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NASA SP-7037 (51)

AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 51

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 1974 in

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

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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 Special Bibliography* (NASA SP-7037) lists 206 reports, journal articles, and other documents originally announced in November 1974 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* or *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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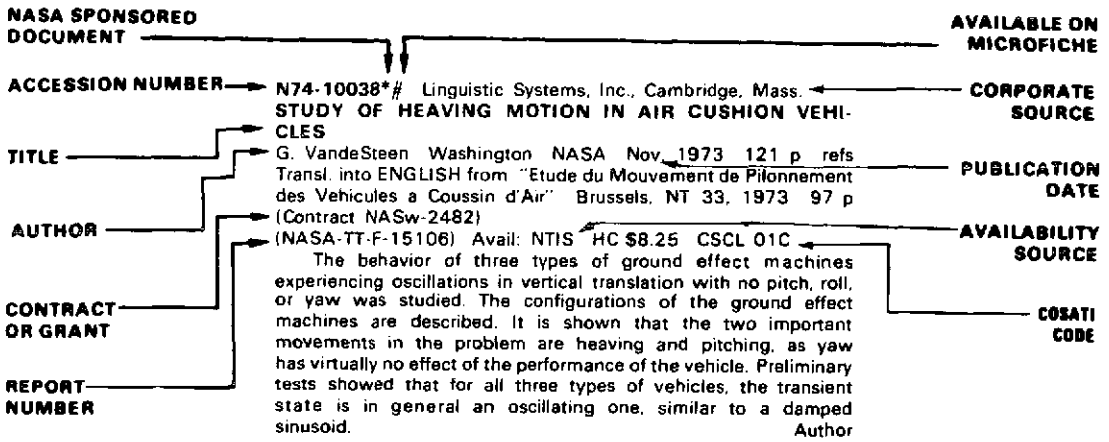

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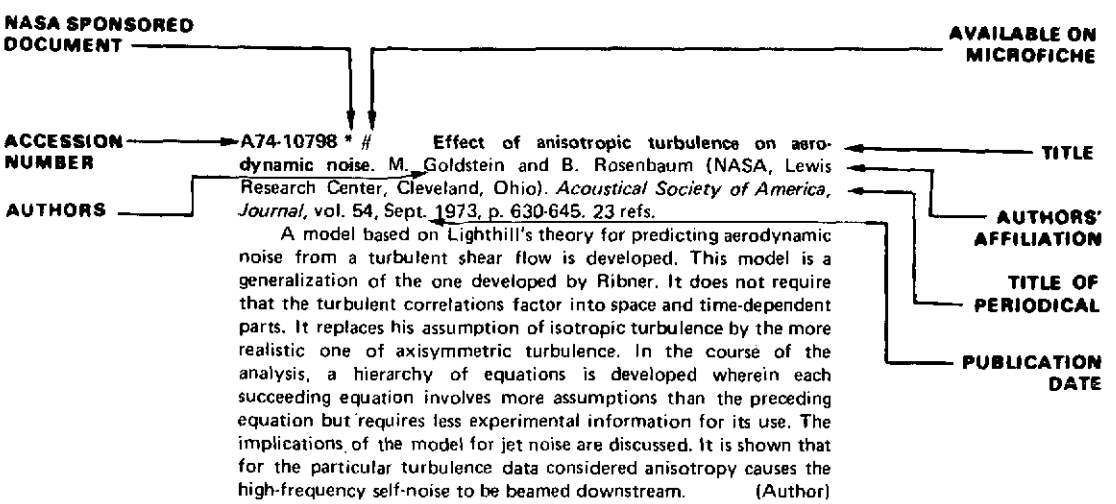

AERONAUTICAL ENGINEERING

A Special Bibliography (Suppl. 51) DECEMBER 1974

IAA ENTRIES

A74-41032 # **The effect of the Mach number on wave-drag optimized fuselages and profiles in the case of supersonic flow (Der Einfluss der Machzahl auf wellenwiderstandsoptimierte Rümpfe und Profile bei Überschallanströmung).** J. Wellmann (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Aerodynamik, Braunschweig, West Germany). *Zeitschrift für angewandte Mathematik und Mechanik*, vol. 54, July 1974, p. 389-404. 44 refs. In German.

The contours with minimal wave drag, calculated according to the theory of slender bodies, show no dependence upon the Mach number, whereas some non-linear optimizations indicate such an influence. Assuming a non-contradictory linearisation of the laws of preservation, a closed linear theory is given, in which the optimization of bodies of revolution is exactly and explicitly possible. The contours represented by the stream function contain the previous solutions as asymptotic exceptions and are also valid for higher Mach numbers. (Author)

A74-41041 # **Aerodynamic interference in a system of two harmonically oscillating airfoils in an incompressible flow.** J. Grzedzinski (Polska Akademia Nauk, Instytut Podstawowych Problemow Techniki, Warsaw, Poland). *(Symposium on Advanced Problems and Methods in Fluid Mechanics, 11th, Kamienny Potok, Poland, Sept. 1973.) Archiwum Mechaniki Stosowanej*, vol. 26, no. 3, 1974, p. 383-389.

Calculation was made of the aerodynamic derivatives due to interaction of two harmonically oscillating thin airfoils with chords situated on the straight lines parallel to the direction of undisturbed flow. It was assumed that the fluid is inviscid and incompressible. Under certain simplifying assumptions leading to the linearization of the problem, a system of two integral equations for the pressure distribution on the airfoils was arrived at and solved by the method of least squares. Numerical results concerning a biplane are presented. (Author)

A74-41044 # **The structure and decay of trailing vortices.** P. G. Saffman (California Institute of Technology, Pasadena, Calif.). *(Symposium on Advanced Problems and Methods in Fluid Mechanics, 11th, Kamienny Potok, Poland, Sept. 1973.) Archiwum Mechaniki Stosowanej*, vol. 26, no. 3, 1974, p. 423-439. 19 refs. Grant No. AF-AFOSR-71-2092; Contract No. N00014-67-A-0467-0027.

The roll up of the trailing vortex sheet behind a high aspect ratio wing is examined. The results are used to infer the initial structure of the trailing vortices. The decay of the trailing vortices is considered. The existence of axial velocities toward the wing is explained. The effect of the internal structure on the growth rates of the mutual instability of a pair of trailing vortices is calculated. (Author)

A74-41262 **Composite structures.** D. M. Purdy (Douglas Aircraft Co., Long Beach, Calif.). In: Structural mechanics computer programs: Surveys, assessments, and availability; Proceedings of the Symposium, University of Maryland, College Park, Md., June 12-14, 1974. Charlottesville, University Press of Virginia, 1974, p. 411-438. 17 refs.

Special-purpose computer programs for use in composite structure analysis which are available for public distribution to qualified organizations are surveyed and assessed. Programs which are currently in existence fall into four basic categories: strength and stiffness analysis, stability analysis, laminate optimization, and bonded joint analysis. It is observed that the status of available programs generally parallels the state of composite structure usage. That is, most composite structure activities are R&D oriented with a few production applications starting to appear. Most of the programs were developed as part of R&D programs and require varying levels of modifications to make them useful on a production basis. (Author)

A74-41305 # **Application to the Viggen aircraft configuration of the polar coordinate method for unsteady subsonic flow.** V. J. E. Stark (Saab-Scania AB, Linkoping, Sweden). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-03*. 12 p. 10 refs.

