UN HELICOPTERE ANTI-CHAR DE NUIT]
G. Ferlet and J. L. Mascle *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 10 p In FRENCH

Avail: NTIS HC A11/MF A01

A direct consequence of the growing complexity of modern aircraft missions is the increase of equipment workloads, which can reach a critical level in many cases. It is important to consider this problem from the beginning of the aircraft definition stage so that some really integrated solutions which guarantee maximum operational efficiency can be proposed for the equipment-system interface. Such a step requires the adoption of a rigorous, systematic work method that is capable of accounting for diverse data such as technological constraints or operational requirements, in order to obtain optimal solutions. A methodology used in the study of the equipment-system interface for an antitank helicopter capable of performing its mission by day as well as by night is presented. The technique distinguishes five stages in the iterative process, thus permitting progressive improvement in the definition of the interface, as a function of the difficulties considered at different stages. Transl. by A.R.H.

N79-30212# Naval Air Systems Command, Washington, D. C. Advanced Aircraft Development and Systems Objectives Office.
PROJECT NAVTOLAND (NAVY VERTICAL TAKEOFF AND LANDING CAPABILITY DEVELOPMENT)
Thomas S. Momiyama *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 20 p refs

Avail: NTIS HC A11/MF A01

The U.S. Navy's integrated systems approach to improve the helicopter and fixed-wing VSTOL aircraft operational capabilities at sea and in tactical sites is described. The current capability is limited to generally 400 foot ceiling and one mile visibility to 200 foot and 1/2 mile weather minima due to elementary flight control systems or lack of precision approach and landing guidance. Inability to cope with ship motions limits the small air capable ship operations generally to Sea State 3. The NAVTOLAND project goals are zero ceiling and 1/8 mile visibility weather minima and Sea State 5 operation. An integrated development of the aircraft flight control and display systems to provide flying qualities with satisfactory level of pilot workload and the shipboard and tactical site installed guidance systems and visual landing aids to effect precision in touchdown is applied toward improvement of the helicopter and AV-8 HARRIER operations and toward development of all-weather and rough sea operations of all future Navy and Marine Corps VSTOL aircraft. M.M.M.

N79-30213# Bodenseewerk Geraetetechnik G.m.b.H., Ueberlingen (West Germany).
GCU, THE GUIDANCE AND CONTROL UNIT FOR ALL WEATHER APPROACH
Hartmut Boehret *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 11 p refs

Avail: NTIS HC A11/MF A01

The guidance and control unit GCU development by Bodenseewerk and sponsored by the German Ministry of Defense, demonstrated in flight test the improvements of future landing procedures. The short-captured steep approach paths generated by the GCU can be flown manually with the flight director instrument due to the high accuracy of signal processing by means of Kalman filter techniques. The technical equipment is presented and the flight test results are discussed. M.M.M.

N79-30214# McDonnell-Douglas Corp., St. Louis, Mo. Electronics Branch.
SIMULATION AND STUDY OF V/STOL LANDING AIDS FOR USMC AV-8 AIRCRAFT
W. E. Bode, R. A. Kendrick, and E. J. Kane *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 16 p

Avail: NTIS HC A11/MF A01

Motion base simulations, flown by USMC Harrier pilots, in which 600 low speed IFR approaches to a forward site and ship were made. Glideslope angles from 3 degrees to 9 degrees were simulated and flown both head up and head down. An attitude hold autopilot was evaluated and flight director steering was studied. The effects of crosswind, turbulence, sea state and system errors were included in the simulation. Visual landing aids for ships and forward sites were devised and aircraft and ground/ship based equipment selected. At the heart of the study was the evaluation by the pilots of the degree of improvement offered by the simulated landing aids. M.M.M.

N79-30215# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
IMPLEMENTATION OF FLIGHT CONTROL IN AN INTEGRATED GUIDANCE AND CONTROL SYSTEM
H. J. Bangen, W. Hoffmann, and W. Metzdorff *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 11 p refs

Avail: NTIS HC A11/MF A01

The hardware and software technology is presented as it is required to solve the control problem in the integrated helicopter guidance and control system. M.M.M.

N79-30216# Societe de Fabrication d'Instruments de Mesure SFIM, Massy (France).
STABILIZING ELECTRO-OPTICAL SYSTEMS ON HELICOPTERS [STABILISATION DES SYSTEMES ELECTRO-OPTIQUES SUR HELICOPTERES]
Dominique dePonteves *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 5 p In FRENCH; ENGLISH summary

Avail: NTIS HC A11/MF A01

The stabilization of both the APX-BEZU M260 gyrostabilized sights used for surveillance and the aiming of antitank missiles, and the APX M397 sight, used with an IR goniometer to aim the HOT missile, is implemented by a mechanical relation between a mirror and a conventional gyro. The development of infrared sensors needing large optical aperture led to the design and implementation of a two-axis, tuned gyro which can be used either as a free gyro or as a rate gyro. Its performance allows the stabilization of the most performing optical sensors with a MTF degradation of not more than 15 percent. Preliminary flight tests were performed on an electro-optical system which combines a TV camera with a very high focal length, a laser range finder, and a twin-focal FLIR in order to determine its feasibility for aiming a weapon aiming system suing 8 to 13 microns band. Transfer functions are discussed. A.R.H.

N79-30217# Rockwell International Corp., Cedar Rapids, Iowa. Collins Government Avionics Div.
AN ADVANCED GUIDANCE AND CONTROL SYSTEM FOR RESCUE HELICOPTERS
Kenneth W. McElreath *In* AGARD The Guidance and Control of Helicopters and V/STOL Aircraft at Night and in Poor Visibility May 1979 17 p
Avail: NTIS HC A11/MF A01

After identifying the tasks in accomplishing a search and rescue mission, Rockwell-Collins established guidelines and priorities for designing and integrating the system elements. The development of the avionics system architecture is reported and the features of each element which contribute to the adverse weather capability of the integrated system are described. M.M.M.

N79-30218# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
STABILITY AND CONTROL
May 1979 359 p refs In ENGLISH and FRENCH Presented at the Flight Mech. Panel Symp. on Stability and Control, Ottawa, 25-28 Sep. 1978
(AGARD-CP-260; ISBN-92-835-0239-6) Avail: NTIS HC A16/MF A01

The fundamental relationship between the use of advanced control concepts and appropriate aircraft design is considered. Experiences in stability and control, the application of active control and the general problems concerning its use, including those of mathematical models, and results obtained with control configured vehicles are discussed. Criteria for satisfactory behavior of aircraft with advanced stability and control systems and the participation of the pilot are included.

N79-30219*# National Aeronautics and Space Administration, Washington, D. C.
SYSTEMS IMPLICATIONS OF ACTIVE CONTROLS
Peter R. Kurzhals *In* AGARD Stability and Control May 1979 16 p refs
Avail: NTIS HC A16/MF A01

Control configured vehicle design and system considerations are outlined and representative applications of active control for fighter and transport aircraft are summarized. Specific examples include relaxed static stability and angle of attack limiting on the F-16, envelope limiting and ride smoothing on the F-8, maneuver load and control and relaxed static stability on the L-1011, load alleviation for the C-5, and B-1 ride control. Principal features, problem areas, and mechanization trends for these and projected future active control applications are outlined. J.M.S.

N79-30220# Lockheed Missiles and Space Co., Sunnyvale, Calif.
A SUMMARY OF AGARD FDP MEETING ON DYNAMIC STABILITY PARAMETERS
L. E. Ericsson *In* AGARD Stability and Control May 1979 23 p refs
Avail: NTIS HC A16/MF A01

Wind tunnel and flight testing techniques, analytical techniques, including motion analysis and nonlinear formulations were covered along with sensitivity and simulator studies to assess the importance of the various dynamic stability parameters, including cross coupling effects between lateral and longitudinal degrees of freedom. The extent to which the practice of decoupling lateral and longitudinal degrees of freedom must be abandoned was addressed. It was decided that when describing the vehicle dynamics of advanced aircraft and aerospace vehicles, which perform sustained operations at high angles of attack, the cross coupling effects are usually significant, and lateral and longitudinal degrees of freedom must be considered together. J.M.S.

N79-30221# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
STRUCTURAL ASPECTS OF ACTIVE CONTROLS
Roger Destuynder *In* AGARD Stability and Control May 1979 12 p refs In FRENCH; ENGLISH summary

Avail: NTIS HC A16/MF A01

Various papers presented at the specialists meeting sponsored by the Structures and Materials Panel in Lisbon (1977) are summarized. Emphasis is placed on the following main points: (1) the use of preliminary simple calculations to cover the different configurations and the possible control laws; (2) improvement with the help of corrections obtained by wind tunnel tests; and (3) proof, through flight test or wind tunnel test, of the validity of the solution. Progress in flutter suppression obtained at ONERA is also reported. A.R.H.

N79-30223# General Dynamics/Fort Worth, Tex.
ENHANCED FIGHTER MISSION EFFECTIVENESS BY USE OF INTEGRATED FLIGHT SYSTEMS
John H. Watson and Willie S. Bennett *In* AGARD Stability and Control May 1979 13 p refs

Avail: NTIS HC A16/MF A01

The performance of the modern fighter aircraft and its flight systems is discussed. Improvement in effectiveness through proper functional integration of the pilot, his crew station, and the flight systems is emphasized. The incorporation of advanced control modes, the integration of avionic systems and the flight control systems, and the unification of all aircraft functions under the control of a flight management system are among the factors considered. J.M.S.

N79-30224# Societe Nationale Industrielle Aerospatiale, Toulouse (France).
RESULTS RELATED TO SIMULATED AND IN-FLIGHT EXPERIMENTATION WITH AN ELECTRIC FLIGHT CONTROL SYSTEM THAT CAN BE GENERALIZED [RESULTATS RELATIFS A L'EXPERIMENTATION SUR SIMULATEUR ET EN VOL D'UN SYSTEME DE COMMANDES DE VOL ELECTRIQUES GENERALISABLES]
A. Cazenave and J. Irvoas *In* AGARD Stability and Control May 1979 21 p In FRENCH

Avail: NTIS HC A16/MF A01

Studies of the performance of a transport aircraft with slender airfoils whose longitudinal stability is assured by the use of elevators show the advantage of moving back the center of gravity in order to improve finesse at low speeds; the optimal centering is located beyond the operationally acceptable rear limit for handling with classical flight controls. An electric flight control system which permits control under conditions of pronounced instability across the control stick was designed, used in a simulator, and then flight tested on the T.S.S. Concorde. The form of the control laws considered is described as well as the improvements made after the simulation. Characteristics and the results obtained in flight are presented and compared to predictions. Transl. by A.R.H.

N79-30225# Northrop Corp., Hawthorne, Calif. Aircraft Corp.
IMPROVEMENT OF FIGHTER AIRCRAFT MANEUVERABILITY THROUGH EMPLOYMENT OF CONTROL CONFIGURED VEHICLE TECHNOLOGY
Janusz Stalony-Dobrzanski and Naren Shah *In* AGARD Stability and Control May 1979 22 p refs

Avail: NTIS HC A16/MF A01

The control configured vehicle (CCV) design concept employing concurrently the traditional disciplines as well as full authority automatic control system design, is shown to offer a very large combat performance improvement over conventional design approach. This improvement is due primarily to the freedom, under CCV concept, of designing statistically longitudinally unstable configurations. The configuration selected for the evaluation is a tailless clipped delta employing advanced structure and engine technologies. The performance gains are achieved simultaneously with decreased aircraft and fuel weight for the same mission. The feasibility of designing a stability and command augmentation (SCAS) for the statically unstable configurations is demonstrated. The full authority SCAS provides excellent flying qualities in general flying and target tracking modes. The departure prevention feature permits true 'head-out-of-cockpit' flying without the pilot having ever to consult flight instruments for safety. The system was evaluated extensively on a moving base simulator. The practical limitations to the degree of static instability are discussed. J.M.S.

N79-30226# Royal Aircraft Establishment, Farnborough (England). Flight Systems Dept.
LATERAL STABILITY AT HIGH ANGLES OF ATTACK, PARTICULARLY WING ROCK
A. Jean Ross *In* AGARD Stability and Control May 1979 19 p refs
Avail: NTIS HC A16/MF A01

The Gnat aircraft exhibits wing rock at high subsonic Mach numbers, but the onset of wing rock is delayed to higher angles of attack if fuel tanks are carried on the wings. Flight responses of Dutch roll and wing rock oscillations in steady turns were analyzed to give the variation of the stability derivatives with angles of attack at various Mach numbers for both aircraft configurations. The results show that the onset of wing rock occurs when the damping of the Dutch roll mode is zero, due mainly to loss in damping-in-roll derivative at high angle of attack. The stability derivatives from flight tests were compared with wind tunnel results, and show the same trends with angle of attack. The values of the linear derivatives were used as a basis for evaluating the effects of various added aerodynamic nonlinearities, both to explore the possible mechanisms for the limit cycle type of wing rock responses, and to calculate the changes in response due to an idealized stability augmentation system. Author

N79-30227# Hochschule der Bundeswehr, Munich. (West Germany).
STALL BEHAVIOUR EVALUATION FROM FLIGHT TEST RESULTS
G. Sachs and H. Wuennenberg (Dornier-Werke G.m.b.H., Friedrichshafen) *In* AGARD Stability and Control May 1979 9 p refs
Avail: NTIS HC A16/MF A01

By comparing the dynamic stall behavior of a combat aircraft with a simulation, a special type of discrepancy in roll was found. The simulation was based on the best wind tunnel data available. The examination leads to the conclusion, that the aircraft is disturbed by random-type 'fluctuation' forces and moments. The order of magnitude was estimated from the scattering region of the wind tunnel data beyond C sub L max. By introducing these effects into the mathematical model it was possible to simulate the pilot in the loop dynamic stall behavior with the aid of a simple mathematical pilot model. For a general application in the design stage of a new project, new wind tunnel test techniques including the measurement of the time dependent parameters will be necessary. Author

N79-30229# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
AIRCRAFT RESPONSE TO WINDSHEARS AND DOWN-DRAUGHTS
J. C. vanderVaart *In* AGARD Stability and Control May 1979 16 p refs
Avail: NTIS HC A16/MF A01

After a short review of current methods of modelling low altitude random atmospheric turbulence and variations of mean wind with altitude (windshears), a description is given of an analytical method to find deterministic wind or turbulence time histories that cause largest deviations of aircraft motion variables. Some numerical examples illustrate that small variations of wind, in particular of horizontal wind, may cause relatively large deviations relative to a desired aircraft trajectory. Finally, it is shown that the problem of finding 'worst case' response to deterministic changes in wind can be reduced to that of the statistics of a random white noise driven linear system. Author

N79-30230# Aeritalia S.p.A., Torino (Italy). Combat Aircraft Group.
GUST ALLEVIATOR FEASIBILITY STUDY FOR G91Y
R. Carabelli *In* AGARD Stability and Control May 1979 12 p ref
Avail: NTIS HC A16/MF A01

A feasibility study was carried out of an active system to alleviate the turbulence effects on a light attack aircraft during the penetration phase of a ground attack mission. The study was tailored to the G91Y and the conclusions were that proceeding through an experimental research by developing a flying prototype would be preferable. The risks implicit in the achievement of the required accuracy in measuring the gust velocity were very high. The proposed system works on two axes. An open loop subsystem driven by the normal component of the gust velocity on the pitch axis and a roll damper on the lateral is indicated as an adequate solution to meet profitable cockpit 'g' reductions and weapon delivery accuracy improvement as well. R.E.S.

N79-30231# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
DESIGN CONSIDERATIONS FOR RELIABLE FBW FLIGHT CONTROL
James K. Ramage and James W. Morris *In* AGARD Stability and Control May 1979 15 p refs

Avail: NTIS HC A16/MF A01

Critical design considerations which both aircraft designers and flight control systems engineers must bear in mind in the design and implementation of fly by wire flight control systems are presented. R.E.S.

N79-30232# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugmechanik.
OPEN/CLOSED LOOP IDENTIFICATION OF STABILITY AND CONTROL CHARACTERISTICS OF COMBAT AIRCRAFT
R. Koehler and M. Marchand *In* AGARD Stability and Control May 1979 11 p
Avail: NTIS HC A16/MF A01

General aspects of assessing flying qualities of augmented aircraft using system identification methods are discussed. The aircraft under test was equipped with a stability augmentation system which had a complex dynamic behavior. The dynamics influenced the flying qualities as well as the applicability of investigation methods. Therefore, the influence and recognizability of the stability augmentation system dynamics on handling quality evaluations and system identifications were inquired and pilot-in-the-loop investigations were made using the system identification results. R.E.S.

N79-30233# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugmechanik.
DYNAMIC WINDTUNNEL SIMULATION OF ACTIVE CONTROL SYSTEMS
P. G. Hamel and B. Krag *In* AGARD Stability and Control May 1979 10 p refs

Avail: NTIS HC A16/MF A01

Research studies were conducted to demonstrate the application potential of dynamic simulation in a wind tunnels test facility. Elastic mode control and ride smoothing systems were scaled to model frequency and tested in a 3 m subsonic gust windtunnel. An open loop active control ride smoothing system was optimized for the Dornier-TNT light transport aircraft experimental program. Dynamic wind tunnel flight tests of this program were successfully completed. R.E.S.

N79-30234# Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany). Military Aircraft Div.
STABILITY AND CONTROL ASPECTS OF THE CCV-F104C
H. Beh, U. Korte, and G. Loebert *In* AGARD Stability and Control May 1979 18 p refs

Avail: NTIS HC A16/MF A01

The control configured vehicle and its implementation, and the design of the control laws are described. The superior flight performance of the control configured vehicle-flight control system is compared with that of the basic F 104G on the basis of simulator results. The validity of these results was demonstrated by comparison of the principal characteristics of longitudinal and lateral motion measured in flight with the corresponding predicted values. R.E.S.