A Fortran program for calculation of aerodynamic forces on oscillating wing configurations in subsonic flow has been developed on the basis of the so-called Polar Coordinate Method. In this method, the normal velocities, that correspond to the functions in a linear approximation of the jump in the advanced velocity potential, are calculated by using polar coordinates as integration variables and a tangent function for subtraction of the kernel function singularity. The program, which is applicable to configurations with control-surfaces, has been applied to the Viggen configurations. Results from this application are shown together with favorable comparisons with reliable results of other methods for three simple wings. (Author)

A74-41306 # **Two-dimensional wind tunnel tests on a conventional wing section over a wide range of Reynolds numbers and up to high subsonic free-stream speeds.** D. Brown (National Research Council, Ottawa, Canada). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-04*. 22 p. 13 refs.

A74-41307 # **Effects of Reynolds number on swept-wing-body configurations with high lift devices at transonic speeds.** E. Atraghji (National Aeronautical Establishment, Ottawa, Canada) and H. Sorensen (Forsvarsdepartementet, Flygtekniska Forsoksanstalten, Bromma, Sweden). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-05*. 28 p. 8 refs.

Reynolds number effects in the Re range from 1 million to 5 million and Mach range of 0.5 to 0.95 were investigated experimentally on swept-wing-body configurations with various degrees of leading edge droop. For the models with zero droop the effects of Reynolds number are found to be quite large at Mach 0.5, especially on the axial force, the lift dependent drag, and buffet onset. These effects are progressive in the Reynolds number range investigated and show no asymptotic tendency towards the upper part of the range. The observed effects decrease with rising Mach number. However, at supercritical Mach numbers, the pitching moment at small angles of attack shows considerable Reynolds number dependency. Similar effects are observed on the configurations having leading edge droop, but these effects are smaller than those for the zero droop cases. (Author)

A74-41309 # **The interaction of local and overall buckling of thin-walled structures.** A. van der Neut (Delft, Technische Hogeschool, Delft, Netherlands). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-07.* 14 p. 12 refs.

The commonly accepted criterion of optimization of thin structures that local and overall buckling loads should coincide overlooks the unfavourable effect of coupling between these two modes. The equilibrium at the local buckling load is instable under certain conditions; instable equilibrium yields imperfection sensitivity. Two imperfections are important: initial waviness of the composing plate strips and initial curvature of the axis of the structure. Three models have been investigated: (1) the strut composed of 2 equal load carrying flanges; (2) the plate with stringers not affected by local buckling; (3) a simplified representation of a panel stiffened by top-hat stringers. Models (1) and (2) represent extreme conditions as to mode interaction. The purpose with the model (3) is to explore the significance of mode interaction for the strength of heavily stiffened wing panels. (Author)

A74-41310 # **Fail-safe characteristics of built-up sheet structures.** H. Vlieger (National Luchtvaartlaboratorium, Amsterdam, Netherlands). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-08.* 14 p. 9 refs. Research supported by the Netherlands Agency for Aerospace Programs.

During the operational life of an aircraft, structure cracks or partial failures may occur. When it concerns a fail-safe design, the airworthiness requirements demand that the structure can still withstand a prescribed load when a certain amount of damage is present. It is essential then that the damage can be detected during regular inspections before it has extended to a dangerous size. Thus, apart from reliable inspection procedures, a thorough knowledge of crack propagation and residual strength characteristics of fail-safe structures is required. The present paper presents some results of residual strength and crack propagation computations for stiffened panels, using unstiffened panel data and accounting for the sheet-stiffener interaction. The computational results are compared with experimental data. (Author)

A74-41312 * # **Review of NASA supercritical airfoils.** R. T. Whitcomb (NASA, Langley Research Center, Transonic Aerodynamics Branch, Hampton, Va.). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-10.* 12 p. 21 refs.

NASA supercritical airfoils are characterized by a substantially reduced curvature of the midcord region of the upper surface together with increased camber near the trailing edge. The basic aerodynamic phenomena associated with the airfoils and representative wind tunnel results are discussed. The results indicate that the drag rise Mach numbers for NASA supercritical airfoils are 0.1 higher than for comparable NACA 6-series airfoils. A recent analytic method for predicting the aerodynamic characteristics of supercritical airfoils is described. The flight demonstration programs of three applications of supercritical airfoils utilizing the F-8, T-2C and F-111 as test beds are summarized. (Author)

A74-41313 # **Transonic lift augmentation of two-dimensional supercritical aerofoils by means of aft camber, slot blowing and jet flaps, in high Reynolds number flow.** D. J. Peake, A. J. Bowker, M. Mokry (National Aeronautical Establishment, Ottawa, Canada), H. Yoshihara, and R. Magnus (General Dynamics Corp., Convair Aerospace Div., San Diego, Calif.). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-11.* 75 p. 33 refs. Navy-supported research.

A74-41314 # **Research on the transonic aerofoil sections at the National Aerospace Laboratory, Japan.** T. Shigemi (National Aerospace Laboratory, Tokyo, Japan). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-12.* 13 p. 15 refs.

Recent studies on transonic aerofoil sections are briefly reviewed. It was found that we can obtain exact solutions for the flow past various aerofoil sections if we only superpose additional functions to the well-established hodograph solution for the lifting circular cylinder. Various sections have been computed until now; some of them were tested in a 2-m transonic wind tunnel and results showed a good agreement with the theory. An additional remark is given on empirical procedures developed in parallel with the above theory, which furnish us with a quick access to the aerofoil design problem. (Author)

A74-41317 # **Influence of sloshing in wing tip tanks on the vibration natural modes of an aircraft.** R. Valid and R. Ohayon (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-15.* 10 p. 20 refs. In French.

The vibration natural modes of an aircraft may be modified by the movements of liquids contained in wing tip tanks. These modifications may render critical, as regards flutter, some modes that would not have been had not these movements been taken into account. A calculation method is proposed for predicting this influence in a reasonably simple manner. This method is based either on the fluid finite-element method and the use of a selective criterion to introduce the actually perturbating sloshing modes, or on the use of a step-by-step method in which only the perturbation acting on previously chosen modes is calculated. (Author)

A74-41318 # **Theoretical and experimental research on vibrations of thin walled stiffened structures.** G. Cavallini and A. Salvetti (Pisa, Università, Pisa, Italy). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-16.* 15 p. 8 refs.

This paper deals with the problem of the natural modes of vibration in thin-walled stiffened structures. A theoretical method was carried out which takes into account rigid displacements as well as distortion of the stringer cross section. The results of the theoretical approach were compared with data obtained from testing stiffened panels; the tests were performed with an experimental apparatus which utilizes pneumatic exciters and noncontacting displacement transducers to obtain frequencies and modes of vibration. Such a comparison shows a satisfying agreement between the theoretical and experimental results and emphasizes the importance of the cross section distortion as far as stress in the stringer is concerned. (Author)

A74-41321 # **Viscous effects in transonic flow past airfoils.** J. J. Kacprzynski (National Research Council, Ottawa, Canada). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-19.* 21 p. 26 refs.

Contemporary supercritical airfoils are very sensitive to viscous effects. Even a very high Reynolds number wind tunnel test shows

large differences compared with inviscid flow. The present work discusses methods of calculating viscous transonic flow. It is shown that the wind tunnel effects are difficult to separate and in order to have agreement between test and theory, one has to use not the theoretical results for free flow, but for viscous flow in the tunnel between porous walls. (Author)

A74-41322 # **Analysis of viscous flow over swept wings.** E. Krause (Rheinisch-Westfälische Technische Hochschule, Aachen, West Germany). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-20.* 10 p. 21 refs.

Compressible laminar and incompressible laminar and turbulent flows are investigated for three swept wings with infinite aspect ratio at various Reynolds numbers. The predictions obtained by finite-difference integration of the boundary-layer equations are compared with experimental data. Three closure assumptions have been tested in comparison calculations. Second- and fourth-order accurate solutions show that laminar flows can be calculated without difficulty up to separation. For turbulent flows, the closure assumptions fail near separation when large cross flows are present. (Author)

A74-41323 # **New materials and structures.** W. R. Johnston (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-21.* 11 p.

The history of aircraft structural failures, particularly those resulting from fatigue, have prompted researchers to develop both new materials and structural forms to reduce the effects of fatigue. The development and refinement of fracture mechanics and crack propagation theory have enabled a fairly rigorous definition of the problem. The results are metals having slower crack growth rates, new design concepts for metals such that the historical problems are circumvented, and new advanced composite materials exhibiting different properties and damage characteristics. The application of these new materials, particularly the composited, will result in new design techniques; the composites require that the designer add a new dimension to his design, that of designing the material. (Author)

A74-41324 # **Advanced material applications to subsonic transport aviation.** D. G. Smillie and D. M. Purdy (Douglas Aircraft Co., Long Beach, Calif.). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-22.* 19 p. 11 refs.

The application of advanced materials to subsonic transport airframes is identified as the technological area offering great potential for aircraft system improvements. The role of new emerging materials for subsonic transport aircraft structures is defined and evaluated. The effects of the application of these materials to commercial and military aircraft systems in terms of system economics and vehicle performance are quantitatively examined, including the impact on contributing engineering and other technical disiciplines. The benefits to be realized through the integration of the materials into a vehicle system are assessed in terms of system sensitivity to discrete selective usage. A plan for incorporation of advanced materials in subsonic transport systems is discussed. A series of R&D programs designed to develop the technology and demonstrate the inservice life characteristics is outlined. (Author)

A74-41328 # **Recent contributions to the solution of non-linear aerodynamic interference problems.** D. Hummel (Braunschweig, Technische Universität, Braunschweig, West Germany). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-26.* 16 p. 27 refs.

The causes of the nonlinear aerodynamic behavior of a high-aspect-ratio wing near the ground are analyzed. The factors producing the nonlinearity are found to be the inclined position of the wing with respect to the ground plane and the effects of velocity perturbations caused by the wing image in the wing-ground interspace. V.Z.

A74-41329 # **On the calculation of non-linear aerodynamic characteristics and the near vortex wake.** J. Rom, C. Zorea, and R. Gordon (Technion - Israel Institute of Technology, Haifa, Israel). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-27.* 15 p. 38 refs. Grant No. AF-AFOSR-71-2145.

Methods for the calculation of the distribution of vortices on the wing planform and on the trailing vortex wake by iterative procedures based on the application of the vortex lattice method concepts are described. In the case when the trailing vortices are taken to leave the wing at the trailing edge only, the calculation results in determining the linear aerodynamic characteristics and the shape of a rolled up wake. The present investigation considers the cases when the vortices from each cell are allowed to leave the wing planform at a fixed angle, and the case when the vortex shedding can be limited to the planform edges only. (Author)

A74-41330 # **Numerical computations of wake vortices behind lifting surfaces.** A. Mattei and E. Santoro (Aeritalia S.p.A., Naples, Italy). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-28.* 23 p. 22 refs.

A numerical method is developed for the calculation of the wake vortices behind lifting wings. According to modern three-dimensional methods, discrete vortices are distributed on the camber surface of the wing and upon the wake. The rolled-up vortex sheet is obtained by a convergent iterative procedure. Different numerical schemes investigated are compared for obtaining smooth solutions and minimizing computer time. (Author)

A74-41333 # **Problems of flight in turbulence (Problèmes du vol en turbulence).** G. Coupry (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-32.* 15 p. 27 refs. In French.

The paper deals with various problems raised by flight in turbulence. The first part is devoted to the description of mathe-

Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-28. 23 p. 22 refs.

A numerical method is developed for the calculation of the wake vortices behind lifting wings. According to modern three-dimensional methods, discrete vortices are distributed on the camber surface of the wing and upon the wake. The rolled-up vortex sheet is obtained by a convergent iterative procedure. Different numerical schemes investigated are compared for obtaining smooth solutions and minimizing computer time. (Author)

A74-41334 # **The deformation of a vortex sheet behind a swept back wing - Comparison of measurements and calculations.** T. E. Labrujere and O. de Vries (National Luchtvaartlaboratorium, Amsterdam, Netherlands). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-33.* 12 p. 11 refs.

The deformation of a vortex sheet behind a 30-deg sweptback wing, has been measured in a low-speed wind tunnel. The measurements included a total-head survey behind the wing, sidewash measurements across to wake, and measurements of trailing vorticity by a vortex indicator. It has been found that 60 percent of the trailing vorticity is concentrated in the tip vortex leaving the wing tip upper surface. Proceeding downstream, the remaining vorticity due to the wing diffuses into the surrounding air without rolling-up into the tip vortex. The deformation of the vortex sheet behind the wing has been calculated by a method, which may be considered as an extension of the NLR panel method for the determination of the pressure distribution of lifting wing-body combinations in uniform flow. (Author)

matical models liable to provide the aircraft designer with a practical representation of the environment encountered by the aircraft. Classical models are briefly recalled, and new approaches are presented. The second section deals with the calculation of the response of a flexible aircraft to such an environment and shows that, as a rule, the turbulence field should be considered as isotropic in this case. In the last part it is shown how active control systems will open the way to a new generation of aircraft that will be less sensitive to gusts, and systems presently under test are described. (Author)

A74-41335 # **Aircraft trailing vortex instabilities.** W. P. Jones and H. L. Chevalier (Texas A & M University, College Station, Tex.). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-34.* 11 p. 15 refs. Grant No. DAHC04-69-C-0015.

A brief summary is given of the results of flight test studies of trailing vortices. The instability of a pair of trailing vortices due to mutual interaction is fully discussed, and theoretical predictions of the wavelength of the vortex oscillations that develop in the far wake of an airplane are compared with values determined from photographic records of the wake behavior of a DeHavilland Beaver DHC-2 aircraft. The different types of instability that can develop with single vortices are also considered, including the vortex bursting phenomenon that occurs with vortices that separate from the leading edges of highly swept wings at incidence. A technique for inducing earlier breakdown and dissipation of the vortices than would occur normally is described. (Author)

A74-41336 # **Experimental investigation of wing-tip vortex abatement.** S. W. Yuan and A. M. Bloom (George Washington University, Washington, D.C.). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-35.* 10 p. 8 refs. Contract No. F33615-73-C-3097.

Detailed measurements of aerodynamic forces and downstream velocity distributions of a model airplane with and without vortex abatement device have been made. Time-mean-average velocity components were measured, using a triple-sensor hot film probe, at 1/2-chord and 5-chord distances behind the trailing edge of the wing. The results of these tests clearly indicate that not only does the vortex abatement device reduce greatly the size of the wing-tip vortex but also the strength of the vortex core. The effect of the vortex abatement device also results in a considerable increase in lift and decrease in drag. (Author)

A74-41337 # **Matched propulsion for advanced vehicles.** G. Rosen (United Aircraft Corp., Hamilton Standard Div., Windsor Locks, Conn.). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-36.* 7 p. 10 refs.