N79-30235# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
DESIGN GUIDANCE FROM FIGHTER CCV FLIGHT EVALUATIONS
Frank R. Swortzel and Jack D. McAllister (Gen. Dyn./Ft. Worth, Tex.) *In* AGARD Stability and Control May 1979 21 p refs

Avail: NTIS HC A16/MF A01

Flight control of the Fighter Control Configuration Vehicle (CCV) marked the first exploitation of six degree-of-freedom flight control concepts for a new way to fly. An 87 flight, 125 flight hour test was conducted on a modified YF-16. Validation of the new control concepts was accomplished and significant capabilities to improve overall mission effectiveness of fighter aircraft were demonstrated. The program also included pilot evaluation of the CCV control modes applied to air-to-air and air-to-ground mission oriented tasks. Resulting control features included direct force control, independent fuselage aiming and translation, maneuver enhancement and gust alleviation. Performance benefits of relaxed static stability were also evaluated. G.Y.

N79-30236# Lockheed-California Co., Burbank.
L-1011 ACTIVE CONTROLS, DESIGN PHILOSOPHY AND EXPERIENCE
David M. Urie *In* AGARD Stability and Control May 1979 9 p refs
Avail: NTIS HC A16/MF A01

Aircraft active control can be defined as control effectors activated by sensors through computers without pilot commands. A certificated commercial transport airplane, the Lockheed L-1011, currently employs several highly sophisticated systems satisfying this definition. The experience gained through development flight testing, commercial flight operation, and flight simulation research on active control applications is presented with the intent of relating design philosophy and results. G.Y.

N79-30237# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Flugmechanik.
IN-FLIGHT HANDLING QUALITIES INVESTIGATION OF VARIOUS LONGITUDINAL SHORT TERM DYNAMICS AND DIRECT LIFT CONTROL COMBINATIONS FOR FLIGHT PATH TRACKING USING DFVLR HFB 320 VARIABLE STABILITY AIRCRAFT
D. Hanke and H.-H. Lange *In* AGARD Stability and Control May 1979 10 p refs

Avail: NTIS HC A16/MF A01

An in-flight investigation of DLC for wide body transport aircraft was carried out using DFVLR 320 variable stability aircraft which incorporates an advanced all digital model following system. The aircraft/DLC configuration parameters was investigated in an altitude compensatory tracking task in which the pilot has to minimize the error between commanded and actual altitude. To determine the influence of motion cues, the tracking task is carried out both on the ground and in-flight. Using the HFB 320 as a fixed base and an in-flight simulator, an ideal situation for comparing the fixed base and in-flight simulation results exists. In addition pilot-in-the-loop analysis for flight path tracking with DLC is performed. The results are given in the form of subjective pilot effort ratings and pilot-aircraft performance measures. The results are further compared with a flight path tracking criterion. G.Y.

N79-30238# British Aerospace Aircraft Group, Warton (England).
FLYING QUALITIES AND THE FLY-BY-WIRE AEROPLANE
J. C. Gibson *In* AGARD Stability and Control May 1979 8 p refs
Avail: NTIS HC A16/MF A01

The tornado flight control system was designed to give good stability, damping, and resistance to external disturbances. This was achieved by optimization of feedback gains and filters. Response to pilot inputs was then shaped by stick commands gains and filters. This process resulted in generally excellent flying qualities. Pilots reported a high level of confidence inspired by the easy and precise control with extremely good circuit handling and instrument flight characteristics. However, some deficiencies were noted associated in some cases with nonaircraft-like responses and these were eliminated by modifications to the command shaping. This experience emphasized that a specification which ensures entirely satisfactory flying qualities does not exist. Several areas where requirements are deficient or absent are illustrated. G.Y.

N79-30239# Naval Air Systems Command, Washington, D. C.
ARE TODAY'S SPECIFICATIONS APPROPRIATE FOR TOMORROW'S AIRPLANES?
R. C. AHarrah, W. J. Lamanna (McDonnell Aircraft Co., St. Louis, Mo.), and J. Hodgkinson *In* AGARD Stability and Control May 1979 12 p refs

Avail: NTIS HC A16/MF A01

An approach for taking any system of a higher order that is addressed in the current specifications, and producing an equivalent system of an appropriate order, which is directly relatable to the specification parameters is presented. Example applications of the equivalent systems approach to various higher order systems are presented; the insights of this approach to the newest fighter aircraft design are discussed; and very preliminary results are presented on a flight program which investigates equivalent systems. G.Y.

N79-30240# National Aerospace Lab., Amsterdam (Netherlands).
A SIMULATOR INVESTIGATION OF HANDLING QUALITY CRITERIA FOR CCV TRANSPORT AIRCRAFT
H. A. Mooij, W. P. deBoer, and M. F. C. vanGool *In* AGARD Stability and Control May 1979 14 p refs Sponsored in cooperation with Netherlands Agency for Aerospace Programs and Dept. of Civil Aviation of the Netherlands

Avail: NTIS HC A16/MF A01

The introduction of CCV (Control Configured Vehicle) concepts in the design of certain categories of future transport aircraft requires definition of handling quality criteria for such aircraft. These criteria should be applicable to guidance in flight control system design as well as in airworthiness certification. In an attempt to contribute new insight in this matter, approach and landing flight simulation investigations were performed using a moving base flight simulator. The conceptual aircraft was a jet transport aircraft developed around the relaxed static stability concept and equipped with a primary flight control system of the rate-command/attitude-hold type for pitch and roll control. Based on measured pilot/aircraft performance, pilot ratings and pilot commentary, boundary values for satisfactory handling qualities for the parameters investigated were established. G.Y.

N79-30242# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
ONERA'S MODEL OF THE PILOT IN DISCRETE TIME [LE MODELE DE PILOTE EN TEMPS DISCRET DE L'ONERA]
Daniel Cavalli *In* AGARD Stability and Control May 1979 11 p refs In FRENCH

Avail: NTIS HC A16/MF A01

Numerical simulation of pilot performance provides a tool for evaluating the efficiency of pilot-aircraft systems and permits the study of the handling quality of new aircraft from the concept stage. Pilot performance is considered as a discreet time process in which decision making has a sequential character. The development of the ONERA model is described and its originality demonstrated by comparison with already existing models. Results obtained during application of the model in a study of performance degradation when the static margins of the simulated aircraft were decreased are presented. Transl. by A.R.H.

N79-30243*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FLIGHT EXPERIENCE WITH ADVANCED CONTROLS AND DISPLAYS DURING PILOTED CURVED DECELERATING APPROACHES IN A POWERED-LIFT STOL AIRCRAFT
W. S. Hindson (Natl. Res. Council of Can., Ottawa) and G. H. Hardy *In* AGARD Stability and Control May 1979 12 p refs
Avail: NTIS HC A16/MF A01

A program to assess the feasibility of piloted STOL approaches along predefined, steep, curved, and decelerating approach profiles was carried out with a powered-lift STOL aircraft. To reduce the pilot workload associated with the basic control requirements of a powered-lift aircraft equipped with redundant controls and operating on the backside of the power curve, separate stability augmentation systems for attitude and speed were provided, as well as a supporting flight director and special electronic cockpit displays. The control, display, and procedural features are described for the flight experiment that led to the conclusion that, given an adequate navigation environment, such constrained approaches may be feasible from a pilot acceptance point of view. G.Y.

N79-30246# New Mexico Univ., Albuquerque. Civil Engineering Research Facility.
AN EVALUATION OF ASPHALT-RUBBER MIXTURES FOR USE IN PAVEMENT SYSTEMS Final Report, Apr. 1977 - Feb. 1979
Dale S. Decker, Donald F. Griffin, and John P. Nielsen Tyndall AFB, Fla. Civil and Environ. Eng. Develop. Office Apr. 1979 83 p refs
(Contract F29601-76-C-0015; AF Proj. 2104)
(AD-A069448; CEEDO-TR-79-02) Avail: NTIS HC A05/MF A01 CSCL 13/3

The design and construction of airfield pavements have not been developed sufficiently to provide pavements that will not crack. Cracking is a response to traffic and environmental conditions or to the construction material. For many years, rubber in several different forms has been added to asphalt with limited success in reducing pavement cracking. This report reviews the efforts to control cracking by incorporating rubber and asphalt for application as membrane interlayers, surface seal coats, crack fillers, and joint sealers. The extensive literature review indicates that conflicting conclusions have been reached regarding varied applications of the asphalt-rubber material. Of the asphalt-rubber products available, those with high percentages of rubber (20 to 30 percent by weight) appear to be the most promising for airfield pavements, although the effectiveness of asphalt-rubber in controlling or reducing pavement cracking has not been conclusively demonstrated. No superiority of one asphalt-rubber product was indicated in the literature. Because of the danger of loose aggregate chips, the literature indicates that chip seal applications should not be used on facilities where loose chips could be a problem. Therefore, the membrane interlayer is the only application of asphalt-rubber that should be considered for military runways at this time. GRA

N79-30247# European Space Agency, Paris (France).
WALL CORRECTIONS IN TRANSONIC WIND TUNNEL: EQUIVALENT POROSITY
Xavier Vaucheret May 1979 135 p refs Transl. into ENGLISH of 'Corrections de Parois en Soufflerie Transsonique Porosite Equivalente', Rept. ONERA-P-1977-3 ONERA, Paris, 1977
(ESA-TT-545; ONERA-P-1977-3) Avail: NTIS HC A07/MF A01

A method for calculating wall effect corrections is presented for the present design of transonic wind tunnel test sections with perforated horizontal walls and for the dimensions of complete models or two dimensional profiles currently used in industrial testing. The calculations are performed using the concept of constant equivalent porosity on the walls, assuming symmetrical operation of the two walls in three dimensional flow and asymetrical operation in two dimensional flow. The experimental methods of determining the equivalent porosity are described. Finally, test section/model configurations are investigated in an attempt to minimize the wall effects. Author (ESA)

N79-30301*# Boeing Aerospace Co., Seattle, Wash.
DEVELOPMENT AND DEMONSTRATION OF MANUFACTURING PROCESSES FOR FABRICATING GRAPHITE/PMR-15 POLYIMIDE STRUCTURAL ELEMENTS
C. H. Sheppard, J. T. Hoggatt, and W. A. Symonds *In* NASA. Langley Res. Center Graphite/Polyimide Composites Aug. 1979 p 61-84
(Contract NAS1-15009)
Avail: NTIS HC A19/MF A01 CSCL 11D

The processing requirements for graphite/PMR-15 polyimide composites developed to demonstrate the structural integrity of polyimide composite structural elements at temperatures up to 589K (600 F) are described. Major tasks included: quality assurance development; materials and process development; specification verification; flat panel fabrication; stiffened panel fabrication; honeycomb panel fabrication; chopped fiber moldings; and demonstration component fabrication. Materials, processing, and quality assurance documents were prepared from experimentally derived data. Structural elements consisting of flat panels, corrugated stiffeners, I-beams, hat stiffeners, honeycomb panels, and chopped fiber moldings were made and tested. Property data from 219K (-65 F) to 589K (600 F) were obtained. All elements were made in a production environment. The size of each element was sufficient to insure production capability and structural component applicability. Problems associated with adhesive bonding, laminate and structural element analysis, material variability, and test methods were addressed. J.M.S.

N79-30315*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
FATIGUE AND FRACTURE
Walter Illg and Richard A. Everett, Jr. (Army Res. and Technol. Labs.) *In its* Graphite/Polyimide Composites Aug. 1979 p 259-272
Avail: NTIS HC A19/MF A01 CSCL 11D

The effects of the load/temperature environment of the shuttle on the fatigue life of the body-flap were investigated by conducting real time and accelerated flight-by-flight tests up to 500 flights on coupons containing holes. On the fracture side, much is known about the sensitivity of the tensile strengths of composites to holes and other flaws, predominantly at room temperature. The effects of notches were assessed for graphite/polyimides at the expected temperature extremes of the body-flap: 117K (-250 F) to 589K (600 F). Results indicate that the shuttle temperature extremes may affect fatigue properties HTS/PMR-15. There is no significant effect of temperature on notch-strength. Tensile strengths for specimens with holes and slots are equal. S.E.S.

N79-30317*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
MECHANICAL AND THERMOPHYSICAL PROPERTIES OF GRAPHITE/POLYIMIDE COMPOSITE MATERIALS
Donald R. Rummler and Ronald K. Clark *In its* Graphite/Polyimide Composites Aug. 1979 p 289-302 refs

Avail: NTIS HC A19/MF A01 CSCL 11D

An on-going program to characterize advanced composites for up to 50,000 hours of exposure to simulated supersonic cruise environments is summarized. Results are presented for up to 25,000 hours of thermal exposure and 10,000 hours of flight simulation at temperatures up to 560K (550 F) with emphasis on HTS/710 graphite/polyimide composite material. Results to date indicate that the maximum use temperature for HTS/710 may be reduced to 505K (450 F) for long-time (1000 hours) application such as the supersonic transport. Preliminary thermophysical properties data for HTS/PMR15 graphite/polyimide were generated. These data include thermal conductivity, thermal expansion, and specific heat from 115K (-252 F) to 590K (600 F) and emittance at room temperature and 590K (600 F). The purpose in generating these data was to validate use of state-of-the-art property measurement methods for advanced graphite fiber reinforced resin matrix composites. Based on results to this point, thermal expansion measurements for composites are most difficult to perform. A high degree of caution in conducting thermal expansion tests and analyzing results is required to produce reliable data. Author

N79-30332# Naval Research Lab., Washington, D. C.
HIGH PERFORMANCE COMPOSITES AND ADHESIVES FOR V/STOL AIRCRAFT Annual Report, 1 Sep. 1977 - 30 Nov. 1978
Luther B. Lockhart, Jr. 23 May 1979 163 p
(SF54502001)
(AD-A069611; NRL-MR-4005; AR-3) Avail: NTIS HC A08/MF A01 CSCL 11/2

An interdisciplinary program has been undertaken to address the composite and adhesive materials requirements of V/STOL aircraft. The primary tasks are to develop and characterize high modulus, high toughness resins with use temperatures of 350 F to 450 F or higher, to develop fabrication technology of newly developed resin matrices for graphite-fiber reinforced composites, to develop composite failure criteria for design optimization and to establish appropriate quality control parameters. This report is the third annual review of the program, covering the period 1 September 1977 to 30 November 1978. The reporting period was extended to permit completion of an important phase of the task on fracture behavior of composites. During the reporting period, two of the original tasks, Resin Synthesis and Radiation Curing, were terminated but related work is being continued under other in-house projects to follow up leads developed in this program. Among recent accomplishments are the demonstration that resin fracture energy can affect composite interlaminar toughness in fiber-reinforced composites, the development of quality control methodology for phthalocyanine precursor resins, the successful fabrication of phthalocyanine/graphite fiber composites from prepreg, and the completion of room temperature fracture tests of NARMCO 5208/T300 composite over four quadrants of load space and Hexcel F178/T300 composite in one quadrant and further verification of the ability to use this data to predict failure in a box-beam structure. GRA

N79-30334# Grumman Aerospace Corp., Bethpage, N.Y.
METALLIC COATINGS FOR GRAPHITE/EPOXY COMPOSITES Final Report, 1 May 1977 - 31 Oct. 1978
Christian J. Staebler, Jr. and Bonnie F. Simpers May 1979 91 p refs
(Contract N00019-77-C-0250)
(AD-A069871) Avail: NTIS HC A05/MF A01 CSCL 11/2

Metallic coating systems for graphite/epoxy laminated aircraft structures were developed to provide protection against moisture penetration, electromagnetic interference (EMI), paint strippers and lightning strikes. Foil coatings and metal-filled resin coatings were evaluated to assess the protection ability in each of these areas. The foil coatings provided a significant reduction in the moisture penetration and the associated strength loss of the laminate after exposure to humidity and humidity-thermal spiking. Two techniques were developed for the application of foil coatings to graphite/epoxy laminates. Solid aluminum foil was applied to cured laminates in a secondary bonding operation. Perforated aluminum foil was bonded to the laminate in a co-curing operation. The co-curing application required that the laminate be prebled prior to application of the foil and final co-curing to obtain the optimum strength and thickness of the laminate. GRA

N79-30335# General Dynamics/Convair, San Diego, Calif.
ULTRA-HIGH-MODULUS GRAPHITE-EPOXY CONICAL SHELL DEVELOPMENT, SUPPLEMENT Final Report, 1 Dec. 1976 - 30 May 1978
Julius Hertz, Edward E. Spier, and Norman R. Adsit Apr. 1979 73 p refs
(Contract DAAG46-76-C-0008; DA Proj. 1W1-62113-A-661)
(AD-A069795; CASD-ASC-78-001; AMMRC-TR-78-38-Suppl)
Avail: NTIS HC A04/MF A01 CSCL 11/2

The work reported herein represents a preliminary evaluation of support ring concepts for an advanced terminal interceptor (ATI). An ultra-high-modulus grahite/epoxy subscale cone was fabricated and a wedge shaped ring was secondary bonded internally. The cone and ring were successfully tested beyond ultimate load at both RT and 325F. A unique helicoil attachment concept for transferring load into the ring was demonstrated. GRA

N79-30391# European Space Agency, Paris (France).
THE INFLUENCE OF THE ENVIRONMENT ON THE ELASTOPLASTIC PROPERTIES OF ADHESIVES IN METAL BONDED JOINTS
Walter Althof, Gerhard Klinger, Gerhard Neumann, and Johanna Schlothauer Feb. 1979 89 p refs Transl. into ENGLISH of 'Klimaeinfluss auf die Kennwerte des elasto-plastischen Verhaltens von Klebstoffen in Metallklebungen', DFVLR Brunswick Report DLR-FB-77-63, 8 Aug. 1978 Original report in GERMAN previously announced as ESA-90854 Original German report available from DFVLR, Cologne DM 43,40
(ESA-TT-521; DLR-FB-77-63) Avail: NTIS HC A05/MF A01