Increasing demands for improved transportation in the face of today's fuel and environmental constraints calls for advanced vehicles with better matching of propulsion to their specialized needs. The very high-bypass variable-pitch fan is described as a new and effective means to this end. It offers good low-speed performance, low fuel consumption, and low noise level in a compact, lightweight propulsion package. Representative advanced commercial and military aircraft are examined to show the potential benefits from the marriage of optimum higher-bypass fans with existing core engines. (Author)

A74-41338 # **Theoretical and experimental studies of a high pressure ratio centrifugal compressor at reduced rotating speed (Etudes théorique et expérimentale d'un compresseur centrifuge à taux de compression élevé, en régime partiel).** Y. Ribaud and P. Avram (ONERA, Châtillon-soux-Bagneux, Hauts-de-Seine, France). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-37.* 10 p. 9 refs. In French.

A centrifugal compressor is described which is designed so that there is no pressure gradient normal to the rotor meridian line. The rotor is built in three sections: (1) the inducer, including eight blades, for flow collecting, (2) a helicoidal section, with 32 blades, where most of the tangential deflection is obtained, and (3) a purely radial part, with 64 blades. This rotor configuration was chosen in order to provide an almost homogeneous flow, both tangentially and axially. By using a variable-stagger, two-dimensional diffuser, it has been possible to assess the quality of this rotor, which was tested in freon 114 in order to minimize mechanical problems. Results obtained at reduced rotating speed are promising: a compression rate of 5.95 with 81.5 per cent maximum efficiency. Furthermore, tests of the diffuser at Mach 1.25, corresponding in air to high pressure ratios of 8 to 10, showed that, even though a localized flow separation at the throat occurs, the static pressure recovery ratio of 0.65 is already quite satisfactory. (Author)

A74-41341 # **Turbulent trailing vortex with central jet or wake.** J. A. H. Graham, B. G. Newman, and W. R. Phillips (McGill University, Montreal, Canada). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-40.* 16 p. 30 refs.

The concentrated trailing vortices from the wings of heavy aircraft contain significant rotational velocities which may persist for as long as ten minutes. To reduce this time, the turbulence level in the core of the vortex may be increased by superimposing a longitudinal jet or wake. A series of experiments have been made in a circular wind tunnel with a trailing vortex along its center line. Jets or wakes of varying momentum were added to the center of the vortex. The mean velocity and the complete Reynolds stress tensor were measured at various azimuthal positions. An approximate theory has been developed for the decay of the vortex in the presence of a small-increment jet or wake by assuming that the jet dominates the flow and provides a scalar eddy viscosity which may be used to predict the growth of the vortex. (Author)

A74-41342 # **The determination of ice deposition on slender wings - An experimental technique and simplified theory.** J. W. Flower (Bristol, University, Bristol, England). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-41.* 13 p. 7 refs.

A slender wing at incidence generates strong vortices above the upper surface that can entrain water droplets and create ice deposits on that upper, or leeward, surface. Such deposits cannot be as accurately reproduced in icing tunnels as the more usual deposits on the forward facing surfaces. A novel technique has been evolved that uses a water tunnel with small glass beads representing the supercooled water droplets. This technique can be shown to simulate full scale trajectories more accurately than those in conventional icing tunnels, and deposition rates have been deduced from study of bead impingement. (Author)

A74-41343 # **Determination of ice shapes and their effect on the aerodynamic characteristics for the unprotected tail of the A 300.** B. Laschka and R. E. Jesse (Messerschmitt-Bölkow-Blohm GmbH, Munich, West Germany). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-42.* 11 p. 10 refs.

The tail surfaces of the European Airbus A 300 are not equipped with a de-icing or anti-icing system. It could be shown by analysis and tests that, under maximum icing conditions defined in FAR 25, the aircraft remains completely safe, stable and controllable within its flight envelope. This paper outlines the procedure applied to determine the ice accretion on the unprotected surfaces and its influence on the aerodynamic characteristics of the airplane. This comprises investigation of the most severe icing conditions within the flight regime, theoretical calculation and analysis of ice shapes based

on impingement analysis, icing wind tunnel tests, and establishing aerodynamic data with ice accretion. (Author)

A74-41346 # **Experimental study of viscous flow on multiple element airfoils.** B. L. G. Ljungstrom (Forsvarsdepartementet, Flygtekniska Forsoksanstalten, Bromma, Sweden). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-46.* 13 p. 13 refs.

Boundary-layer measurements have been carried out on a two-dimensional high-lift wing with a leading edge slat and a single slotted trailing edge flap in order to study the interaction between the different viscous layers involved. Suction is used as a way to vary the conditions for the viscous flow. The effects of viscous interaction on the development of displacement thickness and shape factor are evaluated. It is found that the best high-lift performance is obtained when there is only marginal interaction between all the viscous layers. Some boundary layer surveys over double and triple slotted flaps are shown which verify previous assumptions about optimum interaction. The experiments have been compared to calculations with a viscous multiple method developed by Stevens and Goradia. (Author)

A74-41348 # **Status and future of determination of aerodynamic derivatives from flight data.** V. Klein (Cranfield Institute of Technology, Cranfield, England). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-48.* 13 p. 14 refs. Research supported by the Department of Defence (Procurement Executive).

The evaluation of aerodynamic derivatives from flight data based on system identification is considered. The estimation procedure includes the equation error method, the output error method and the generalized maximum likelihood method. The problems concerning accuracy, sensitivity and identifiability are also discussed. The general computing algorithm for the first two methods and the future development in the area of aircraft parameter estimation are briefly mentioned. The maximum likelihood estimation technique is demonstrated in two examples. The first example includes the longitudinal short period motion of a slender delta-wing research aircraft; the second one, the lateral motion of a fighter aircraft. (Author)

A74-41349 # **Estimates of the stability derivatives of a helicopter from flight measurements.** D. G. Gould and W. S. Hindson (National Aeronautical Establishment, Ottawa, Canada). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-49.* 8 p. 6 refs.

A least-squares quasi-linearization procedure has been used to obtain estimates of the dominant lateral-directional and longitudinal stability derivatives from in-flight response tests of a single-rotor, medium sized helicopter. The particular adaptation of the classical least-squares method had two features, believed to be unique, to reduce the influence on the resulting derivative estimates of peculiarities of the model and of the particular circumstances of the tests. (Author)

A74-41350 # **A study of the Concorde air intake in yaw.** J. Leynaert (ONERA, Châtillon-sous-Bagneux, Hauts-de-Seine, France) and T. W. Brown (British Aircraft Corp., Ltd., Bristol, England), and D. Collard (Société Nationale Industrielle Aérospatiale, Paris, France). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-50.* 13 p.

The Concorde air intakes are two-dimensional but the splitter which separates the twin intakes introduces a nonsymmetrical sensitivity to yaw. The yaw effects are studied on models, and the effectiveness of various geometrical modifications and other aerodynamic adjustments are presented. These studies are completed by engine intake compatibility tests in the wind tunnel and by flight test. (Author)

A74-41353 # **Computation of aerodynamic loads on helicopter rotorblades in forward flight, using the method of the acceleration potential.** T. van Holten (Delft, Technische Hogeschool, Delft, Netherlands). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-54.* 13 p.