The shear modulus, the stress at 1% shear-strain, the shear strength, the strain at fracture, and the appertaining shear stress-strain diagrams were analyzed for ten aircraft structural adhesives. These values are calculated from the measured load-deflection behavior of the adhesive in the bond line of lap joints with a thick adherend and a small overlap length, as well as from the torsion pendulum testing of cast adhesives. The measurements are made before and after a long exposure to warmth, cold, moisture, warmth combined with moisture, and changes between cold and combined warmth and moisture. The environmental effects on the adhesion between adherend and adhesives as observed in the tests are described. Author (ESA)

N79-30490# Civil Aeromedical Inst., Oklahoma City, Okla.
ELECTRICAL INSULATION FIRE CHARACTERISTICS. VOLUME 2: TOXICITY Final Report, Jul. 1976 - Jul. 1978
Charles R. Crane, Boyd R. Endecott, Donald C. Sanders, and John K. Abbott Dec. 1978 102 p refs
(Contracts DOT/TSC-RA-77-15; DOT/TSC-RA-77-16)
(PB-294841/2; UMTA-MA-06-0025;
DOT-TSC-UMTA-78-48-11) Avail: NTIS HC A06/MF A01 CSCL 13F

The relative inhalation toxicity of the thermal degradation products or gaseous pyrolysis of selected types of electrical wiring insulations was determined. The specific materials to be evaluated were selected from a much larger population on the basis of prior testing of properties other than toxicity. The relative toxicities of the combustion products of 14 electrical wiring insulations were evaluated using animal incapacitation as a measure of toxicity. One gram insulation samples were pyrolyzed in a quartz combustion tube connected in-line with a 12.6 liter exposure chamber by an air recirculation assembly to form a closed exposure system. Each material was pyrolyzed under three thermal degradation conditions and the time to incapacitation for the shortest time condition was used to rank the materials in order of their relative potential toxicity. GRA

N79-30555# Timken Co., Canton, Ohio.
TAPERED ROLLER BEARING DEVELOPMENT FOR AIRCRAFT TURBINE ENGINES Final Report, 8 Mar. 1976 - 8 Mar. 1979
Peter S. Orvos and G. J. Pressler Wright-Patterson AFB, Ohio AFAPL Mar. 1979 102 p refs
(Contract F33615-76-C-2019; AF Proj. 3048)
(AD-A069440; AFAPL-TR-79-2007) Avail: NTIS HC A06/MF A01 CSCL 13/9

Finite element methods were used to structurally analyze various potential cage designs for tapered roller bearings operating at 3.5 million DN. The race guided Z design exhibited the greatest strength. Short duration evaluation tests verified these findings. Performance tests were conducted to determine bearing loss characteristics and oil-off survival. Parameters investigated, which influence losses (torque or heat generation), were speed, load, lubricant properties, lubricant flow rate and lubricant distribution. Oil-off survival tests were successfully run at 1.5 and 2.0 million DN. The bearing fatigue life tests conducted at 3 million DN showed a high degree of life scatter. The 90 percent survival level was 2.78 times the unadjusted catalog life expectancy. GRA

N79-30876*# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
LIGHTNING HAZARDS OVERVIEW: AVIATION REQUIREMENTS AND INTERESTS
Phillip B. Corn *In* NASA. Marshall Space Flight Center Proc.: Workshop on the Need for Lightning Observations from Space Jul. 1979 p 126-135 refs

Avail: NTIS HC A12/MF A01 CSCL 04A

A ten-year history of USAF lightning incidents is presented along with a discussion of the problems posed by lightning to current aircraft, and the hazards it constitutes to the electrical and electronic subsystems of new technology aircraft. Lightning technical protection technical needs, both engineering and operational, include: (1) in-flight data on lightning electrical parameters; (2) tech base and guidelines for protection of advanced systems and structures; (3) improved laboratory test techniques; (4) analysis techniques for predicting induced effects; (5) lightning strike incident data from general aviation; (6) lightning detection systems; (7) pilot reports on lightning strikes; and (8) better training in lightning awareness. A.R.H.

N79-30959# Computer Sciences Corp., Silver Spring, Md. Systems Sciences Div.
CENTRAL FLOW CONTROL SOFTWARE DESIGN DOCUMENT. VOLUME 1: OPERATIONAL SOFTWARE COMPLEX Final Report
Jan. 1979 542 p refs
(Contract DOT-FA77WA-3955)
(AD-A070973; CSC/SD-78/6172-Vol-1; FAA-RD-79-33-Vol-1)
Avail: NTIS HC A23/MF A01 CSCL 09/2

The Central flow control (CFC) software system functional requirements established in the Federal Aviation Administration's (FAA) computer program functional specifications are translated into implemented software programs. The exact configuration of the computer programs produced for CFC software system is described. A complete technical description of the software functions, structures, operating environment, data organization, visual table of contents, program listings, and data and module cross references is provided. The operational complex which operates in real time mode and is comprised of the executive, database, simulation, and applications subsystems is described. J.M.S.

N79-30960# Computer Sciences Corp., Silver Spring, Md. Systems Sciences Div.
CENTRAL FLOW CONTROL SOFTWARE DESIGN DOCUMENT. VOLUME 2: SUPPORT SOFTWARE COMPLEX Final Report
Jan. 1979 593 p
(Contract DOT-FA77WA-3955)
(AD-A070771; CSC/SD-78/6172-Vol-2; FAA-RD-79-33-Vol-2)
Avail: NTIS HC A25/MF A01 CSCL 09/2

The support complex (SPCX) which operates in an off-line mode and is comprised of the system development, system generation, system test, and system analysis subsystems is described. J.M.S.

N79-31136*# National Aeronautics and Space Administration, Washington, D. C.
A COMPARISON OF PREDICTIONS OBTAINED FROM WIND TUNNEL TESTS AND THE RESULTS FROM CRUISING FLIGHT: AIRBUS AND CONCORDE
J. Berger Aug. 1979 71 p refs Transl. into ENGLISH of "Comparison entre les resultats de vol en croisiere: Airbus et Concorde", AGARD-CP-242, Rept-20 Presented at Flight Mechanics Panel Specialists Meeting on Performance Prediction Methods, Paris, France, 11-13 Oct. 1977 Original language document was announced as N78-26074 Transl. by Kanner (Leo) Associates, Redwood City, Calif. Original doc. prep. by Aerospatiale (France)
(Contract NASw-3199)
(NASA-TM-75238; AGARD-CP-242; Rept-20) Avail: NTIS HC A04/MF A01 CSCL 02A

Following a summary of the methods used to establish aerodynamic data and propulsion data, a comparison was made in the form of the drag (or thrust) difference between flight results and predictions made on the basis of these data. Certain hypothesis and improvements on aerodynamic data were presented in order to explain the slight deficit found on Airbus and Concorde. M.M.M.

N79-31137*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THE PROMISE OF MULTICYCLIC CONTROL
John L. McCloud, III Aug. 1979 36 p refs
(NASA-TM-78621; A-7955) Avail: NTIS HC A03/MF A01 CSCL 02A

Several types of rotors which employ multicyclic control are reviewed and compared. Their differences are high-lighted and their potential advantages and disadvantages are discussed. The flow field these rotors must operate in is discussed, and it is shown that simultaneous elimination of vibration and oscillatory blade loads is not an inherent solution to the roughness problem. The use of rotor blades as energy absorbers is proposed. Input-output relations are considered and a gain control for ROMULAN, a multicyclic controlling computer program, is introduced. Implications of the introduction of multicyclic systems into helicopters are discussed. A.W.H.

N79-31138# Textron Bell Aerospace Co., New Orleans, La.
MARITIME PATROL AIRSHIP CONCEPT STUDY Final Report, 18 Apr. - 31 Oct. 1978
James C. Bell, James D. Marketos, and A. D. Topping 16 Nov. 1978 242 p refs
(Contract N62269-78-M-6956)
(AD-A070131; NADC-78074-60; Rept-7575-927030) Avail: NTIS HC A11/MF A01 CSCL 01/3

Results of a preliminary conceptual parametric design study for a maritime patrol airship to be used by the U. S. Coast Guard or Navy are presented. Eight different Coast Guard mission profiles are considered, and an optimum airship point design is developed for each. The report discusses mission requirements, airship operational requirements, the conceptual design approach, and the parametric design study which uses a computer program to assist in optimizing the critical parameters for each airship mission design. The study includes airship sizes from 220,000 cu ft 18,000 lb vertical takeoff weight to 3,000,000 cu ft 230,000 lb vertical takeoff weight. Results show the unique features of the Bell unballasted, reversible thrust airship design and the critical need for design optimiztion, owing to the sensitivity of the airship design parameters. The computer design program shows airship conceptual differences and design trends rather than absolute design configurations, since it uses the preliminary subsystem weight relationships developed for recent airship parametric studies. Although the study design trends should remain valid, additional studies are recommended to establish better subsystem weight estimates and to incorporate life-cycle costing. GRA

N79-31141*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
POWERED LOW-ASPECT-RATIO WING IN GROUND EFFECT (WIG) AERODYNAMIC CHARACTERISTICS
James L. Thomas, John W. Paulson, Jr., and Richard J. Margason Jul. 1979 49 p refs
(NASA-TM-78793) Avail: NTIS HC A03/MF A01 CSCL 01A

A wing-in-ground effect configuration was investigated. The configuration used large diameter, low pressure ratio fans mounted about 0.76 wing chord ahead of the wing leading edge to achieve a power augmented ram wing during operation in ground effect. Tests of both in and out of ground effect aerodynamic transition characteristics from very low speeds to cruise speeds are described. The investigation provided a number of conclusions concerning the aerodynamic/propulsive performance interaction. While power augmented lift is required for low speed flight, there is a thrust loss when the efflux is trapped under the wing which reduced the effective thrust to weight available for acceleration by about a third of the installed thrust to weight ratio. A.W.H.

N79-31143*# Old Dominion Univ., Norfolk, Va.
SUBSONIC WIND-TUNNEL INVESTIGATION OF LEADING-EDGE DEVICES ON DELTA WINGS (DATA REPORT)
M. Rao Dhanvada and Thomas D. Johnson, Jr. Aug. 1979 131 p refs
(Grant NGR-47-003-052)
(NASA-CR-159120) Avail: NTIS HC A07/MF A01 CSCL 01A

The drag reduction potential of leading edge devices on delta wings at high lift is presented. Fences, pylon type vortex generators, chordwise slots, and sharp plate extensions were tested on wing models with 60 and 74 degree swept blunt leading edges at angles of attack to 32 degrees. Six component balance and leading edge surface pressure measurements were taken with various geometry and spanwise arrangements of the devices. Tables listing the data, without analysis, are presented. A.W.H.

N79-31144*# Boeing Commercial Airplane Co., Seattle, Wash.
DYNAMIC LOADS ANALYSIS SYSTEM (DYLOFLEX) SUMMARY. VOLUME 1: ENGINEERING FORMULATION
R. D. Miller, R. I. Kroll, and R. E. Clemmons Sep. 1979 88 p refs 2 Vol.
(Contract NAS1-13918)
(NASA-CR-2846-1; D6-44455-Vol-1) Avail: NTIS HC A05/MF A01 CSCL 01A

The DYLOFLEX computer program system expands the aeroelastic cycle from that in the FLEXSTAB computer program system to include dynamic loads analyses involving active controls. Two aerodynamic options exist within DYLOFLEX. The analyst can formulate the problem with unsteady aerodynamics calculated using the doublet lattice method or with quasi-steady aerodynamics formulated from either FLEXSTAB or doublet lattice steady state aerodynamics with unsteady effects approximated by indicial lift growth functions. The equations of motion are formulated assuming straight and level flight and small motions. Loads are calculated using the force summation technique. DYLOFLEX consists of nine standalone programs which can be linked with each other by magnetic files used to transmit the required data between programs. Author

N79-31145*# Boeing Commercial Airplane Co., Seattle, Wash.
DYNAMIC LOADS ANALYSIS SYSTEM (DYLOFLEX) SUMMARY. VOLUME 2: SUPPLEMENTAL SYSTEM DESIGN INFORMATION
R. D. Miller, R. I. Kroll, and R. E. Clemmons Sep. 1979 60 p refs 2 Vol.
(Contract NAS1-13918)
(NASA-CR-2846-2; D6-44455-Vol-2) Avail: NTIS HC A04/MF A01 CSCL 01A

Contents: execution of the DYLOFLEX program system; magnetic file format; DYLIB - the DYLOFLEX alternate subroutine library; and prefaces for DYLIB subroutines. A.R.H.

N79-31146# Aeronautical Research Labs., Melbourne (Australia).
LATERAL AERODYNAMICS EXTRACTED FROM FLIGHT TEST USING A PARAMETER ESTIMATION METHOD
R. A. Feik Oct. 1978 45 p refs
(ARL-AERO-NOTE-380; AR-001-311) Avail: NTIS HC A03/MF A01

Flight data from a 60 deg delta wing aircraft was analyzed using a modified Newton-Raphson parameter estimation procedure. The model equations used for the analysis were extended to account for sideslip vane errors and for lateral accelerometer position error. Lateral derivatives extracted from the data were compared with wind tunnel measurements and theoretical estimates and areas of agreement and disagreement identified. The method was also applied to the analysis of fin loads measured in flight and some tentative conclusions reached. The results confirm the effectiveness of the parameter identification procedure in flight test analysis and its ready applicability to a variety of related problems. M.M.M.

N79-31147*# Boeing Commercial Airplane Co., Seattle, Wash.
MODAL INTERPOLATION PROGRAM, L215(INTERP). VOLUME 2: SUPPLEMENTAL SYSTEM DESIGN AND MAINTENANCE DOCUMENT
M. Y. Hirayama and R. I. Kroll Washington NASA Sep. 1979 69 p refs
(Contract NAS1-13918)
(NASA-CR-2848; D6-44457) Avail: NTIS HC A04/MF A01 CSCL 01A

The design, structure, and usage of the modal interpolation program L215 are presented. The program uses modal data sets of arrays containing interpolation coefficients. The interpolation arrays are used to determine displacements at various aerodynamic control points. The displacements consist of translations normal to the aerodynamic surface and surface slopes that are parallel and perpendicular to the free stream direction. Five different interpolation methods are available. A.W.H.

N79-31148*# Boeing Commercial Airplane Co., Seattle, Wash.
A PROGRAM TO COMPUTE THREE-DIMENSIONAL SUBSONIC UNSTEADY AERODYNAMIC CHARACTERISTICS USING THE DOUBLET LATTICE METHOD, L216 (DUBFLEX). VOLUME 2: SUPPLEMENTAL SYSTEM DESIGN AND MAINTENANCE DOCUMENT Topical Report, May 1975 - May 1977
B. A. Harrison and M. Richard Washington NASA Sep. 1979 75 p refs 2 Vol.
(Contract NAS1-13918)
(NASA-CR-2850; D6-44459) Avail: NTIS HC A04/MF A01 CSCL 01A

The information necessary for execution of the digital computer program L216 on the CDC 6600 is described. L216 characteristics are based on the doublet lattice method. Arbitrary aerodynamic configurations may be represented with combinations of nonplanar lifting surfaces composed of finite constant pressure panel elements, and axially summetric slender bodies composed of constant pressure line elements. Program input consists of configuration geometry, aerodynamic parameters, and modal data; output includes element geometry, pressure difference distributions, integrated aerodynamic coefficients, stability derivatives, generalized aerodynamic forces, and aerodynamic influence coefficient matrices. Optionally, modal data may be input on magnetic field (tape or disk), and certain geometric and aerodynamic output may be saved for subsequent use. A.R.H.

N79-31149*# Bihrle Applied Research, Inc., Jericho, N. Y.
ROTARY BALANCE DATA FOR A TYPICAL SINGLE-ENGINE GENERAL AVIATION DESIGN FOR AN ANGLE-OF-ATTACK RANGE OF 8 DEG TO 90 DEG. 2: HIGH-WING MODEL A
William Mulcay and Robert Rose Washington NASA Sep. 1979 116 p refs
(Contract NAS1-14849)
(NASA-CR-3101) Avail: NTIS HC A06/MF A01 CSCL 01A

Aerodynamic characteristics obtained in a rotational flow environment utilizing a rotary balance located in the Langley spin tunnel are presented in plotted form for a 1/5-scale, single-engine, high-wing, general aviation airplane model. The configurations tested included various tail designs and fuselage shapes. Data are presented without analysis for an angle of attack range of 8 to 90 degrees and clockwise and counter-clockwise rotations covering an Omega b/2 v range from 0 to 0.85. M.M.M.

N79-31151*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
WIND-TUNNEL INVESTIGATION OF AN ARMED MINI REMOTELY PILOTED VEHICLE
Arthur E. Phelps, III Sep. 1979 62 p refs Prepared in cooperation with Army Aviation Research and Development Command, St. Louis, Mo.
(DA Proj. 1L1-61102-AH-45)
(NASA-TM-80132; L-13026; AVRADCOM-TR-79-41) Avail: NTIS HC A04/MF A01 CSCL 01A

A wind tunnel investigation of a full scale remotely piloted vehicle (RPV) armed with rocket launchers was conducted. The model had unacceptable longitudinal stability characteristics at negative angles of attack in the original design configuration. The addition of a pair of fins mounted in a V arrangement on the propeller shroud resulted in a configuration with acceptable longitudinal stability characteristics. The addition of wing mounted external stores to the modified configuration resulted in a slight reduction in the longitudinal stability. The lateral directional characteristics of the model were generally good, but the model had low directional stability at low angles of attack. Aerodynamic control power was very strong around all three axes. A.W.H.