A74-41354 # **Static aeroelastic effects on the aerodynamics of the Saab 37 Viggen aircraft, a comparison between calculations, wind tunnel tests and flight tests.** J. Kloos and S. G. L. Elmeland (Saab-Scania AB, Linkoping, Sweden). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-55.* 9 p.

A74-41357 # **Noise shielding aircraft configurations - A comparison between predicted and experimental results.** G. Hellstrom (Saab-Scania AB, Linkoping, Sweden). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-58.* 11 p. 7 refs.

By a suitable engine position above a wing or tailplane, shielding of forward and rear arc noise by these surfaces might be obtained below the flight path during flyover. Ground tests have been performed to evaluate these shielding effects. A small full scale turbofan engine was mounted well above the ground and the influence of shields of various geometry and positions on the noise radiation was measured. Shielding of intake and exhaust noise sources were investigated separately. The purpose of the tests has been to verify an existing prediction method, mainly applicable to internal noise sources characteristic of high bypass fan engines. Significant noise attenuation due to shielding has been measured, and the results show good agreement with prediction. (Author)

A74-41358 # **Recent developments at the ultimate noise barrier.** J. S. Gibson (Lockheed-Georgia Co., Marietta, Ga.). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-59.* 12 p. 46 refs.

Review of developments in the aircraft nonengine aerodynamic noise field as it relates to community noise. Noise of this type is caused by air flow over the aircraft surfaces and around landing gear, unsteady aerodynamic forces on the wings, and trailing wakes and vortices. As this kind of noise represents the minimum noise that can be made by an aircraft in flight, it has been called the ultimate noise barrier. The background of this noise phenomenon and the development of analytical and experimental techniques are discussed. Recent aerodynamic noise measurements of very large transport aircraft have confirmed predictions based on small aircraft technology. Unsteady aerodynamics of the wing and landing gear/wheel well turbulence are shown to be the two most significant noise sources. (Author)

A74-41397 **Small gas turbines for helicopters /Halford Memorial Lecture/.** R. M. Lucas (Rolls-Royce /1971/, Ltd., Small Engine Div., Leavesden, Herts., England). *Aeronautical Journal,* vol. 78, July 1974, p. 305-314.

The thermodynamic cycle on which the performance of a gas turbine engine basically depends is not directly affected by engine size. For a given pressure ratio and maximum cycle temperature, the overall power and efficiency are unaffected by size except for secondary effects as a change in the efficiencies of compression and expansion. Within the engine energy is added to, and extracted from, the working fluid in the processes of compression and expansion by the generation of kinetic energy and its subsequent conversion to pressure or potential energy. Thus gas velocity (expressed non-dimensionally as Mach number) emerges as the all-important parameter, and this velocity is independent of engine size. As an engine gets smaller the level of required gas velocity remains the same and this calls for a retention of blade velocity and axial through-flow velocity. It follows that as the engine gets smaller cross sectional flow areas diminish and rotational speeds rise. F.R.L.

A74-41398 **A device for generating an artificial boundary layer in a short axial distance in a supersonic flow.** P. Philpot (National Gas Turbine Establishment, Farnborough, Hants., England). *Aeronautical Journal*, vol. 78, July 1974, p. 320-324.

This note describes the first tests of a device, developed at the National Gas Turbine Establishment (NGTE), which at supersonic speeds generates in a short axial distance a layer of low energy air with a pressure distribution approximation to that of a 'natural' turbulent layer. The device, referred to as a Boundary Layer Generator (BLG) was developed on a small-scale model and was then applied full scale to two different powerplants in Cell 4 of the Engine Test Facility at NGTE. It is noted that, while the BLG may simulate the boundary layer on the adjacent surface, it does not, of course simulate the general flow field due to those parts of the aircraft forward of the intake. F.R.L.

A74-41411 * **Unified approach to aerodynamic sound generation in the presence of solid boundaries.** M. Goldstein (NASA, Lewis Research Center, Cleveland, Ohio). *Acoustical Society of America, Journal*, vol. 56, Aug. 1974, p. 497-509. 20 refs.

A general equation governing aerodynamic sound generation in the presence of solid boundaries is derived. It is shown that all the theories in the literature appear as special cases of this general equation. Derived special equations for propeller and fan noise are likewise shown to be more general than the conventional equations in that they make allowance for variation in retarded time over the blade surfaces. M.V.E.

A74-41444 **Investigations concerning the interference between annular wing and hub body in the case of annular wing/hub body configurations (Untersuchungen zur Interferenz zwischen Ringflügel und Nabenkörper bei Ringflügel-Nabenkörper-Konfigurationen).** S. Schultz (Dornier GmbH, Friedrichshafen, West Germany). *Zeitschrift für Flugwissenschaften*, vol. 22, Aug. 1974, p. 266-271. 6 refs. In German.

For annular wing/hub body configurations, for which experimentally determined drag coefficients of the two single components of annular wing and hub tip are available, and for related configurations with modified hub bodies the pressure distributions are theoretically determined according to an available method. The resulting drag coefficients are compared between each other and with experimental data. The discussion of the results clearly shows the great influence of a hub thickening behind the annular wing, which covers up the influence of the hub tip position. An estimation method is presented for the length of the distance of the hub thickening where an interference effect adulterating the measurement is no longer to be expected from the annular wing. (Author)

A74-41651 # **YF-17 design concepts.** J. Patierno (Northrop Corp., Hawthorne, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Design, Flight Test and Operations Meeting, 6th, Los Angeles, Calif., Aug. 12-14, 1974, Paper 74-936.* 10 p.

The USAF Lightweight Fighter philosophy of high performance at low cost has been implemented in selecting the design concepts for the YF-17 aircraft. Unique aerodynamic, propulsion and structural design features have been developed for prototype demonstration. For example, incorporated in the YF-17 are a hybrid wing planform, automatic variable wing camber, differential area ruling, forebody strakes, a horizontal tail sized for supersonic maneuvering, an underwing inlet location, wing root slots for fuselage boundary layer diversion, a unique advanced turbojet engine, and extensive graphite composite structure. The concepts and the benefits derived are described to illustrate the rationale for selection. (Author)

A74-41652 # **Development and flight test progress of the YF-17.** J. B. Jordan (Northrop Corp., Hawthorne, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Design, Flight Test and Operations Meeting, 6th, Los Angeles, Calif., Aug. 12-14, 1974, Paper 74-941.* 5 p.

Wind tunnel results on the YF-17 were augmented by 'pilot-in-the-loop' testing on a moving base simulator. The Large Amplitude Simulator/Wide Angle Visual System (LAS/WAVS) was a very important tool in supporting development prior to and during flight tests. The LAS/WAVS Simulator consists of a cockpit inside a hemisphere which is gimbal-mounted on a 30-foot beam, with earth/sky and target image presented on the hemisphere. Motion with five degrees of freedom is provided for the full operational envelope of the YF-17, since it is that of a typical target aircraft. As indicated in the results of the first flight test series of the YF-17, flight test data continue to be used as a check on the simulation, just as simulator results are being used to predict and refine scale airplane characteristics. (Author)

A74-41654 * # **Airframe noise - The next aircraft noise barrier.** H. G. Morgan and J. C. Hardin (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aircraft Design, Flight Test and Operations Meeting, 6th, Los Angeles, Calif., Aug. 12-14, 1974, Paper 74-949.* 8 p. 8 refs.

Progress in quieting the commercial aviation fleet has been achieved by reducing the noise generated by jet engines. Recent tests have indicated that noise produced by airflow over aircraft surfaces (lifting surfaces, landing gear, flaps, and cavities) is only 8 to 10 EPNdB below certification requirements for current aircraft and will likely be a design consideration for aircraft of the future as engines become still quieter. This paper reviews the state of the art for understanding, predicting, and control of airframe noise. Levels and spectral content of the noise, correlation with important variables, and noise generation mechanisms are discussed. The noise floors for future aircraft, the direction of research projects, and likely impact of this new technology on aircraft design are indicated. (Author)

A74-41655 * # **Aerodynamic and acoustic performance of ejectors for engine-under-the-wing concepts.** U. von Glahn, J. Goodykoontz, and D. Groesbeck (NASA, Lewis Research Center, V/STOL and Noise Div., Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Design, Flight Test and Operations Meeting, 6th, Los Angeles, Calif., Aug. 12-14, 1974, Paper 74-950.* 48 p. 15 refs.

Subsonic thrust augmentation, exhaust plume velocity contours and acoustic characteristics of a small-scale, 6-tube mixer nozzle with ejector were obtained with and without a wing. Thrust augmentation up to 30 percent was achieved. Aerodynamic results showed that at a given location, greater downstream velocities are obtained with an ejector than with the baseline nozzle. Ejectors reduce high frequency noise; however, low-frequency noise amplification also occurs. Acoustic reflections off the wing increase the noise level to a ground observer. With an ejector, the acoustic benefits of forward velocity may be significantly reduced compared with the baseline nozzle. (Author)

A74-41656 # **A head-up display for all-weather approach and landing of tilt-wing V/STOL aircraft.** T. Gold (Sperry Rand Corp., Great Neck, N.Y.) and R. M. Walchli (U.S. Navy, Naval Air Test Center, Patuxent River, Md.). *American Institute of Aeronautics and Astronautics, Aircraft Design, Flight Test and Operations Meeting, 6th, Los Angeles, Calif., Aug. 12-14, 1974, Paper 74-952.* 14 p.

A head-up display (HUD) was developed for the CL-84 to provide guidance, control, and monitoring information to the pilot during approach and transition to hover in a format compatible with visual flight (1:1). Approaches under the hood were conducted at various descent angles, using the SPN-42 radar for guidance. Visual approaches were also performed. Digital data from sensor, display, control, and guidance systems were recorded for performance evaluation. Results indicate that the HUD is a useful, flexible device to assist the V/STOL pilot in landing in instrument or mixed weather, with smooth transition between instrument and visual flight. (Author)

A74-41658 # **YC-15 powerplant system design and development.** J. D. Thompson (Douglas Aircraft Co., Long Beach, Calif.). *American Institute of Aeronautics and Astronautics, Aircraft Design, Flight Test and Operations Meeting, 6th, Los Angeles, Calif., Aug. 12-14, 1974, Paper 74-973.* 9 p.

The development of the YC-15 engine installation was based upon the existing low-cost, reliable JT8D-17 engine and makes maximum use of off-the-shelf systems and components. New problems were posed resulting from the exhaust jet being reacted against aircraft structure to achieve propulsive augmented lift. Design of the nacelle, pylon, engine inlet, exhaust nozzle, and thrust reverser were all influenced by requirements unique to the externally blown flap STOL concept. Engine ground tests with flight-nacelle hardware have demonstrated operational functions, structural integrity, and fulfillment of performance goals. (Author)

A74-41662 * # **Evaluation of a new jet flap propulsive-lift system for turbofan-powered STOL transports.** Y. T. Chin (Lockheed-Georgia Co., Marietta, Ga.), T. N. Aiken (NASA, Ames Research Center, Moffett Field, Calif.), and G. S. Oates, Jr. (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Design, Flight Test and Operations Meeting, 6th, Los Angeles, Calif., Aug. 12-14, 1974, Paper 74-993.* 12 p. 6 refs.

A large-scale STOL transport model with a new jet flap propulsive-lift system was subject to wind-tunnel testing. Aerodynamically, this IBF system combines the benefits of the jet flap and the mechanical flap with boundary layer control. Structurally, it creates its own spanwise air duct with the deflection of the mechanical flap. An additional short-chord control flap, located at the jet-flap exit, provides a powerful means for flight path and lateral controls. The results show that the overall effectiveness of this flap system compares well with other jet flap propulsive-lift systems. A preliminary study based on the wind-tunnel data was made on a medium-size IBF STOL jet transport configuration for a typical-military mission. This study showed that the IBF results in a configuration with a relatively low T/W ratio, making the system an attractive candidate for future designs. (Author)

A74-41663 # **V/STOL demonstrator vehicle for ejector thrust augmentation technology.** J. M. Byrnes, R. D. Murphy, R. F. Ball, K. S. Nagaraja, D. L. Hammond, E. A. Langleben, and R. B. English (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aircraft Design, Flight Test and Operations Meeting, 6th, Los Angeles, Calif., Aug. 12-14, 1974, Paper 74-995.* 14 p. 14 refs.

The objective of this effort was to design a vehicle for the inflight demonstration of an ejector thrust augmentation concept. The approach was a design arrangement and parametric study based on an off-the-shelf engine. The result is a small, remotely piloted vehicle (RPV) specifically designed as a V/STOL ejector concept. The size, or injection area ratio of the ejectors is an optimum 13.5, which produces a thrust augmentation ratio of 1.66, or a VTOL weight of 896 pounds. The ejector installation is fully vectorable from hover to a maximum speed of 227 knots, but its real payload potential is reflected by a 80 per cent overload capability with a 1000 foot STOL ground roll. At the VTOL weight, a 30+ gallon fuel payload gives a 100 minute endurance at sea level. (Author)

A74-41770 # **Stability of the tail surfaces (Ob ustoichivosti opereniia).** V. A. Pavlov. *Aviatsionnaia Tekhnika,* vol. 17, no. 2, 1974, p. 62-66. In Russian.

By analyzing the strain state produced in multiply hinged tail surfaces by a deflection of the rudder, it is shown that due to rotation about hinge axes bent by external forces, the rudder experiences an additional load in its own plane. This leads to a flexure of the rudder in its plane of maximum rigidity. With increasing stabilizer curvature, the forces increase in proportion with the deflection of the rudder. At a stabilizer curvature that is critical for a given angle of deflection of the rudder, the rudder/stabilizer system becomes unstable in the sense that the rudder deflection angles assume opposite signs. Using Timoshenko's theory of beam stability in plane bending, it is shown that for certain ratios of rudder to stabilizer rigidity, external loads may lead to this type of instability even in modern aircraft if the rudder deflection angle exceeds a certain critical value. V.P.

A74-41796 # **A simple, near-optimal takeoff control policy for a heavily loaded helicopter operating from a restricted area.** F. H. Schmitz and C. R. Vause (U.S. Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-812.* 9 p. 5 refs. Members, $1.50; nonmembers, $2.00.