N79-31152*# Bihrle Applied Research, Inc., Jericho, N. Y.
ROTARY BALANCE DATA FOR A SINGLE-ENGINE TRAINER DESIGN FOR AN ANGLE-OF-ATTACK RANGE OF 8 DEG TO 90 DEG
Paul Pantason and Waldo Dickens Washington NASA Aug. 1979 327 p
(Contract NAS1-14849)
(NASA-CR-3099) Avail: NTIS HC A15/MF A01 CSCL 01A

Aerodynamic characteristics obtained in a rotational flow environment utilizing a rotary balance located in the Langley spin tunnel are presented in plotted form for a 1/6 scale, single engine trainer airplane model. The configurations tested included the basic airplane, various wing leading edge devices, elevator, aileron and rudder control settings as well as airplane components. Data are presented without analysis for an angle of attack range of 8 to 90 degrees and clockwise and counter-clockwise rotations. Author

N79-31153*# Boeing Commercial Airplane Co., Seattle, Wash.
EQUATION MODIFYING PROGRAM, L219 (EQMOD). VOLUME 2: SUPPLEMENTAL SYSTEM DESIGN AND MAINTENANCE DOCUMENT Topical Report, May 1975 - May 1977
M. Y. Hirayama, R. E. Clemmons, and R. D. Miller Washington NASA Sep. 1979 65 p refs
(Contract NAS1-13918)
(NASA-CR-2856; D6-44465-Vol-2) Avail: NTIS HC A04/MF A01 CSCL 01A

A digital computer program, L219 (EQMOD), available for execution on the CDC 6600 is described. The program modifies matrices according to card input instructions and prepares magnetic files of matrices suitable for use in the linear systems analysis program (QR) and the random harmonic analysis program L221 (TEV156). The particular field of application of the program is the modification of the theoretical equations of motion and load equations generated in DYLOFLEX by the equation of motion program (L217) and the load equation program (L218), respectively. J.M.S.

N79-31154*# Boeing Commercial Airplane Co., Seattle, Wash.
TIME HISTORY SOLUTION PROGRAM, L225 (TEV126). VOLUME 2: SUPPLEMENTAL SYSTEM DESIGN AND MAINTENANCE DOCUMENT Topical Report, May 1975 - May 1977
A. Tornallyay, R. E. Clemmons, and R. I. Kroll Washington NASA Sep. 1979 34 p refs
(Contract NAS1-13918)
(NASA-CR-2860; D6-44469-Vol-2) Avail: NTIS HC A03/MF A01 CSCL 01A

The time history solution program L225 (TEV126) is described. The program calculates the time responses of a linear system by convoluting the impulsive response functions with the time dependent excitation. The convolution is performed as a multiplication in the frequency domain. Fast Fourier transform techniques are used to transform the product back into the time domain to obtain response time histories. The design and structure of the program is presented. A.W.H.

N79-31155*# Boeing Commercial Airplane Co., Seattle, Wash.
A PROGRAM FOR CALCULATING LOAD COEFFICIENT MATRICES UTILIZING THE FORCE SUMMATION METHOD, L218 (LOADS). VOLUME 2: SUPPLEMENTAL SYSTEM DESIGN AND MAINTENANCE DOCUMENT Topical Report, May 1975 - May 1977
L. R. Anderson and R. D. Miller Washington NASA Sep. 1979 94 p refs
(Contract NAS1-13918)
(NASA-CR-2854; D6-44463-Vol-2) Avail: NTIS HC A05/MF A01 CSCL 01A

The LOADS computer program L218 which calculates dynamic load coefficient matrices utilizing the force summation method is described. The load equations are derived for a flight vehicle in straight and level flight and excited by gusts and/or control motions. In addition, sensor equations are calculated for use with an active control system. The load coefficient matrices are calculated for the following types of loads: (1) translational and rotational accelerations, velocities, and displacements; (2) panel aerodynamic forces; (3) net panel forces; and (4) shears, bending moments, and torsions. J.M.S.

N79-31156# ARO, Inc., Arnold Air Force Station, Tenn.
A FORCE AND MOMENT TEST OF A 1/24-SCALE F-111 MODEL AT MACH NUMBERS FROM 0.7 TO 1.3 Final Report
C. G. Burchfield AEDC 2 Mar. 1979 17 p refs
(AD-A070192; AEDC-TSR-79-P14) Avail: NTIS HC A02/MF A01 CSCL 01/3

A test program was conducted in the Propulsion Wind Tunnel 16 T to determine forces and moments on a 1/24-scale F-111 model. Data were obtained at Mach numbers from 0.7 to 1.3 at total pressures of 1200 and 2000 psfa. Model angle of attack was varied from 2 to 20 deg at 0 deg sideslip. Sideslip angles were varied from -10 to 10 deg at 10 and 15 deg angles of attack. GRA

N79-31157# Purdue Univ., Lafayette, Ind. School of Aeronautics and Astronautics.
FLUTTER ANALYSIS OF TWO-DIMENSIONAL AND TWO-DEGREE-OF-FREEDOM AIRFOILS IN SMALL-DISTURBANCE, UNSTEADY TRANSONIC FLOW Final Report, Nov. 1977 - Oct. 1978
T. Y. Yang, Alfred G. Striz, and P. Guruswamy Dec. 1978 116 p refs
(Grant AF-AFOSR-3523-78; AF Proj. 2307)
(AD-A069223; AFFDL-TR-78-202) Avail: NTIS HC A06/MF A01 CSCL 20/4

Flutter analyses are performed for a NACA 64A006 and a NACA 64A010 airfoil by simultaneously using two transonic aerodynamic computational codes: (1) STRANS2 and UTRANS2 based on the relaxation method and (2) LTRAN2 based on the indicial and time-integration methods. Flutter results are obtained as plots of flutter speeds and the corresponding reduced frequencies versus one of the four parameters: airfoil-air mass ratio; position of the mass center; position of the elastic axis; and free stream Mach number. On each figure, several sets of curves for different values of plunge-to-pitch frequency ratios are shown simultaneously. The flutter results obtained by using relaxation and the indicial methods are, in general, in good agreement. The present flutter results for a special case of a thin parabolic airfoil at a low transonic Mach number of 0.7 compare favorably with that obtained by using linear flat plate theory. The trend of each flutter curve and the effect of each parameter are discussed in detail. GRA

N79-31159# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
EXPERIMENTAL DATA BASE FOR COMPUTER PROGRAM ASSESSMENT: REPORT OF THE FLUID DYNAMICS PANEL WORKING GROUP 04
May 1979 609 p refs
(AGARD-AR-138; ISBN-92-835-1323-1) Avail: NTIS HC A99/MF A01

The acquisition of highly reliable wind tunnel test data for aircraft design was investigated.

N79-31160# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany).
INTRODUCTION AND OVERVIEW OF CONFIGURATIONS
Juergen Barche *In* AGARD Exptl. Data Base for Computer Program Assessment May 1979 5 p

Avail: NTIS HC A99/MF A01

An overview of the application of two- and three-dimensional transonic flows to aircraft design is presented. The criteria for two-dimensional, three-dimensional, and body-alone configurations are tabulated. F.O.S.

N79-31163*# National Aeronautics and Space Administration, Washington, D. C.
SUPERSONIC TRANSPORT VIS-A-VIS ENERGY SAVINGS
G. Cormery Sep. 1979 27 p Transl. into ENGLISH from Aeron. Astronaut (Paris), vol. 69, no. 2, 1978 p 3-14 Original

language document was announced as A78-35893 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASw-3199)
(NASA-TM-75464) Avail: NTIS HC A03/MF A01 CSCL 01C

The energy and economic saving modifications in supersonic transportation are studied. Modifications in the propulsion systems and in the aerodynamic configurations of the Concorde aircraft to reduce noise generation and increase fuel efficiency are discussed. The conversion of supersonic aircraft from fuel oils to synthetic fuels is examined. A.W.H.

N79-31164*# Boeing Vertol Co., Philadelphia, Pa.
DEVELOPMENT OF CRASHWORTHY PASSENGER SEATS FOR GENERAL-AVIATION AIRCRAFT
M. J. Reilly and A. E. Tanner Aug. 1979 112 p refs
(Contract NAS1-14637)
(NASA-CR-159100; D210-11336-1) Avail: NTIS HC A06/MF A01 CSCL 01C

Two types of energy absorbing passenger seat concepts suitable for installation in light twin-engine fixed wing aircraft were developed. An existing passenger seat for such an aircraft was used to obtain the envelope constraints. Ceiling suspended and floor supported seat concept designs were developed. A restraint system suitable for both concepts was designed. Energy absorbing hardware for both concepts was fabricated and tension and compression tests were conducted to demonstrate the stroking capability and the force deflection characteristics. Crash impact analysis was made and seat loads developed. The basic seat structures were analyzed to determine the adequacy of their strength under impact loading. R.E.S.

N79-31165# National Transportation Safety Board, Washington, D. C.
AIRCRAFT ACCIDENT REPORT: SWIFT AIRE LINES, INC., NORD 262, N418SA, MARINA DEL REY, CALIFORNIA, MARCH 10, 1979
16 Aug. 1979 32 p
(NTSB-AAR-79-13) Avail: NTIS HC A03/MF A01

On March 10, 1979, Flight 235, A-Nord 262, ditched in the Santa Monica Bay near Marina Del Rey, California, shortly after takeoff from Los Angeles International Airport. Flight 235 was a scheduled commuter airline passenger flight from Los Angeles, California, to Santa Maria, California, with four passengers and three crewmembers on board. The probable cause of the accident was determined to be the flightcrew's mismanagement of an emergency procedure following an autofeather of the right propeller which resulted in their shutting down the remaining engine. Contributing to the accident was the unavailability of vital restart information to the crew. A.W.H.

N79-31166*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
CONFERENCE ON FIRE RESISTANT MATERIALS: A COMPILATION OF PRESENTATIONS AND PAPERS
Demetrius A. Kourtides, ed. and Gerald A. Johnson, ed. (Boeing Com. Airplane Co., Seattle, Wash.) Jul. 1979 287 p Conf. held in Seattle, 1-2 Mar. 1979
(NASA-CP-2094; A-7894) Avail: NTIS HC A13/MF A01 CSCL 01C

The proceedings of the NASA IRE Resistant Materials Engineering (FIREMEN) Program held at Boeing Commercial Airplane Company, Seattle, Washington, on March 1-2, 1979 are reported. The conference was to discuss the results of research by the National Aeronautics and Space Administration in the field of aircraft fire safety and fire-resistant materials. The program topics include the following: (1) large-scale testing; (2) fire toxicology; (3) polymeric materials; and (4) fire modeling.

N79-31167*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
AIRPORT FLAMMABILITY, FULL SCALE FIRE TESTS
Richard W. Bricker *In* NASA. Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 1-12

Avail: NTIS HC A13/MF A01 CSCL 01C

The primary objectives of the fire tests are: (1) conduct full scale test with 737 fuselages by the end of 1980; (2) demonstrate evacuation time increase to five minutes minimum; (3) show that exterior fire will not penetrate an intact cabin for five minutes; (4) show that closed cabin will not have excess smoke or temperatures above 400 F; and (5) demonstrate that fire in cabin opening will not propagate throughout cabin. The test program has three phases. A test schedule and status of required materials are presented. G.Y.

N79-31168*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
SEAT TEST PROGRAM
Richard W. Bricker *In* NASA. Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 13-26

Avail: NTIS HC A13/MF A01 CSCL 01C

The test program has the objectives to: (1) evaluate severity of newspaper ignition source with contemporary seats (determine weight loss, visual damage, and if ignition source is severe enough to show improvement with new material configurations); (2) compare damage with jet A-1 ignition source; and (3) determine if materials for seat tests pass FAR 25 and obtain LO1. Test configurations, data acquired, material test results, seat test results, and conclusions are presented. G.Y.

N79-31169*# Southwest Foundation for Research and Education, San Antonio, Tex.
RECENT ADVANCES IN MATERIALS TOXICOLOGY
Dane M. Russo *In* NASA. Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 27-43

Avail: NTIS HC A13/MF A01 CSCL 01C

An overview of the fire toxicology program, its principal objectives and approach, is outlined. The laboratory methods of assessing pyrolysis product toxicity for two experiments are presented. The two experiments are: a comparison of test end points; and an evaluation of operant techniques. A third experiment is outlined for a comparison of full-scale and laboratory toxicity tests, with the purpose of determining animal survivability in full-scale tests. Future research plans are also outlined. G.Y.

N79-31170*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
STATUS OF CANDIDATE MATERIALS FOR FULL-SCALE TESTS IN THE 737 FUSELAGE
Daniel Supkis *In* NASA. Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 45-69

Avail: NTIS HC A13/MF A01 CSCL 01C

The test program has the objectives to: (1) increase passenger evacuation time to a minimum of five minutes from commercial aircraft in case of a fire; (2) prevent an external fire from entering closed cabins for five minutes by using fire barrier materials in the exterior wall; (3) demonstrate that a closed cabin will not reach 400 F; and (4) prove that a fire near a cabin opening will not propagate through the cabin for a minimum of five minutes. The materials status is outlined for seat cushions, upholstery and associated seat materials, wall and ceiling panels, floor panels, carpet and carpet underlay, windows, cargo bay liners, insulation bagging, and thermal acoustical insulation. G.Y.

N79-31171*# Solar Turbines International, San Diego, Calif.
DEVELOPMENT OF FIRE-RESISTANT, LOW SMOKE GENERATING, THERMALLY STABLE END ITEMS FOR COMMERCIAL AIRCRAFT AND SPACECRAFT USING A BASIC POLYIMIDE RESIN
John Gagliani *In* NASA. Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 71-92

Avail: NTIS HC A13/MF A01 CSCL 01C

Experimental data pertinent to flexible resilient foams, low density wall panels, high strength floor panels and thermal acoustical insulation are presented. An evaluation of the effect of the heterocyclic diamine component on the compression set of the foams was carried out. Processes and compositions for fabricating wall panels were evaluated. Thermal acoustical polyimide materials were developed to replace conventional glass batting insulation. To reduce the thermal stresses and improve the burn through resistance, cross linked polyimide foams were developed but not evaluated. G.Y.

N79-31172*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
GLOBAL ENCLOSURE FIRE MODELING WITH APPLICATIONS
Jay William Stuart *In* NASA. Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 93-101

Avail: NTIS HC A13/MF A01 CSCL 01C
A brief review of LERC (Limiting Energy Release Criteria) is presented. Application of LERC to JSC/Boeing ignition source full-scale tests and to JSC/Dacfir math-model validation tests is outlined. It is concluded that: (1) a complete LERC application to the JSC/Boeing tests verifies the fuel load criterion as the limiting constraint; (2) the variability of magnitude and form of the results of repeated tests with and without small variations in parameters emphasizes the significance of the local flow, species concentration, and heat transfer distribution; and (3) weight loss measurements of recent JSC tests show consistent results with prior methods, fuel load constrained. G.Y.

N79-31173*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ENCLOSURE FIRE DYNAMICS MODEL
Josette Bellan *In* NASA. Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 103-116

Avail: NTIS HC A13/MF A01 CSCL 01C
A practical situation of an enclosure fire is presented and why the need for a fire dynamic model is addressed. The difficulties in establishing a model are discussed, along with a brief review of enclosure fire models available. The approximation of the practical situation and the model developed are presented. G.Y.

N79-31175*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
FUSELAGE VENTILATION UNDER WIND CONDITIONS
Jay William Stuart *In* NASA. Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 127-134

Avail: NTIS HC A13/MF A01 CSCL 01C
To determine realistic fuselage ventilation rates for post-crash fires and full-scale fire tests, the effects on wind-about fuselage ventilation rate of various parameters were studied. The parameters investigated were fuselage size and shape, fuselage orientation and proximity to ground, fuselage-opening and location, and wind speed and direction. F.O.S.

N79-31176*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
FIRE RESISTANT AIRCRAFT SEAT PROGRAM
Larry A. Fewell *In its* Conf. on Fire Resistant Mater. Jul. 1979 p 135-166
Avail: NTIS HC A13/MF A01 CSCL 01C
Foams, textiles, and thermoformable plastics were tested to determine which materials were fire retardant, and safe for aircraft passenger seats. Seat components investigated were the decorative fabric cover, slip covers, fire blocking layer, cushion reinforcement, and the cushioning layer. F.O.S.

N79-31177*# Boeing Commercial Airplane Co., Seattle, Wash.
A REVIEW OF BOEING INTERIOR MATERIALS AND FIRE TEST METHODS DEVELOPMENT PROGRAMS
Eugene Bara *In* NASA Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 167-181

Avail: NTIS HC A13/MF A01 CSCL 01C
Total materials systems requirements, and government and industry programs are outlined along with a new fire test methodology, and the potential decrease in post crash fire hazards. The flammability, smoke and toxicity goals, and the scope of materials systems are tabulated. F.O.S.

N79-31178*# Boeing Commercial Airplane Co., Seattle, Wash.
FIREMEN PROGRAM Status Report
Roy A. Anderson and Gerald A. Johnson *In* NASA. Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 183-222

Avail: NTIS HC A13/MF A01 CSCL 01C
An overview of the program to improve fire retardant interior panels is presented. The sandwich panel makeup for different components, and the burn test results are presented. F.O.S.

N79-31183*# Isovolta Co., Wiener Neudorf (Austria).
THE FLUORENONE POLYESTER ISO FPE OF ISOVOLTA COMPANY, AUSTRIA
H. Weber *In* NASA. Ames Res. Center Conf. on Fire Resistant Mater. Jul. 1979 p 271-282

Avail: NTIS HC A13/MF A01 CSCL 01C
Methods for the synthesis of ISO-FPE are described, and the mechanical properties are given. The industrial production of powder and film is discussed. F.O.S.