Optimal control theory has been applied to an experimentally verified mathematical model of a heavily loaded helicopter operating in ground effect in order to develop a simple, near-optimal takeoff control policy. Primary emphasis is placed on understanding the physical tradeoffs and implications involved in a STOL-type takeoff. The significant results presented include: the development of a two-segment, near-optimal control technique for heavily loaded helicopters, exiting from a confined area; and a means of estimating, from hover performance, the distance required to clear an obstacle in the departure path. (Author)

A74-41797 # **A display of energy-maneuverability performance information for fighter aircraft.** J. M. Loh (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio) and A. H. Lusty, Jr. (General Dynamics Corp., Fort Worth, Tex.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-814.* 10 p. 5 refs. Members, $1.50; nonmembers, $2.00.

The need for a computer-generated head-up display of energy-maneuverability performance information is established for the new generation of high-performance fighter aircraft. Display requirements are outlined, and a recommended display is discussed with respect to the relevancy of the parameters and the effectiveness of the formats. The functional behavior of the display parameters is discussed in relation to the simplifications required to ensure the compatibility of the mechanization procedure with a small storage capacity onboard computer. Finally, the utilization of the display is described relative to training and combat applications, and suggestions for further refinement and enhancement are outlined. (Author)

A74-41803 # **An investigation of overall systems criteria for the longitudinal flying qualities of highly augmented fighter aircraft.** R. T. N. Chen and E. M. Boothe (Calspan Corp., Buffalo, N.Y.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-833.* 11 p. 13 refs. Members, $1.50; nonmembers, $2.00. Contract No. F33615-73-C-3051.

A longitudinal control system design procedure based on previously developed design criteria, including those of MIL-F-8785B and suggested revisions to MIL-F-8785B, was developed. Four separate flight control systems were designed using combinations of normal acceleration, change in angle of attack and pitch rate feedback with constant gains and a forward loop gain scheduled with dynamic pressure. The USAF variable stability NT-33A airplane was used as a flight test vehicle to evaluate each of the four systems. The NT-33A was augmented by its variable stability system to simulate the characteristics of a typical unaugmented, high-performance fighter aircraft. The control systems to be evaluated were mechanized around the simulated airplane. The results of the flight test showed that all four of the flight control systems provided satisfactory flying qualities for the flight phases evaluated. (Author)

A74-41809 # **Direct force control for light airplanes.** D. L. Kohlman (Kansas, University, Lawrence, Kan.) and D. R. Ellis (Princeton University, Princeton, N.J.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Con-*

ference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-862. 8 p. 15 refs. Members, $1.50; nonmembers, $2.00.

The use of direct lift control and direct side force control for light aircraft is reviewed. The many possible applications of both techniques, with their advantages and disadvantages, are discussed. A summary of each relevant simulator and flight test investigation which has been conducted is presented. Recommendations for additional investigations in this area are made. (Author)

A74-42032 # **Lateral control and sailplane design considerations to optimize altitude gain while thermalling.** E. E. Larrabee (MIT, Cambridge, Mass.). *AIAA, MIT, and SSA, International Symposium on the Technology and Science of Low Speed and Motorless Flight, 2nd, Cambridge, Mass., Sept. 11-13, 1974, AIAA Paper 74-1004.* 8 p. 7 refs.

A study is made of the combination of control deflections which minimize the drag (and therefore the rate of sink) of a representative sailplane when it flies in a circle of arbitrary radius. A small amount of inward sideslip is generally desirable, and aileron and rudder deflections can be minimized by choice of wing dihedral angle. The more complicated problem of optimizing the rate of climb in a thermal current, which may be modeled by a Hill's spherical vortex, depends on the size of the sailplane, the radius of turn, and the size and buoyancy of the thermal bubble. The rate of climb of the sailplane tends to become equal to the vertical velocity of the bubble. (Author)

A74-42034 # **The use of gliders for airfoil section research and development.** S. J. Miley (Bell Helicopter Co., Fort Worth, Tex.). *AIAA, MIT, and SSA, International Symposium on the Technology and Science of Low Speed and Motorless Flight, 2nd, Cambridge, Mass., Sept. 11-13, 1974, AIAA Paper 74-1008.* 7 p.

The practical aspects of utilizing glider free-flight testing in lieu of wind-tunnel facilities for airfoil and wing section research are presented. Four topic areas are discussed: type of glider best suited, test model installations, basic instrumentation, and safety considerations. Photographs and illustrations are included to detail specific installation configurations and hardware. (Author)

A74-42037 # **An experimental investigation of the aerodynamic characteristics of stepped-wedge airfoils at low speeds.** J. D. DeLaurier and J. M. Harris (Battelle Memorial Institute, Columbus, Ohio). *AIAA, MIT, and SSA, International Symposium on the Technology and Science of Low Speed and Motorless Flight, 2nd, Cambridge, Mass., Sept. 11-13, 1974, AIAA Paper 74-1015.* 8 p.

A74-42038 # **On the design of airfoils for low Reynolds numbers.** S. J. Miley (Bell Helicopter Co., Fort Worth, Tex.). *AIAA, MIT, and SSA, International Symposium on the Technology and Science of Low Speed and Motorless Flight, 2nd, Cambridge, Mass., Sept. 11-13, 1974, AIAA Paper 74-1017.* 16 p. 15 refs. Army-supported research.

A theoretical investigation of the influence of low Reynolds numbers on the design of airfoil sections has been performed. A lower limiting Reynolds number is reached below which only laminar flow supportable pressure distributions may be used for airfoil design. The use of boundary layer transpiration was shown to alleviate this problem somewhat. A study of the effects of lowering the Reynolds number on the turbulent boundary layer in the adverse pressure gradient region indicated that the degree of obtainable pressure recovery is also lowered correspondingly. To test the validity of the employed transition criterion and turbulent flow prediction method at low Reynolds numbers, an airfoil section was designed and tested in a low turbulence environment. The experimental results supported the validity of the theoretical methods. (Author)

A74-42039 # **The quest for high-lift.** F. X. Wortmann (Stuttgart, Universität, Stuttgart, West Germany). *AIAA, MIT, and SSA, International Symposium on the Technology and Science of Low Speed and Motorless Flight, 2nd, Cambridge, Mass., Sept. 11-13, 1974, AIAA Paper 74-1018.* 6 p. 9 refs.

Exploratory tests were done with four highly cambered single-element airfoils designed for high lift and large lift-drag ratios at Reynolds numbers of one up to three million. Windtunnel results show maximum lift coefficients of 2.0 to 2.4 and glide ratios of 150 to 200. The endurance ratio go well up to values of 200 to 250. Despite the high maximum lift, the stall characteristics can be considered as acceptable. (Author)

A74-42040 # **An analytic survey of low-speed flying devices - Natural and man-made.** J. H. McMasters (Camp Trails Co., Phoenix, Ariz.). *AIAA, MIT, and SSA, International Symposium on the Technology and Science of Low Speed and Motorless Flight, 2nd, Cambridge, Mass., Sept. 11-13, 1974, AIAA Paper 74-1019.* 13 p. 61 refs.