N79-31184# Air Force Engineering and Services Center, Tyndall AFB, Fla.
AN EVALUATION OF THE BIRD AIRCRAFT STRIKE HAZARD AT HILL AFB, UTAH (AFLC)
Jeffrey J. Short, James S. Kent, Ardrah L. Buddin, III, and William H. Niemeier Jan. 1979 45 p refs
(AD-A070459; AFESC-TM-1-79) Avail: NTIS HC A03/MF A01 CSCL 01/2
Hill Air Base was surveyed from 30 September to 12 October 1978 and from 28 to 30 January 1979 by the Air Force Engineering and Services Center Bird/Aircraft Strike Hazard Bash Team. Insect populations, vegetation, bird activity and local geography were studied to assess the impact of birds on flying operations at the base. GRA

N79-31185*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
UHF COPLANAR-SLOT ANTENNA FOR AIRCRAFT-TO-SATELLITE DATA COMMUNICATIONS
Royce W. Myhre 1979 21 p refs Presented at the Printed Circuit Antenna Technol. Workshop, Las Cruces, N. Mex., 17-19 Oct. 1979; sponsored by New Mexico State Univ. and the Army Res. Office Physical Sci. Lab.
(NASA-TM-79239; E-146) Avail: NTIS HC A02/MF A01 CSCL 17B
A lightweight low drag coplanar slot antenna was developed for use on commercial jet aircraft that will provide upper hemisphere coverage in the UHF band at frequencies of 402 and 468 MHz is described. The antenna is designed to transmit meteorological data from wide body jet aircraft to ground users via synchronous meteorological data relay satellites. The low profile antenna (23.5 cm wide by 38.1 cm long slot by 1.9 cm high) is a conformal antenna utilizing the coplanar approach with the advantages of broad frequency bandwidth and improved electrical integrity over wide range of temperature. The antenna is circular polarized, has anon axis gain of near +2.5 dB, and a HPBW greater than 90 deg. Areas discussed include antenna design, radiation characteristics, flight testing, and system performance. K.L.

N79-31186*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
FLIGHT PERFORMANCE OF THE TCV B-737 AIRPLANE AT KENNEDY AIRPORT USING TRSB/MLS GUIDANCE
William F. White and Leonard V. Clark Jul. 1979 29 p refs
(NASA-TM-80148) Avail: NTIS HC A03/MF A01 CSCL 17G
The terminal configured vehicle (TCV) B 737 was flown in demonstration of the time reference scanning beam/microwave landing system (TRSB/MLS). The flight performance of the TCV airplane during the demonstration automatic approaches and landings while utilizing TRSB/MLS guidance is reported. The TRSB/MLS is shown to provide the terminal area guidance necessary for flying curved automatic approaches with short finals. A.W.H.

N79-31189# Naval Postgraduate School, Monterey, Calif.
A DEVELOPMENTAL COMPUTER MODEL FOR INVESTIGATIONS OF AIR TRAFFIC MANAGEMENT PROBLEMS: A CASE INVESTIGATING TWO DECISION STRATEGIES M.S. Thesis
John Thomas Malokas, Jr. and Arvid Paul Pederson Mar. 1979 133 p refs
(AD-A071075) Avail: NTIS HC A07/MF A01 CSCL 17/7

A computer simulation model designed to help solve regional air traffic scheduling problems was developed. Bases, mission areas, and aircraft were modeled using the simulation language SIMSCRIPT. Events in the simulation included takeoffs, departures, enroutes, missions, arrivals at Initial Approach Fixes (IAFs) and landings. To demonstrate potential use of the model, the problem of rescheduling Strategic Air Command (SAC) aircraft upon base closures was addressed. Two strategies for the diversion of such aircraft were developed, implemented and the results compared on the basis of impact on final destination bases and average aircraft airborne time. Strategy 1 entailed the rerouting of aircraft to designated alternate bases or to the nearest open base without constraint. Strategy 2 involved the selection of an alternate base by insuring that parking spaces and appropriate maintenance support were available. Finally, extensions to the model and recommendations are discussed. GRA

N79-31192*# Lockheed-California Co., Burbank.
TESTING AND ANALYSIS OF DUAL-MODE ADAPTIVE LANDING GEAR, TAXI MODE TEST SYSTEM FOR YF-12A
Max A. Gamon Sep. 1979 54 p refs Sponsored by NASA
(NASA-CR-144884; LR-28776) Avail: NTIS HC A04/MF A01 CSCL 01C

The effectiveness of a dual mode adaptive landing gear system in reducing the dynamic response of an airplane during ground taxiing was studied. The dynamic taxi tests of the YF-12A research airplane are presented. A digital computer program which simulated the test conditions is discussed. The dual mode system as tested provides dynamic taxi response reductions of 25 percent at the cg and 30 to 45 percent at the cockpit. A.W.H.

N79-31193*# Rockwell International Corp., Los Angeles, Calif. Aircraft Div.
RIDE QUALITIES CRITERIA VALIDATION/PILOT PERFORMANCE STUDY: FLIGHT TEST RESULTS Final Report
Louis U. Nardi, Harry Y. Kawana, and David C. Greek Sep. 1979 69 p refs
(Contract NAS4-2542)
(NASA-CR-144885; NA-78-897) Avail: NTIS HC A04/MF A01 CSCL 01C

Pilot performance during a terrain following flight was studied for ride quality criteria validation. Data from manual and automatic terrain following operations conducted during low level penetrations were analyzed to determine the effect of ride qualities on crew performance. The conditions analyzed included varying levels of turbulence, terrain roughness, and mission duration with a ride smoothing system on and off. Limited validation of the B-1 ride quality criteria and some of the first order interactions between ride qualities and pilot/vehicle performance are highlighted. An earlier B-1 flight simulation program correlated well with the flight test results. A.W.H.

N79-31194# Aeronautical Research Labs., Melbourne (Australia).
LOAD SPECTRUM MEASURING EQUIPMENT. PART 1: DETAILS OF MK 1 SYSTEM PRESENTLY USED TO ACQUIRE DATA IN WESSEX MK 31B HELICOPTERS
K. F. Fraser and U. R. Krieser Aug. 1978 54 p refs
(ARL-MECH-ENG-NOTE-371; AR-001-301) Avail: NTIS HC A04/MF A01

Measuring equipment was developed which uses a set of electromechanical counters to indicate the integrated time in seconds for which torque loading on a transmission component falls within each of a number of bands. Separation of the torque level into bands is made possible using a single transducer, an amplifier with zero and gain adjustments for setting the extremes of the torque range of interest, an analogue to digital converter and decoder to separate the torque range into bands and counters to totalize contributions in each band. Author

N79-31195*# Lockheed-Georgia Co., Marietta.
CORRELATION OF DATA RELATED TO SHOCK-INDUCED TRAILING-EDGE SEPARATION AND EXTRAPOLATION TO FLIGHT REYNOLDS NUMBER
J. F. Cahill and P. C. Connor Washington NASA Sep. 1979 82 p refs
(Contract NAS2-9331)
(NASA-CR-3178) Avail: NTIS HC A05/MF A01 CSCL 01C

Pressure data from a number of previous wind tunnel and flight investigations of high speed transport type wings were analyzed with the intent of developing a procedure for extrapolating low Reynolds number data to flight conditions. These analyses produced a correlation of the development of trailing-edge separation resulting from increases in Mach number and/or angle of attack and show that scale effects on this correlated separation development and the resulting shock location changes fall into a regular and apparently universal pattern. Further studies appear warranted to refine the correlation through a detailed consideration of boundary layer characteristics, and to evaluate scale effects on supercritical wings. Author

N79-31197# Douglas Aircraft Co., Inc., Long Beach, Calif.
EFFECT OF TRANSPORT/BOMBER LOADS SPECTRUM ON CRACK GROWTH Final Technical Report, Sep. 1976 - Sep. 1978
P. R. Abelkis Nov. 1978 217 p refs
(Contract F33615-76-C-3116)
(AD-A069287; AFFDL-TR-78-134) Avail: NTIS HC A10/MF A01 CSCL 01/3

This program investigated analytically and experimentally the effect of transport/bomber loads spectrum variations on crack growth. The spectrum represented a STOL transport (C-15) wing lower surface loading. The 116 spectrum variations were generated, grouped in the following categories: (1) baseline spectra, (2) mission mix, (3) sequence of missions, (4) individual flight length, (5) flight segments, (6) exceedances spectra, (7) design stress level, (8) valley/peak coupling, (9) low load truncation, (10) high infrequent loads, (11) clipping of large loads, (12) miscellaneous variations, and (13) combined variations. Spectra were generated as random cycle-by-cycle, flight-by-flight sequences. Analyses and tests were performed on 7475-T7651 aluminum, to .25 inches, starting with an initial through-the-thickness 0.03-inch crack out of a 1/4-inch diameter hole. Crack growth analysis predictions were made for all 116 spectra using the linear model. Crack growth tests were performed with 33 of these spectra. Good correlation was obtained between analysis and test results in all cases except with spectra dealing with increased frequency and magnitude of high infrequent loads and spectra which were drastically changed from a wing-type to a vertical tail-type spectrum. Largest effects on crack growth life, as measured in flight hours, was due to flight length, mission, mission mix, and design stress level variations. Based on the results of this program, fleetwide crack growth variations by a factor of 100 and 10 could be experienced, depending on whether it was short-term or long-term variation. GRA

N79-31198# Douglas Aircraft Co., Inc., Long Beach, Calif.
A USER'S MANUAL FOR A COMPUTER PROGRAM TO GENERATE FATIGUE SPECTRUM LOADING SEQUENCES Final Technical Report, Sep. 1976 - Sep. 1978
P. R. Abelkis, P. M. Lee, and B. P. Tate Nov. 1978 246 p refs
(Contract F33615-76-C-3116)
(AD-A069288; AFFDL-TR-78-136) Avail: NTIS HC A11/MF A01 CSCL 01/3

The report contains, in the form of a user's manual, the listing and complete description of a computer program to generate fatigue spectrum loading sequences. The program is specifically tailored for the development of random cycle-by-cycle, flight-by-flight loading sequences typical of aircraft structures. However, its general features allow the development of any type spectrum. The random sequence of cycles and flights is produced by a random number generator. Alternate non-random flight sequences can also be generated. The basic input data consists of loads exceedances spectra or data to calculate such spectra by the program. The program contains the following spectrum editing features: (1) truncation - elimination of cycles as a function of range and R, peak or valley, (2) clipping - loads below or above a specified clipping value are set equal to that value, (3) all loads in the spectrum are multiplied by a constant. The output is a valley, peak sequence of the loads spectrum. The spectrum may be read into a magnetic tape to be used in other analyses or in testing. GRA

N79-31199# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
INVESTIGATION OF ROLL PERFORMANCE FOR A HIGHLY NONLINEAR STATICALLY UNSTABLE FIGHTER-TYPE AIRCRAFT M.S. Thesis
Paul L. Vergez Mar. 1979 101 p refs
(AD-A069301; AFIT/GGO/EE/79-4) Avail: NTIS HC A06/MF A01 CSCL 01/3

A linearized model of a fighter-type aircraft with significant roll-pitch inertial coupling, including its full flight control system is required in order to conduct a comparative analysis between body axis rolls and velocity (stability) axis rolls. The stability of the aircraft is checked at various roll rates for both body axis and velocity axis rolls. This is done by examining the signs of the eigenvalues of the linearized model-positive for unstable and negative for stable. It is found that at various angles of attack the velocity axis rolls prove to be at least as stable and, in most cases, more stable than body axis rolls. The stability is also observable for various combinations of flight control systems. In developing a nonlinear coupled equation solver, a single equation with known solutions is considered first. This is done to show a simplified version of what the nonlinear program is required to do. Next, a pair of nonlinear coupled equations is analyzed. The development of the program for the single equation case proves to be successful, but certain problems arise when working with a pair of coupled equations. This thesis provides a good foothold on a method of analysis known as Bifurcation Analysis and Catastrophe Theory which can be used to solve the nonlinear coupled aircraft equations. This thesis presents some of the problems which could be encountered. GRA

N79-31200# Dayton Univ. Research Inst., Ohio.
FUEL TANK SURVIVABILITY FOR HYDRODYNAMIC RAM INDUCED BY HIGH VELOCITY FRAGMENTS. PART 2: NUMERICAL ANALYSES Final Report, Oct. 1977 - Oct. 1978
Sheldon H. Schuster and Jack S. Macales Wright-Patterson AFB, Ohio AFFDL Feb. 1979 104 p Prepared by California Research and Technology, Inc., Woodland Hills
(Contract F33615-77-C-2082; AF Proj. 2402)
(AD-A070128; AFFDL-TR-78-182-Pt-2) Avail: NTIS HC A06/MF A01 CSCL 01/3

Numerical finite difference CRALE and finite element NONSAP calculations of the behavior of fuel tank front panels, penetrated by steel fragments impacting at velocities of 1.0-2.0 km/sec were used to explain the phenomena observed in an accompanying experimental program Part I of this report. Analytic expressions for the variation of peak pressure and impulse along the panel as functions of fragment size, velocity, and panel areal density were derived from the finite difference runs and used as boundary conditions in the finite element calculations of panel failure and displacements. GRA

N79-31201# Douglas Aircraft Co., Inc., Long Beach, Calif.
WINDSHIELD TECHNOLOGY DEMONSTRATOR PROGRAM-CANOPY DETAIL DESIGN OPTIONS STUDY Final Report, Feb. 1977 - Sep. 1978
M. J. Coker, J. B. Hoffman, and J. J. Lawrence, Jr. Wright-Patterson AFB, Ohio AFFDL Sep. 1978 352 p refs
(Contract F33615-75-C-3105; AF Proj. 2202)
(AD-A070376; MDC-J7176; AFFDL-TR-78-114) Avail: NTIS HC A16/MF A01 CSCL 01/3

This report documents the work accomplished for the Windshield Technology Demonstrator Program. The studies, analyses, testing, and development accomplished during this program involved a total system approach required for aircraft canopies in the context of the continuing Air Force generic wind shield development programs. State-of-the-art applications of new transparency materials have been devised from both military and commercial aircraft with major attention directed to the topics of bird impact resistance, structural design integration, systems integration, and design for maintainability and reliability. The authors and Air Force Flight Dynamics Laboratory FEW agree that the various disciplines and essential technical design concepts represented, including associated reports noted in Section IV, should all be utilized in arriving at an optimum design of the canopy system for any production aircraft. GRA

N79-31202# Dayton Univ., Ohio. Research Inst.
FUEL TANK SURVIVABILITY FOR HYDRODYNAMIC RAM INDUCED BY HIGH VELOCITY FRAGMENTS. PART 1: EXPERIMENTAL RESULTS AND DESIGN SUMMARY Final Report, Sep. 1977 - Oct. 1978
S. J. Bless Wright-Patterson AFB, Ohio AFFDL Jan. 1979 127 p refs
(Contract F33615-77-C-2082; AF Proj. 2402)
(AD-A070113; UDR-TR-78-115-Pt-1; AFFDL-TR-78-182-Pt-1) Avail: NTIS HC A07/MF A01 CSCL 01/3

Failure data, displacement data, and pressure data were obtained from laboratory experiments. Panels were made from 7075- T6 and 2024- T3 aluminum and from graphite epoxy panel thicknesses were 1.6 to 6.35 mm. Protection included 10 mm ballistic foam and stiffeners. Projectiles were 5.6 g and 11.7 g spheres and cubes. Failures were always catastrophic, and failure thresholds were always abrupt. When cracks formed, they ran across the panels, except when stiffeners were present. In thin panels, cracks initiated at the corners of the perforation when cubical fragments were used. The entrance panel damage was primarily induced by the shock wave generated by the impact. The very high shock pressure resulted in impulsive loading of the panels that caused prompt crack formation. Cracks were propagated by the displacement field. GRA

N79-31203# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
EVALUATION OF F-111 WEAPON BAY AERO-ACOUSTIC AND WEAPON SEPARATION IMPROVEMENT TECHNIQUES Final Technical Report, 1 May 1976 - 1 Aug. 1978
Rodney L. Clark Feb. 1979 150 p refs
(AF Proj. 2404)
(AD-A070253; AFFDL-TR-79-3003) Avail: NTIS HC A07/MF A01 CSCL 01/3

Several aero-acoustic suppression devices have been evaluated which were considered feasible for installation on an F-111 aircraft for flight test evaluation. The most promising modification consists of a saw tooth spoiler mounted at the leading edge of the weapon bay. This device would be erected to a 90 degree position during the bay doors opening sequence. The spoiler is folded flush with the fuselage during all other flight conditions. Wind tunnel tests have shown that this spoiler improves the aero-acoustic environment within the open weapon bay and improves the weapon separation characteristics over the Mach range of .95 to 1.3 investigated during the drop test phase. GRA

N79-31204# Argonne National Lab., Ill.
ANALYSIS OF PLUME RISE FROM JET AIRCRAFT
R. J. Yamartino, J. Lee, S. Bremer, D. Smith, and J. Calman 1979 7 p refs Presented at the 4th Symp. on Turbulence, Diffusion and Air Pollution, Boston, 15-18 Jan. 1979 Sponsored in part by FAA and Air Force Prepared in cooperation with Environmental Research and Technology, Lexington, Mass.
(Contract W-31-109-eng-38)
(CONF-790142-1) Avail: NTIS HC A02/MF A01

Preliminary results of an investigation of the behavior of buoyant jet engine exhaust plumes in a crosswind are discussed and attempts are made to identify the degree to which the plume rise can be described by relationships developed for other types of sources. At least four factors were found to affect the rate of dilution of jet exhaust before it reached receptors adjacent to taxiways or runways: (1) turbulent mixing of the jet exhaust at the engine exit; (2) buoyant plume rise; (3) advective dilution; and (4) dispersion by ambient turbulence. DOE

N79-31205# Arinc Research Corp., Annapolis, Md.
RELIABILITY IMPROVEMENT WARRANTY TERMS AND CONDITIONS FOR THE INTEGRATED AVIONICS CONTROL SYSTEMS (IACS) Final Report, Jan. - Mar. 1979
Larry Cox May 1979 44 p
(Contract DAAB07-78-A-6606)
(AD-A069454; Rept-1573-01-1-1927) Avail: NTIS HC A03/MF A01 CSCL 01/3

The Advanced Systems Division of the U.S. Army Avionics Research and Development Activity at Fort Monmouth, New Jersey, has issued Engineering Development (ED) contracts to two contractors for the Integrated Avionics Control System (IACS). One of the features of the ED progam will be a complete logistics support analysis (LSA) of Reliability Improvement Warranty (RIW) as an alternative to Army organic support. ARINC Research Corportion assisted the IACS Project Office in the development of draft RIW terms and conditions on which the LSA will be based. This report presents the activities that were performed and describes the draft RIW and conditions that were developed. GRA

N79-31206*# National Aeronautics and Space Administration, Washington, D. C.
INVESTIGATION OF AIR STREAM FROM COMBUSTOR-LINER AIR ENTRY HOLES, 3
Tetsuro Aiba and Tokuji Nakano Aug. 1979 37 p refs Transl. into ENGLISH of "Ko fuka nenshoki no kukiko kara no nagare ni tsuite, 3" Natl. Aerospace Lab., Tokyo, NAL-TR-369, 1974 23 p Original language document was announced as N75-17358 Transl. by Scientific Translations Service, Santa Barbara, Calif.
(Contract NASw-3198)
(NASA-TM-75430; NAL-TR-369) Avail: NTIS HC A03/MF A01 CSCL 21E

Jets flowing from air entry holes of the combustor liner of a gas turbine were investigated. Cold air was supplied through the air entry holes into the primary hot gas flows. The mass flow of the primary hot gas and issuing jets was measured, and the behavior of the air jets was studied by the measurement of the temperature distribution of the gas mixture. The air jets flowing from three circular air entry holes, single streamwise long holes, and two opposing circular holes, parallel to the primary flow were studied along with the effects of jet and gas stream velocities, and of gas temperature. The discharge coefficient, the maximum penetration of the jets, the jet flow path, the mixing of the jets, and temperature distribution across the jets were investigated. Empirical expressions which describe the characteristics of the jets under the conditions of the experiments were formulated. A.W.H.

N79-31207*# General Electric Co., Cincinnati, Ohio.
EXPERIMENTAL CLEAN COMBUSTOR PROGRAM (ECCP), PHASE 3 Final Report
C. C. Gleason and D. W. Bahr 1 Jun. 1979 201 p refs
(Contract NAS3-19736)
(NASA-CR-135384; R79AEG410) Avail: NTIS HC A10/MF A01 CSCL 21E

A double annular advanced technology combustor with low pollutant emission levels was evaluated in a series of CF6-50 engine tests. Engine lightoff was readily obtained and no difficulties were encountered with combustor staging. Engine acceleration and deceleration were smooth, responsive and essentially the same as those obtainable with the CF6-50 combustor. The emission reductions obtained in carbon monoxide, hydrocarbons, and nitrogen oxide levels were 55, 95, and 30 percent, respectively, at an idle power setting of 3.3 percent of takeoff power on an EPA parameter basis. Acceptable smoke levels were also obtained. The exit temperature distribution of the combustor was found to be its major performance deficiency. In all other important combustion system performance aspects, the combustor was found to be generally satisfactory. K.L.

N79-31208*# Pratt and Whitney Aircraft, East Hartford, Conn. Commercial Products Div.
JT9D-70/59 IMPROVED HIGH PRESSURE TURBINE ACTIVE CLEARANCE CONTROL SYSTEM
W. O. Gaffin 8 Jun. 1979 66 p ref
(Contract NAS8-20630)
(NASA-CR-159661; PWA-5515-87C) Avail: NTIS HC A04/MF A01 CSCL 21E

The JT9D-70/59 high pressure turbine active clearance control system was modified to provide reduction of blade tip clearance when the system is activated during cruise operation. The modification increased the flow capacity and air impingement effectiveness of the cooling air manifold to augment turbine case shrinkage capability, and increased responsiveness of the airseal clearance to case shrinkage. The simulated altitude engine testing indicated a significant improvement in specific fuel consumption with the modified system. A 1000 cycle engine endurance test showed no unusual wear or performance deterioration effects on the engine or the clearance control system. Rig tests indicated that the air impingement and seal support configurations used in the engine tests are near optimum. K.L.

N79-31209# National Aviation Facilities Experimental Center, Atlantic City, N. J.
EXHAUST EMISSION TRAVERSE INVESTIGATION OF A JT3D-1 TURBOFAN ENGINE Final Report, Jan. 1975 - Aug. 1978
Gerald R. Slusher Jun. 1979 55 p refs
(FAA Proj. 201-521-100)
(AD-A072019; FAA-RD-79-23; FAA-NA-79-10) Avail: NTIS HC A04/MF A01 CSCL 21/5

The emissions in the exhaust plume of a JT3D-1 turbofan engine were investigated to optimize the shape, size, and location of fixed probes for acquiring representative emission samples. Traverse measurements of 153 points over the exhaust nozzle were accomplished with the sample points located in the corners of two inch squares forming a traverse grid. The average emission levels, contours, and profile distributions were determined. The predicted performances of area weighted cruciform and diamond probe designs were calculated from interpolations of the traverse contours. A.W.H.

N79-31210*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AN OVERVIEW OF NASA RESEARCH ON POSITIVE DISPLACEMENT TYPE GENERAL AVIATION ENGINES
E. E. Kempke and E. A. Willis 1979 40 p refs Presented at the Aircraft Systems and Technol. Meeting N. Y., 20-22 Aug. 1979; sponsored by AIAA
(NASA-TM-79254; E-165; AIAA-79-1824) Avail: NTIS HC A03/MF A01 CSCL 21E

The general aviation positive displacement engine program encompassing conventional, lightweight diesel, and rotary combustion engines is described. Lean operation of current production type spark ignition engines and advanced alternative engine concepts are emphasized. J.M.S.

N79-31211# National Aviation Facilities Experimental Center, Atlantic City, N. J.
EXHAUST EMISSIONS CHARACTERISTICS FOR A GENERAL AVIATION LIGHT AIRCRAFT TELEDYNE CONTINENTAL MOTORS TSIO-360-C PISTON ENGINE Final Report
Eric E. Becker May 1979 78 p refs
(FAA Proj. 201-521-100)
(AD-A070010; FAA-RD-79-14; FAA-NA-79-3) Avail: NTIS HC A05/MF A01 CSCL 21/2

The TSIO-360-C engine (S/N 300244) was tested to develop an exhaust emissions data base. This data base consists of currents of current production baseline emissions characteristics, lean-out emissions data, effects of leaning-out the fuel schedule on cylinder head temperatures, and data showing ambient effects on exhaust emissions and cylinder head temperatures. The engine operating with its current full-rich production fuel schedule could not meet the proposed Environmental Protection Agency (EPA) standard for carbon monoxide (CO) and unburned hydrocarbons (HC) under sea level standard-day conditions. The engine did, however, meet the proposed EPA standard for oxides of nitrogen (NOX) under the same sea level conditions. The results of engine testing under different ambient conditions (essentially sea level standard day to sea level hot day) are also presented, and these results show a trend toward higher levels of emissions output for CO and HC while producing slightly lower levels of NOX. J.M.S.

N79-31212*# United Technologies Corp., East Hartford, Conn.
AERODYNAMIC AND ACOUSTIC INVESTIGATION OF INVERTED VELOCITY PROFILE COANNULAR EXHAUST NOZZLE MODELS AND DEVELOPMENT OF AERODYNAMIC AND ACOUSTIC PREDICTION PROCEDURES Final Report
Richard S. Larson, Douglas P. Nelson, and Bradley S. Stevens Washington NASA Aug. 1979 223 p refs
(Contract NAS3-20061)
(NASA-CR-3168; PWA-5550-8) Avail: NTIS HC A10/MF A01 CSCL 21E

Five co-annular nozzle models, covering a systematic variation of nozzle geometry, were tested statically over a range of exhaust conditions including inverted velocity profile (IVP) (fan to primary stream velocity ratio > 1) and non IVP profiles. Fan nozzle pressure ratio (FNPR) was varied from 1.3 to 4.1 at primary nozzle pressure ratios (PNPR) of 1.53 and 2.0. Fan stream temperatures of 700 K (1260 deg R) and 1089 K(1960 deg R) were tested with primary stream temperatures of 700 K (1260 deg R), 811 K (1460 deg R), and 1089 K (1960 deg R). At fan and primary stream velocities of 610 and 427 m/sec (2000 and 1400 ft/sec), respectively, increasing fan radius ratio from 0.69 to 0.83 reduced peak perceived noise level (PNL) 3 dB, and an increase in primary radius ratio from 0 to 0.81 (fan radius ratio constant at 0.83) reduced peak PNL an additional 1.0 dB. There were no noise reductions at a fan stream velocity of 853 m/sec (2800 ft/sec). Increasing fan radius ratio from 0.69 to 0.83 reduced nozzle thrust coefficient 1.2 to 1.5% at a PNPR of 1.53, and 1.7 to 2.0% at a PNPR of 2.0. The developed acoustic prediction procedure collapsed the existing data with standard deviation varying from + or - 8 dB to + or - 7 dB. The aerodynamic performance prediction procedure collapsed thrust coefficient measurements to within + or - .004 at a FNPR of 4.0 and a PNPR of 2.0. Author

N79-31213*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AERODYNAMIC PERFORMANCE OF 1.38-PRESSURE-RATIO, VARIABLE-PITCH FAN STAGE
Royce D. Moore and Walter M. Osborn Sep. 1979 71 p
(NASA-TP-1502; E-9700) Avail: NTIS HC A04/MF A01 CSCL 21E

The performance of a variable pitch fan stage tested over a range of blade setting angles, speeds, and flows is presented. The fan was designed for a tip speed of 289.6 m/sec and a flow of 29.6 kg/sec. The measured performance agreed reasonably well with the design point. The stall margin was only 5 percent. Static thrust values along an operating line ranged from less than 15 to over 115 percent of that at design angle as the blade setting angle was varied from 25 degrees (closed) to -8 degrees (opened). The use of casing treatment increased the stall margin to 20.6 percent but decreased efficiency by 4 percentage points. A.W.H.

N79-31214*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
AERODYNAMIC PERFORMANCE OF AXIAL-FLOW FAN STAGE OPERATED AT NINE INLET GUIDE VANE ANGLES
Royce D. Moore and Lonnie Reid Sep. 1979 43 p refs
(NASA-TP-1510; E-9714) Avail: NTIS HC A03/MF A01 CSCL 21E

The overall performance of a fan stage with nine inlet guide vane angle settings is presented. These data were obtained over the stable flow range at speeds from 60 to 120 percent of design for vane setting angles from -25 to 42.5 degrees. At design speed and design inlet guide vane angle, the stage has a peak efficiency of 0.892 at a pressure ratio of 1.322 and a flow of 25.31 kg/s. The stall margin based on peak efficiency and stall was 20 percent. Based on an operating line passing through the peak efficiency point at the design setting angle, the useful operating range of the stage at design speed is limited by stall at the positive setting angles and by choke at the negative angles. At design the calculated static thrust along the operating line varied from 68 to 114 percent of that obtained at design setting angle. Author

N79-31215*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
CONCEPTUAL STUDY OF A TURBOJET/RAMJET INLET
John P. Weidner Washington Sep. 1979 25 p refs
(NASA-TM-80141; L-13036) Avail: NTIS HC A02/MF A01 CSCL 21A

An inlet concept for separate turbojet and ramjet engines was defined and compared with an equivalent inlet for a wraparound turboramjet engine. The comparison was made for a typical high altitude hypersonic cruise vehicle where the turbojet inlet capture area was required to be half as large as the ramjet inlet capture area at cruise. The use of a shorter nacelle having substantially lower cooling requirements at cruise for the inlet concept for separate turbojet and ramjet engines is suggested. The separate engine concept better isolates the turbojet from the ramjet, requires no special close off mechanisms within the turbojet, and avoids the circumferential heat load imposed by a wraparound ramjet. A more variable geometry is required. A.W.H.

N79-31216# North Carolina State Univ. at Raleigh. Engineering Design Center.
AN ACTUATOR DISK ANALYSIS OF AN ISOLATED ROTOR WITH DISTORTED INFLOW Progress Report, Jan. 1976 - Dec. 1978
John N. Perkins 31 Mar. 1979 31 p Prepared in cooperation with United Technologies Research Center, E. Hartford, Conn.
(Contract F44620-76-C-0055)
(AD-A069884; NCSU/EDC-79-1) Avail: NTIS HC A03/MF A01 CSCL 21/5

An analytical study of the passage of distorted flow through an isolated, high hub-tip ratio axial compressor is reported. The analysis involves the coupling of the unsteady blade row aerodynamic response (with the flow immediately upstream of the blade row prescribed) with the unsteady duct flow both upstream and downstream of the blade row under the influence of the blade row loading. The numerical solution uses a starting procedure which does not require the inlet plane to be far enough upstream to be unaffected by the presence of the blade row. Hence any experimentally determined distortion at any arbitrary distance upstream of the blade row can be modelled. The results obtained indicate that the predicted pressure profile at the blade row exit is strongly dependent on the experimentally determined steady-state loss and exit flow angle curves, but is almost independent of the magnitude of the first order lag coefficient used to represent the boundary layer time delay through the blade passages. GRA

N79-31217# RAND Corp., Santa Monica, Calif.
AIRCRAFT TURBINE ENGINE MONITORING EXPERIENCE: IMPLICATIONS FOR THE F100 ENGINE DIAGNOSTIC SYSTEM PROGRAM Interim Report, 1977 - 1978
J. L. Birkler and J. R. Nelson Apr. 1979 45 p refs
(Contract F49620-77-C-0023)
(AD-A069282; RAND/R-2391-AF) Avail: NTIS HC A03/MF A01 CSCL 20/5

This briefing report examines the experience gained from several aircraft turbine engine monitoring systems used over the last decade and a half and the implications of that experience for a new monitoring system--the Engine Diagnostic System--under development for the F100 engine on the F-15 and F-16 tactical fighter aircraft. The examination reveals that two different approaches to engine monitoring have evolved in attempts to achieve the goal of improved engine operations, maintenance, and management while reducing support costs. The first concentrates on short-term operations and maintenance aspects and is usually accomplished by recording inflight data in a snapshot mode, i.e., a few seconds of data either at predefined performance windows or when certain engine operating limits are exceeded. The second approach focuses on long-term design-oriented benefits through improved knowledge of the engine operating environment. To achieve the design-oriented benefits, data must be recorded continuously on at least a few aircraft at each operational location. GRA

N79-31218# Air Force Aero Propulsion Lab., Wright-Patterson AFB, Ohio.

AMBIENT CORRECTION FACTORS FOR AIRCRAFT GAS TURBINE IDLE EMISSIONS Technical Report, Jan. 1975 - Oct. 1978

William S. Blazowski and Joel W. Marzeski Mar. 1979 67 p refs Presented at the ASME Gas Turbine Conf., New Orleans, Mar. 1976

(AF Proj. 3048)

(AD-A069240; AFAPL-TR-79-2019) Avail: NTIS HC A04/MF A01 CSCL 20/5

Recent investigations have indicated that aircraft engine exhaust emissions are sensitive to ambient conditions. This paper reports on combustor rig testing intended to evaluate variations due to ambient temperature and pressure with special emphasis on idle engine operating conditions. Empirically determined CO, C sub x, H sub y, and NO sub x correction factors--the ratio of the pollutant emission index value obtained during standard day operation to that resulting during actual ambient conditions--are presented. The effects of engine idle cycle pressure ratio, primary zone fuel-air ratio, and fuel type were investigated. Ambient temperature variations were seen to cause substantial emission changes; correction factors in excess of 2.0 were determined in some cases. Ambient pressure variations were found to be less substantial. A previously published NO sub x emission model and a simplified hydrocarbon combustion analysis are shown to be in general agreement with the empirical results. GRA

N79-31220*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.

ANALYSIS OF A LATERAL PILOT-INDUCED OSCILLATION EXPERIENCED ON THE FIRST FLIGHT OF THE YF-16 AIRCRAFT

John W. Smith Sep. 1979 53 p refs

(NASA-TM-72867) Avail: NTIS HC A04/MF A01 CSCL 01C

In order to compare and assess potential improvements, two control systems were modeled; the original first flight or prototype aircraft system, and a modification of the prototype system, which essentially reduced the overall gain for the takeoff and landing phase. In general, the overall system gain reduction of the modified flight control system was sufficient to avoid lateral pilot-induced oscillation tendencies. Lowering the system gain reduced the tendency to rate saturate, which resulted in correspondingly higher critical pilot gains for the same control input. Author

N79-31221*# Honeywell Systems and Research Center, Minneapolis, Minn.

HELICOPTER HIGH GRAIN CONTROL Final Report

Thomas B. Cunningham and Edwin C. Nunn Jul. 1979 171 p refs

(Contract NAS1-14789)

(NASA-CR-159052; HONEYWELL-79SRC33) Avail: NTIS HC A08/MF A01 CSCL 01C

High gain control is explored through a design study of the CH-47B helicopter. The plans are designed to obtain the maximum bandwidth possible given the hardware constraints. Controls are designed with modal control theory to specific bandwidths and closed loop mode shapes. Comparisons are made to an earlier complementary filter approach. Bandwidth improvement by removal of limitations is explored in order to establish hardware and mechanization options. Improvements in the pitch axis control system and in the rate gyro sensor noise characteristics in all axes are discussed. The use of rotor state feedback is assessed. A.W.H.

N79-31222*# Systems Technology, Inc., Mountain View, Calif.

A COMPILATION AND ANALYSIS OF HELICOPTER HANDLING QUALITIES DATA. VOLUME 2: DATA ANALYSIS

Robert K. Heffley Aug. 1979 176 p refs

(Contract NAS2-9344)

(NASA-CR-3145; TR-1087-2-Vol-2) Avail: NTIS HC A09/MF A01 CSCL 01C

A compilation and an analysis of helicopter handling qualities data are presented. Multiloop manual control methods are used to analyze the descriptive data, stability derivatives, and transfer functions for a six degrees of freedom, quasi static model. A compensatory loop structure is applied to coupled longitudinal, lateral and directional equations in such a way that key handling qualities features are examined directly. A.W.H.

N79-31223*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

THEORETICAL AND EXPERIMENTAL INVESTIGATION OF GROUND-INDUCED EFFECTS FOR A LOW-ASPECT-RATIO HIGHLY SWEPT ARROW-WING CONFIGURATION

Paul L. Coe, Jr. and James L. Thomas Washington Sep. 1976 102 p refs

(NASA-TP-1508; L-13088) Avail: NTIS HC A06/MF A01 CSCL 01C

An investigation was conducted in a V/STOL tunnel to determine the influence of ground proximity on the aerodynamic characteristics of a low-aspect-ratio highly swept arrow-wing configuration. The experimental results showed that as the height above the ground decreases, the configuration experiences substantial increases in lift and reductions in induced drag. Although a significant percentage of these ground-induced performance improvements are lost due to trim requirements, the net performance improvement remains quite favorable. The tests also showed that decreasing ground height results in a substantial increase in the horizontal-tail contribution to longitudinal stability. Comparison of the experimental results with results predicted by a planar vortex-lattice theoretical model shows that the theoretical model provides a good estimate of the ground-induced effect on lift, drag, and longitudinal stability for the wing-body combination. However, the theoretical model does not adequately predict either the zero lift pitching moment or the horizontal-tail downwash characteristics. Author

N79-31224# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

THE DESIGN OF DIGITAL CONTROLLERS FOR THE C-141 AIRCRAFT USING ENTIRE EIGENSTRUCTURE ASSIGNMENT AND THE DEVELOPMENT OF AN INTERACTIVE COMPUTER DESIGN PROGRAM M.S. Thesis

Thomas A. Kennedy Mar. 1979 194 p refs

(AD-A069192; AFIT/GGC/EE/79-1) Avail: NTIS HC A09/MF A01 CSCL 01/2

In this report, a deadbeat tracker and regulator are developed for the C-141 aircraft for three different flight conditions using the method of entire eigenstructure assignment. A heuristic iterative method is presented for determining an 'optimal' sampling time for deadbeat controllers by using the controllability matrix. In order to perform the above designs and to evaluate them through a continuous-time simulation, a computer aided design program is developed. This program allows the complete design and simulation of regulator, tracker, and disturbance rejection control systems with full-order observers. In addition, the program permits complete state-space analysis of the system being designed, including both discrete and continuous-time responses. A user's manual and programmer's guide are provided for further development of the program. GRA

N79-31225# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.

INVESTIGATION OF INVERSE VANDERMONDE MATRIX CALCULATION FOR LINEAR SYSTEM APPLICATIONS M.S. Thesis

Donald Paul Seyler Mar. 1979 178 p refs

(AD-A069241; AFIT/GGC/EE/79-2) Avail: NTIS HC A09/MF A01 CSCL 12/1

Efficient inversion of a 2n x 2n Vandermonde matrix is a key requirement of a new algorithm developed for parameter identification in linear time-invariant systems. It has features very desirable for application to large systems with many unknown parameters, such as adaptive flight control systems. A generalized algorithm for inverting the Vandermonde matrix was proposed. It was chosen for study because its structure parallels that of the first algorithm. The algorithm was coded into a computer subroutine called 'VANINV', and 43 eigensystems were used to test its computational accuracy and efficiency. Four potential problem areas tested were: large system orders, eigenvalues near each other, eigenvalues near zero, and eigenvalues with large magnitude differences. For a comparison, the Vandermonde matrix for each system was also inverted using routines from the International Mathematical and Statistical Library (IMSL). Test results indicated that VANINV is not quite as fast or as accurate as the IMSL routines. However, the tests were limited to systems with real distinct eigenvalues because the IMSL routines cannot handle other types. VANINV in its present form can handle systems having any combination of complex and/or repeated eigenvalues. Therefore, recommendations for further research and several possible means of improving VANINV are outlined. GRA

N79-31226# Honeywell, Inc., St. Louis Park, Minn. Avionics Div.
PROGRAM FOR THE CRITICAL COMPONENTS OF A FLY-BY-TUBE BACKUP FLIGHT CONTROL SYSTEM, PART 1 Final Report, 1 Jan. - 15 Dec. 1978
Walter M. Posingies 15 Jan. 1979 121 p
(Contract N62269-78-C-0003)
(AD-A070387; W0471-FR1-Pt-1; NADC-77197-60-Pt-1) Avail: NTIS HC A06/MF A01 CSCL 01/3

This report presents the results of a program to develop two of the critical components in an advanced fluidic backup primary flight control system defined as the fly-by-tube concept. Components developed include an input transducer, which converts pilot commands into hydraulic differential pressure signals, and fluidic resistor networks that sum these hydraulic signals together to provide the required servoactuator commands. Results show that this concept which uses signal levels up to 400 PSID is accurate, linear, quiet, simple, low cost, relatively insensitive to changes in fluid viscosity, and has a stable null with adequate response. GRA

N79-31227# Systems Control, Inc., Palo Alto, Calif.
PATH CONTROLLERS: UNIFICATION OF CONCEPTS AND COMPARISON OF DESIGN METHODS Final Technical Report, Sep. 1977 - Sep. 1978
J. E. Jones and J. S. Karmarkar Dec. 1978 123 p refs
(Contract F33615-77-C-3079; AF Proj. 2403)
(AD-A070252; AFFDL-TR-78-178) Avail: NTIS HC A06/MF A01 CSCL 01/3

This report documents the basic theme of a series of seminars presented to the Air Force Flight Dynamics Laboratory concerning the role of modern control theory in advanced aircraft guidance and control concepts. The report discusses a number of optimal guidance and control concepts as cast in a path-control formal structure. Trajectory generation concepts include horizontal guidance with and without controlled time of arrival, threat avoidance, performance optimization, and terrain following. Control concepts include linear optimal control and classical techniques. Research areas of high potential payoff are identified. GRA

N79-31228* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
SEAT CUSHION TO PROVIDE REALISTIC ACCELERATION CUES TO AIRCRAFT SIMULATOR PILOT Patent
Billy R. Ashworth, inventor (to NASA) Issued 14 Aug. 1979 10 p Filed 26 Jul. 1978 Supersedes N78-30821 (16 - 21 p 2857) Continuation-in-part of abandoned US Patent Appl. SN-829314, filed 31 Aug. 1977
(NASA-Case-LAR-12149-2; US-Patent-4,164-079; US-Patent-Appl-SN-829314; US-Patent-Appl-SN-928131; US-Patent-Class-35-12E; US-Patent-Class-35-12H) Avail: US Patent and Trademark Office CSCL 14B

Seat cushions, each including an air cell with a non-compressible surface, are disclosed. The apparatus are provided for initially controlling the air pressure in the air cells to allow the two main support areas of the simulator pilot to touch the non-compressible surface and thus begin to compress the flesh near these areas. During a simulated flight the apparatus control the air pressure in the cells to simulate the events that occur in a seat cushion during actual flight. Author

N79-31229# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany).
CONTRIBUTIONS TO EXPERIMENTAL FLUID MECHANICS [BEITRAGE ZUR EXPERIMENTELLEN STROMUNGSMECHANIK]
1977 216 p refs In GERMAN
Avail: NTIS HC A10/MF A01

Various aspects of the reconstruction of aerodynamics testing facilities in West Germany following World War 2 are described in this festschrift honoring Dr. Hubert Ludwieg. His contributions in the development of the high-speed wind tunnel, the 1m x 1m wind tunnel, and the transonic turbine nozzle are stressed. Experiments in spiral flow stability and the application of heated surface elements (films) to measure shear stress on the wall in the three dimensional boundary layer are also discussed. A biography of the scientist a. I a list of his scientific publications is included. A.R.H.

N79-31230*# National Aeronautics and Space Administration, Washington, D. C.
WIND TUNNELS WITH ADAPTED WALLS FOR REDUCING WALL INTERFERENCE
U. Ganzer Aug. 1979 14 p refs Transl. into ENGLISH of Z. fur Flugwissenchaften und Weltraumforschung (West Germany), v 3, no. 2, 1979 p 129-133 Transl. by Kanner (Leo) Associates, Redwood City, Calif. Original doc. prep. by Aero-Space Inst. of Berlin (West Germany)
(Contract NASw-3199)
(NASA-TM-75501) Avail: NTIS HC A02/MF A01 CSCL 14B

The basic principle of adaptable wind tunnel walls is explained. First results of an investigation carried out at the Aero-Space Institute of Berlin Technical University are presented for two dimensional flexible walls and a NACA 0012 airfoil. With five examples exhibiting very different flow conditions it is demonstrated that it is possible to reduce wall interference and to avoid blockage at transonic speeds by wall adaptation. Author

N79-31231# Federal Aviation Administration, Washington, D. C.
POTENTIAL CLOSURE OF AIRPORTS
Jan. 1978 40 p
Avail: NTIS HC A03/MF A01

Airports which are expected to be converted to nonaviation use are identified and measures are suggested to forstall this in cases where the airports involved could help meet transportation and community objectives. The problems cited for the closings are high property taxes, and the high cost of capital improvements and airfield maintenance. Measures examined to aid airports are tax exemptions, zoning and land use controls, and financial aid to assist airport development and maintenance. A.W.H.

N79-31232# Federal Aviation Administration, Washington, D. C.
ADVISORY CIRCULAR. THE PLANNING GRANT PROGRAM FOR AIRPORTS
31 Jan. 1979 75 p
(AC150/5900-1B) Avail: NTIS HC A05/MF A01

The process for applying for grants to prepare airport system plans and airport master plans is described as well as the administrative procedures to be followed in performing planning projects. R.E.S.

N79-31233# Naval Air Engineering Center, Lakehurst, N.J.
SURVEYS OF GROOVES IN 19 BITUMINOUS RUNWAYS Final Report
Richard Melone Mar. 1979 60 p refs
(Contract FA74WAI-423; FAA Proj. 082-431-02)
(AD-A069889; FAA-RD-79-28; NAEC-TD-Misc-R8) Avail: NTIS HC A04/MF A01 CSCL 01/5

The extent and frequency of problems, such as chipping, cracking, rounding, wearing, distorting, and contaminating of the runway grooves were determined A total of ten different problem areas was identified during the survey with wear, running together (closing), and rubber deposits being the most serious of the ten. In general, the grooves were in satisfactory condition and did not result in abnormal deterioration of runway surfaces. Three of the 19 runways surveyed appeared in need of resurfacing and/or regrooving. Groove depths averaged less than the required 1/4 inch, while groove width and pitch measured close to specified dimensions. M.M.M.

N79-31234# Mitre Corp., McLean, Va. METREK Div.
RUNWAY CONFIGURATION MANAGEMENT SYSTEM CONCEPTS Final Report
A. N. Sinha and R. L. Fain May 1979 20 p refs
(Contract DOT-FA79WA-4184)
(AD-A069960; MP-79W00018) Avail: NTIS HC A02/MF A01 CSCL 01/5

Airport congestion is a problem at the busy airports in the U. S. today. Even under moderate growth projections, the problem of increasing delays will worsen at these busy airports, and will spread to other airports which would approach saturation conditions. While long term relief to the congestion problem would be provided by technological improvements, it is essential to fully and efficiently utilize the existing facilities to avoid excessive delays in the near term. This paper addresses the problem of selecting optimal runway configurations to minimize delays through the use of a Runway Configuration Management System. Three concepts of this system are developed to represent the full range of static and dynamic configuration selection processes. The basic model, representing the first level concept, has been developed for Chicago O'Hare International Airport. The applicaton of the model at O'Hare and its possible extensions are also discussed. GRA

N79-31235# Decision Science, Inc., San Diego, Calif.
TACTICAL PERFORMANCE CHARACTERIZATION BASIC METHODOLOGY Final Report, Dec. 1977 - Sep. 1978
Michael J. Walsh, George H. Burgin, and Lawrence J. Fogel May 1979 65 p refs
(Contract F33615-78-C-0011)
(AD-A069297; AFHRL-TR-78-94) Avail: NTIS HC A04/MF A01 CSCL 05/9

This effort is to develop new methods of characterizing important features of tactical performance for display at an instructor/operator station of a flight simulator. In particular, the work included developing a technique for computing the weight or importance that a pilot assigns to various performance criteria. The work documented here represents the first of a two-phase program. Phase 1 involved developing the basic techniques and methods without collecting extensive pilot data. Phase 2 involves applying the methods to real pilot data collected on the Simulator for Air-to-Air Combat. The approach was based upon a previously developed Adaptive Maneuvering Logic (AML) program. This program operates one-on-one against a real opponent to provide practice in combat flying. It operates by computing a 'score' for each of several alternative next-moves and then executing the move rated highest. The score consists of a sum of weights assigned to each of the various criteria that would be satisfied if the move in question were chosen. The weights are fixed in the AML program. Thus, the program uses a fixed set of weights to produce a simulated performance. GRA

N79-31236# General Electric Co., Daytona Beach, Fla. Ground Systems Dept.
LABORATORY DEVELOPMENT OF COMPUTER GENERATED IMAGE DISPLAYS FOR EVALUATION IN TERRAIN FLIGHT TRAINING Final Report
Roland F. Pester 21 Feb. 1979 22 p refs
(Contract DAHC19-77-C-0006; DA Proj. 2Q7-63743-A-772)
(AD-A070065; ARI-RN-79-8) Avail: NTIS HC A02/MF A01 CSCL 05/9

This report describes the formulation of a digital data base and the equipment utilized to display computer generated images of the resultant terrain scenes. Real time and nonreal time equipment equipment is described. Necessary input data for formulation of digital data bases is delineated. Resulting scene data is to be utilized as stimulus material for evaluation of CGI systems to determine their effectiveness as a medium for training navigators and pilots. Author (GRA)

N79-31237# National Bureau of Standards, Washington, D. C. Fluid Engineering Div.
A LOW-VELOCITY AIRFLOW CALIBRATION AND RESEARCH FACILITY Final Technical Note
L. P. Purtell and F. S. Klebanoff Mar. 1979 26 p refs
(Contract DI-BM-HO-133024)
(PB-294501/2; NBS-TN-989) Avail: NTIS HC A03/MF A01 CSCL 14B

A low velocity airflow facility suitable for the calibration of wind speed measuring instruments and research in aerodynamics is described. The flow facility is of the open return type with a test section 20 feet long, and nominally 3 x 3 feet in cross section. Special attention was given to obtaining an air stream with a high degree of spatial uniformity and low turbulence with excellent speed control over the range from 10 to 3300 feet per minute. Laser-optical methods with appropriate signal processing electronics were employed to establish a primary standard for the measurement of very low velocities. Detailed performance characteristics of flow facility and the laser velocity standard are presented. GRA

N79-31354*# Boeing Commercial Airplane Co., Seattle, Wash.
DEVELOPMENT OF AIRCRAFT LAVATORY COMPARTMENTS WITH IMPROVED FIRE RESISTANCE CHARACTERISTICS. PHASE 2: SANDWICH PANEL RESIN SYSTEM DEVELOPMENT Final Report
R. A. Anderson, D. B. Arnold, and G. A. Johnson 1979 284 p refs
(Contract NAS2-8700)
(NASA-CR-152120; D6-46839) Avail: NTIS HC A13/MF A01 CSCL 11D

A NASA-funded program is described which aims to develop a resin system for use in the construction of lavatory wall panels, sidewall panels, and ceiling panels possessing flammability, smoke and gas emission, and toxicity (FS&T) characteristics superior to the existing epoxy resin. Candidate resins studied were phenolic, polyimide, and bismaleimide. Based on the results of a series of FS&T as well as mechanical and aesthetic property tests, a phenolic resin was chosen as the superior material. Material and process specifications covering the phenolic resin based materials were prepared and a method of rating sandwich panel performance was developed. A.R.H.

N79-31357# Naval Weapons Center, China Lake, Calif.
THERMAL CHARACTERISTICS OF 3501-6/AS AND 5208/T300 GRAPHITE EPOXY COMPOSITES Research Report, Feb. - Sep. 1978
Robert F. Kubin May 1979 24 p
(AD-A071067; NWC-TP-6104) Avail: NTIS HC A02/MF A01 CSCL 11/4

The thermal characteristics of two graphite epoxy composites for use as aircraft structural components have been investigated. The activation energies and heats of reaction for pyrolysis of the composites were found to be 19.7 kcal/mole and -18.4 cal/g for 3501-6/AS and 25.0 kcal/mole and -20.4 cal/g for 5208/T300, respectively. The kinetic parameters enable prediction of thermal degradation at flight temperatures. In fire fighting, bulk material temperatures must be reduced well below 300 C to prevent continuation of exothermic pyrolysis reactions. It was also found that differential scanning calorimetry provides a more sensitive test of composite cure than reflectance infrared measurements. GRA

N79-31461# Carleton Univ., Ottawa (Ontario). Dept. of Systems Engineering and Computing Science.
A NOVEL APPROACH TO THE DESIGN OF AN ALL DIGITAL AERONAUTICAL SATELLITE COMMUNICATION SYSTEM
M. E. Ulug *In* AGARD Digital Commun. in Avionics Jun. 1979 16 p refs
Avail: NTIS HC A20/MF A01 CSCL 17B

The design of an all digital aeronautical satellite communication system based on the transparent intelligent network (TI-NET) is described. The novel features of the system, namely a 9.6 kb/s ground to aircraft link which provides a TDMA operation and the statistical multiplexing of the encoded voice and data were experimentally tried out using 12-14 GHz satellite link between Carleton University, in Ottawa, Canada and the NASA AMES Research Center in Palo Alto, California using Hermes (CTS) satellite. Other unique features of the system are the trading off of the satellite up-down delay with the packet formation delay, multi-polling and multiaddressing capability, and the complete transparency to the user's protocol. In addition, the system has a turn around time of 22.5 ms. which is most useful in making quick changes in the polling sequence, as well as producing fast re-transmissions. A polling algorithm which meets the particular needs of the aircraft in high, medium, and low density areas is described. The terrestrial network connecting the communication centers and ground stations in North America is also discussed and its associated interfaces and protocols are defined. It is believed that the proposed system will result in a more efficient use of the communication channels, greater immunity against noise, and a less complex airborn computer with smaller memory. Although the system design is based on a set of hypothetical traffic data, the model can be readily modified to perform at a higher or lower traffic level. In this connection another system using a 4.8 kb/s ground-aircraft link is described and its performance compared with that of the proposed model. J.M.S.

N79-31463# Eurocontrol Agency, Maastricht (Netherlands).
A DIGITAL COMMUNICATION SYSTEM AS GATEWAY BETWEEN ADJACENT COMPUTERIZED AIR TRAFFIC CONTROL CENTRES
M. Baum *In* AGARD Digital Commun. in Avionics Jun. 1979 14 p refs
Avail: NTIS HC A20/MF A01

A practical approach to improve data communication between adjacent computerized air traffic control centers is described. The applied concept is communication procedure conversion by which systems with incompatible transmission procedures can communicate with each other via a gateway system. Procedure conversion meets the basic requirement which is not to intervene in the functioning of the involved local networks and not to require modifications of locally used procedure envelopes. The transit function is realized by conversion of the procedure specific message type and priority on one hand and of address information on the other hand. A flexible table mechanism is chosen instead of fixed coding. Outstanding problems are an efficient link failure processing and an envisaged attachment of a circuit switching function to the message switching principle. J.M.S.

N79-31468# Standard Elektrik Lorenz A.G., Stuttgart (West Germany).
AN ASYNCHRONOUS DATA TRANSMISSION SYSTEM WITH LOW ERROR PROBABILITY FOR THE SETAC LANDING AID
Wolfgang Beier *In* AGARD Digital Commun. in Avionics Jun. 1979 5 p
Avail: NTIS HC A20/MF A01

A serial code which is used in the TACAN compatible landing aid SETAC is described. Its features are optimized for the expected error rate and types of errors as well as for the data transmission rate and the accepted error rate after correction. R.E.S.

N79-31476# Royal Aircraft Establishment, Farnborough (England). Radio and Navigation Dept.
PERFORMANCE PREDICTIONS AND TRIALS OF A HELICOPTER UHF DATA LINK
R. M. Harris *In* AGARD Digital Commun. in Avionics Jun. 1979 17 p refs
Avail: NTIS HC A20/MF A01

A combination of theoretical and experimental studies conducted in order to estimate the bit error rate performance of a digital communication system are reviewed. The system is proposed for the transmission of binary digital data over dedicated simplex UHF radio links between helicopters, and between helicopters and ships. Initial predictions of system performance were based on known characteristics of some helicopter-installed systems and classical treatment of multipath radio wave propagation over a smooth sea. The probability of achieving a particular grade of service was considered as the arithmetical product of several independent statistical parameters. Some of these were related to the temporal and spatial variability of radio wave propagation; others reflected the almost random orientation of the aircraft under operational conditions affecting the signal received via the aircraft's radiation pattern. A method of statistical analysis based on approximate Gaussian frequency distribution functions was applied to the experimental data. Performance predictions are presented in terms of time availability for selected bit error rates. R.E.S.

N79-31478# Technische Universitaet, Brunswick (West Germany).
MULTIPATH PROPAGATION MEASUREMENT BY DOPPLER TECHNIQUE
P. Form, R. Springer, H. Bothe, and K. Klein *In* AGARD Digital Commun. in Avionics Jun. 1979 23 p refs Prepared in cooperation with DFVLR, Brunswick

Avail: NTIS HC A20/MF A01

Some microwave landing system features are discussed with respect to multipath propagation. For illustration of specific multipath effects, a Doppler-shift measurement technique with high angle resolution is presented, which needs simple antennas and equipment and offers easy interpretation. M.M.M.

N79-31480# Technische Universitaet, Brunswick (West Germany). Inst. fuer Nachrichtentechnik.
INVESTIGATION ON INFORMATION ERROR CAUSED BY TRAFFIC LOADING IN APPROACH AND LANDING SYSTEMS
Wolfgang Skupin *In* AGARD Digital Commun. in Avionics Jun. 1979 15 p
Avail: NTIS HC A20/MF A01

For the evaluation of a required approach and landing systems with statistical interrogation ALSSI serving capacity, a traffic model was developed. This model is based on the operational requirements and gives a defined standard traffic volume for a ALSSI. For investigating the reply efficiency and the accuracy of an ALSSI several methods can be employed. By means of probability calculations the reply efficiency can be determined with comparatively low expense. For the determination of the accuracy it is useful to carry out real world system tests with a test a/c. Because of less expense the traffic load is simulated with these tests by pulse generators. More flexibility can be achieved by employing a software simulation. For this a computer model of the traffic loading has to be installed as well as a computer model of the system to be investigated. Some results achieved by employing these methods are presented. M.M.M.

N79-31481# Rome Air Development Center, Griffiss AFB, N.Y.
NEW DEVICES FOR DIGITAL COMMUNICATIONS IN AVIONICS
F. I. Diamond, H. J. Bush, and J. A. Graniero *In* AGARD Digital Commun. in Avionics Jun. 1979 9 p refs

Avail: NTIS HC A20/MF A01

Technological advances in microelectronics to improve capabilities and reduce complexity of digital communication systems in the aircraft industry are assessed. M.M.M.

N79-31482# California Univ., San Diego, La Jolla.
TRANSFORM DOMAIN PROCESSING FOR DIGITAL COMMUNICATION SYSTEMS USING SURFACE ACOUSTIC WAVE DEVICES
L. B. Milstein, D. R. Arsenault, and P. Das *In* AGARD Digital Commun. in Avionics Jun. 1979 16 p refs Prepared in cooperation with Rensselaer Polytech. Inst.
Avail: NTIS HC A20/MF A01

A surface acoustic wave receiver is presented. This device is light and small enough to be used on board aircraft and can receive continuous time-digital signals accurately and securely. The detection of digital signals in the presence of Gaussian noise and interference using this device is studied. M.M.M.

N79-31487# Rensselaer Polytechnic Inst., Troy, N. Y. Electrical and Systems Engineering.
STATE OF THE ART IN DIGITAL SIGNAL PROCESSING WITH APPLICATIONS TO MULTIPLE ACCESS SYSTEMS
Lester A. Gerhardt *In* AGARD Digital Commun. in Avionics Jun. 1979 9 p refs

Avail: NTIS HC A20/MF A01

Advanced developments and trends in the fields of digital signal processing and digital communications were reported. The effects of microprocessors and minicomputers in this development were addressed. The availability of new devices, device technology, and directions are summarized with respect to the emphasis on speed. A discussion of CDM, CDMA, SSMA, and TDMA was reported. The Joint Tactical Information Distribution System was described as a system concept. M.M.M.

N79-31491# Mitre Corp., Bedford, Mass.
IMPLEMENTING JTIDS IN TACTICAL AIRCRAFT
David R. McMillan *In* AGARD Digital Commun. in Avionics Jun. 1979 13 p
Avail: NTIS HC A20/MF A01

The implementation of a high capacity, secure, jam-resistant time division multiple access information system for providing integrated communications, navigation, and identification capabilities is discussed. Major characteristics of the joint tactical information distribution system (JTIDS) in tactical aircraft are summarized and relevant elements of the JTIDS program plan are highlighted. The context for specific requirements to be satisfied with aircraft installations are established in terms of operational functions, sources and sinks of information which support those functions, and current information distribution systems and man-machine interfaces which mechanize the transfer to and from tactical aircraft and their crews. The relative benefit of JTIDS over present solutions to operational information needs is established in this context. An overview of key elements of the tactical aircraft implementation challenge is included. A.R.H.

N79-31524# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany).
CONTRIBUTIONS TO FLUID MECHANICS [BEITRAEGE ZUR STREMUNGSMECHANIK]
1978 184 p refs In GERMAN
Avail: NTIS HC A09/MF A01

Ten articles are presented which cover a wide spectrum of research in the field of theoretical and experimental fluid mechanics. The titles of the articles are: (1) Development of Data Acquistition and Processing Systems for a 3 mm Wind Tunnel; (2) Airfoil Lift in Compressible Subsonic Flow with Separation; (3) Sound Generation in an Induction Motor Fan; (4) The Hypersonic Vacuum Tunnel; (5) Remarks on a Hydraulic Ram; (6) Experimental and Theoretical Pressure Distribution on the Ellipsoid of Revolution; (7) Theoretical Study of the Effect of the Pressure Fluctuation Component in Three Dimensional Turbulent Boundary Layers; (8) Variations of a Parallel Flow Along a Flat Plate Due to a Normally Directed Free Jet; (9) Effects of Solid Boundary Surface in a Flow about a Profile with Separation; and (10) Introduction to the Electronic Data Processing to Improve Cataloging in the Library of the Aerodynamic Testing Facilities in Goettingen. G.Y.

N79-31530# Von Karman Inst. for Fluid Dynamics, Rhode-Saint-Genese (Belgium).
MECHANICS OF BOUNDARY LAYER TRANSITION, PART 2: INSTABILITY AND TRANSITION TO TURBULENCE
Mark V. Morkovin (Martin Co., Baltimore, Md.) Feb. 1968 176 p refs Lecture held at Rhode-Saint-Genese, Belgium 3 Vol.
(VKI-Lecture-Series-3-Pt-2) Avail: NTIS HC A09/MF A01

Instability and transition from laminar to turbulent shear layers is discussed. Topics include advances in understanding the transition and contradictions in transition research. Transition correlations for hypersonic wakes, three dimensional boundary layers, laminar suction wings, heat transfer and boundary layer transition, and Reynolds number effects are covered.

N79-31533*# Douglas Aircraft Co., Inc., Long Beach, Calif.
A NEW APPROACH TO THE SOLUTION OF LARGE, FULL MATRIX EQUATIONS: A TWO-DIMENSIONAL POTENTIAL FLOW FEASIBILITY STUDY Final Report
R. M. James and R. W. Clark Washington NASA Sep. 1979 83 p refs
(Contract NAS1-14892)
(NASA-CR-3173) Avail: NTIS HC A05/MF A01 CSCL 20D

An approach to the solution of matrix problems resulting from integral equations of mathematical physics is presented. Based on the inherent smoothness in such equations, the problem is reformulated using a set of orthogonal basis vectors, leading to an equivalent coefficient problem which can be of lower order without significantly impairing the accuracy of the solution. This approach was evaluated using a two-dimensional Neumann problem describing the inviscid, incompressible flow over an airfoil. Two different kinds of mode functions were investigated, namely eigenfunction series and Fourier series. The method using Fourier series was found preferable. It uses all of the coefficients from a Fast Fourier Transform algorithm in an approximate method which exploits the known structure of the transformed coefficient matrix and very promising results for the flow over a realistic airfoil are obtained. On the basis of the results presented here, an order of magnitude reduction in this computer time can be expected for such problems as compared with the time for a direct matrix solution. M.M.M.

N79-31624*# Boeing Commercial Airplane Co., Seattle, Wash.
ATLAS, AN INTEGRATED STRUCTURAL ANALYSIS AND DESIGN SYSTEM. VOLUME 5: SYSTEM DEMONSTRATION PROBLEMS
R. A. Samuel, ed. Jul. 1979 271 p refs
(Contracts NAS1-12911; DAAG46-75-C-0072)
(NASA-CR-159045; D6-25400-0005-Vol-5) Avail: NTIS HC A12/MF A01 CSCL 20K

One of a series of documents describing the ATLAS System for structural analysis and design is presented. A set of problems is described that demonstrate the various analysis and design capabilities of the ATLAS System proper as well as capabilities available by means of interfaces with other computer programs. Input data and results for each demonstration problem are discussed. Results are compared to theoretical solutions or experimental data where possible. Listings of all input data are included. G.Y.

N79-31628*# Rockwell International Corp., Downey, Calif.
ACTIVELY COOLED PLATE FIN SANDWICH STRUCTURAL PANELS FOR HYPERSONIC AIRCRAFT Final Report
L. M. Smith and C. S. Beuyukian Washington NASA Aug. 1979 172 p refs
(Contract NAS1-13382)
(NASA-CR-3159; SD-78-AP-0074) Avail: NTIS HC A08/MF A01 CSCL 01C

An unshielded actively cooled structural panel was designed for application to a hypersonic aircraft. The design was an all aluminum stringer-stiffened platefin sandwich structure which used a 60/40 mixture of ethylene glycol/water as the coolant. Eight small test specimens of the basic platefin sandwich concept and three fatigue specimens from critical areas of the panel design was fabricated and tested (at room temperature). A test panel representative of all features of the panel design was fabricated and tested to determine the combined thermal/mechanical performance and structural integrity of the system. The overall findings are that: (1) the stringer-stiffened platefin sandwich actively cooling concept results in a low mass design that is an excellent contender for application to a hypersonic vehicle, and (2) the fabrication processes are state of the art but new or modified facilities are required to support full scale panel fabrication. R.E.S.

N79-31687# Consiglio Nazionale delle Ricerche, Rome (Italy). Servizio Attivita Spaziali.

TRANSATLANTIC FLIGHTS OF STRATOSPHERIC BALLOONS [LES VOLS TRANSATLANTIQUES DES BALLONS STRATOSPHERIQUES]

G. P. Cecchini and M. Malavasi *In* ESA European Sounding Rocket, Balloon and Related Res., with Emphasis on Expt. at High Latitudes Jun. 1978 p 377-381 In FRENCH; ENGLISH summary

Avail: NTIS HC A23/MF A01

The use of high altitude balloons as Spacelab complementary low cost research tools is discussed. The economic factors are reviewed and the payload capacity is analyzed, showing that a weight of 1500 kg at a height equivalent to 1.5 millibar is typical of Spacelab conditions. The Milo launching facility (Italy) is described. It is concluded that balloon flights are well suited for pretesting Spacelab payloads. Author (ESA)

N79-31691# Centre National d'Etudes Spatiales, Toulouse (France).

PREVISIONS AND EXPERIMENTAL RESULTS IN OPEN BALLOON CONTROLLED DESCENT [PREVISION ET DEPOUILLEMENTS DE VOLS DE BALLONS OUVERTS EN DESCENTE PILOTE]

M. Romero, M. Rougeron, and C. Tockert *In* ESA European Sounding Rocket, Balloon and Related Res., with Emphasis on Expt. at High Latitudes Jun. 1978 p 397-402 refs In FRENCH

Avail: NTIS HC A23/MF A01

Balloon flight remote control by means of a pole located relief valve and ballast reduction is discussed. A computerized simulation was performed and four balloon flights were executed in 1977. Results show that the proposed flight control method permits a controlled descent or a leveling-off in a simple manner. Author (ESA)

N79-32054*# Boeing Vertol Co., Philadelphia, Pa.

STUDY OF DESIGN CONSTRAINTS ON HELICOPTER NOISE

Harry Sternfeld, Jr. and Carl W. Wiedersum Jul. 1979 91 p refs

(Contract NAS1-15226)

(NASA-CR-159118) Avail: NTIS HC A05/MF A01 CSCL 20A

A means of estimating the noise generated by a helicopter main rotor using information which is generally available during the preliminary design phase of aircraft development is presented. The method utilizes design charts and tables which do not require an understanding of acoustical theory or computational procedures in order to predict the perceived noise level, a weighted sound pressure level, or C weighted sound pressure level of a single hovering rotor. A method for estimating the effective perceived noise level in forward flight is also included. In order to give the designer an assessment of the relative rotor performance, which may be traded off against noise, an additional chart for estimating the percent of available rotor thrust which must be expended in lifting the rotor and drive system, is included as well as approach for comparing the subjective acceptability of various rotors once the absolute sound pressure levels are predicted. A.R.H.

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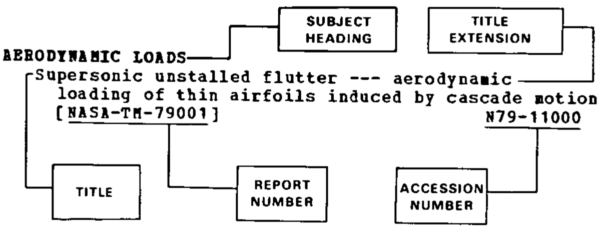

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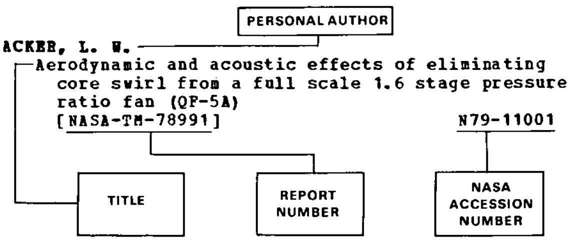

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1. Report No. NASA SP-7037 (116)	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle AERONAUTICAL ENGINEERING A Continuing Bibliography (Supplement 116)		5. Report Date December 1979
		6. Performing Organization Code
7. Author(s)		8. Performing Organization Report No.
		10. Work Unit No.
9. Performing Organization Name and Address National Aeronautics and Space Administration Washington, D. C. 20546		11. Contract or Grant No.
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17. Key Words (Suggested by Author(s))	18. Distribution Statement
Aerodynamics Aeronautical Engineering Aeronautics Bibliographies	Unclassified - Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
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