This paper presents a summary of the geometric, structural, and energetic relations of a wide spectrum of low-speed flying devices. Beginning with small insects, data is presented for the range of fliers including birds, bats, Pterosaurs, hang gliders, man-powered aircraft, sailplanes, general aviation aircraft, and large powered aircraft. The conclusions are that there is remarkable consistency in the size and energetic trends of flying devices covering twelve orders of magnitude in mass, that much can still be learned towards the improvement of aircraft design from a study of natural flight systems, and that serious gaps remain in our knowledge of natural flight. (Author)

A74-42041 # **An evaluation of sailplane drag coefficient parameters from flight test results.** W. A. Soule. *AIAA, MIT, and SSA, International Symposium on the Technology and Science of Low Speed and Motorless Flight, 2nd, Cambridge, Mass., Sept. 11-13, 1974, AIAA Paper 74-1020.* 13 p. 8 refs.

A drag analysis has been performed on flight test data from each of ten sailplanes. The analysis evaluates, as functions of lift coefficient, and analyzes, according to configuration feature, those curve fitting parameters normally considered constant in expressions for drag coefficient. Nondimensional performance curves are plotted from which nondimensional equivalent air and sink speeds at minimum rate-of-sink and maximum lift-to-drag are compared to equivalent theoretical functions of one of the parameters. Results of the study showed the parameters to be nonconstant functions of lift coefficient and such configuration features as canopy contour, horizontal tail position, and fuselage after-body shape. Results of the comparison of experimental and calculated velocities verified the theoretical equations. Effects of configuration features upon the drag parameters are discussed. (Author)

A74-42042 # **Flight testing a highly instrumented sailplane.** A. G. Bennett, J. K. Owens, L. G. Thorne (Mississippi State University, State College, Miss.), and D. T. Ward (USAF, Osan AFB, South Korea). *AIAA, MIT, and SSA, International Symposium on the Technology and Science of Low Speed and Motorless Flight, 2nd, Cambridge, Mass., Sept. 11-13, 1974, AIAA Paper 74-1023.* 10 p. 21 refs. Research supported by Mississippi State University; Contract No. F33615-72-C-1119.

The angle of attack excursions developed by a spinning sailplane were quantitatively explored using a Laister-Kaufmann LK-10A sailplane. Also a series of conventional longitudinal and lateral low angle of attack stability and control maneuvers were flown. The spin characteristics of the sailplane were investigated at 1, 36, 49, and 99% of the allowable center of gravity range. No fully developed spins could be attained for the 1 and 36% center of gravity positions. Fully developed spins could be attained at the 49% CG position when the elevator deflection limit was increased from 15 to 25 deg. It was found that the LK-10A sailplane exhibited two mildly oscillatory spin modes, when flown at 99% aft CG position. The average angles of attack for these two spin modes were approximately 30 and 55 deg, respectively. Maximum angles of attack of 70 deg were attained. (Author)

A74-42044 # **The technological prospects for oscillating-wing propulsion of ultralight gliders.** J. Wolf (Instytut Lotnictwa, Warsaw, Poland). *AIAA, MIT, and SSA, International Symposium on the Technology and Science of Low Speed and Motorless Flight, 2nd, Cambridge, Mass., Sept. 11-13, 1974, AIAA Paper 74-1028.* 12 p. 13 refs.

Basic mechanical and aerodynamical problems of oscillating-wing propulsion for a man-powered hang glider are considered. This propulsion requires elastic suspension of the pilot. The drive is transmitted from the pilot's legs to a stiff-wing structure by a trapeze device. This simple type of propulsion may reach extreme efficiency if appropriate longitudinal control has been provided. Translational-motion oscillating wings are shown to have many advantages as compared with swinging bird-like wings. The soundness of the explained idea of propulsion has been confirmed by morphology analysis and value engineering. (Author)

A74-42045 * # **Analysis and experimental studies of the control of hang gliders.** W. H. Phillips (NASA, Langley Research Center, Flight Dynamics and Control Div., Hampton, Va.). *AIAA, MIT, and SSA, International Symposium on the Technology and Science of Low Speed and Motorless Flight, 2nd, Cambridge, Mass., Sept. 11-13, 1974, AIAA Paper 74-1030.* 11 p.

A theoretical analysis of the longitudinal and lateral characteristics of hang gliders in straight flight, pullups, and turns is presented. Some examples of the characteristics of a straight-wing configuration and a Rogallo-wing configuration are given. A means for improving the control of hang gliders while retaining the same basic control feel is proposed. (Author)

A74-42046 # **New trends and developments in hang gliders.** G. J. Brown. *AIAA, MIT, and SSA, International Symposium on the Technology and Science of Low Speed and Motorless Flight, 2nd, Cambridge, Mass., Sept. 11-13, 1974, AIAA Paper 74-1031.* 7 p.

Many new hang glider designs have been developed in the last two years. These designs include technical features not common to other types of aircraft. Some of these features as well as some technical aspects of hang gliders in general are discussed briefly. Topics include the generalized limits on hang glider performance, the use of high-lift airfoils for rigid-wing hang gliders, glider control methods, advanced flexible wing designs, and general comments on pitch stability and roll control. (Author)

A74-42047 # **MSU Monoplane - A testbed for ultralight vehicle development.** A. G. Bennett (Mississippi State University, State College, Miss.). *AIAA, MIT, and SSA, International Symposium on the Technology and Science of Low Speed and Motorless Flight, 2nd, Cambridge, Mass., Sept. 11-13, 1974, AIAA Paper 74-1033.* 7 p. 7 refs. Research supported by the Mississippi State University.

A large monoplane hanglider is being constructed to explore the upper limits of vehicle size, control, and performance possible for ultralight flight. The basic design objectives were to develop a vehicle which had a stall speed of 15 mph and a L/D exceeding 10. The vehicle has aerodynamic controls about all axes, flaps, and spoilers. The vehicle structure is composed of plane trusses and space frames constructed of spruce and white pine. The wing D-tube is covered with 1-mm birch plywood with spanwide stringer and close rib spacing used to improve the torsional stiffness. The vehicle is to be covered with Dupont Tyvec. All ribs, spars, flaps, ailerons, fuselage frame, rudder and fin have been completed and the D-tube is currently being fabricated. (Author)

A74-42048 # **Some opportunities for progress in ultra-light aeronautics.** J. H. McMasters (Camp Trails Co., Phoenix, Ariz.). *AIAA, MIT, and SSA, International Symposium on the Technology and Science of Low Speed and Motorless Flight, 2nd, Cambridge, Mass., Sept. 11-13, 1974, AIAA Paper 74-1034.* 9 p. 36 refs.

The term ultra-light refers to aircraft with wing loadings below 150 N/sq m. The purpose of this survey is to identify areas in ultra-light aeronautics requiring research and development effort, with particular emphasis on those leading to improvements in performance and safety in motor-less types (e.g. hang gliders). The present state-of-the-art and trends in ultra-light development are briefly reviewed. Topics in aerodynamics, structures, materials, testing and instrumentation requiring further research and/or development are then discussed. An extensive list of references is included as an aid to future research. (Author)

A74-42049 # **Gemini - A variable geometry sailplane.** D. J. Marsden (Alberta, University, Edmonton, Canada). *AIAA, MIT, and SSA, International Symposium on the Technology and Science of Low Speed and Motorless Flight, 2nd, Cambridge, Mass., Sept. 11-13, 1974, AIAA Paper 74-1035.* 8 p. 7 refs.

High wing loading is desirable for cruising flight in a racing sailplane, since it allows higher speed for a given rate of sink. On the other hand, the sailplane must fly slowly with minimum rate of sink to gain height in thermals, and this usually means a conflicting requirement of low wing loading. An alternative approach is to keep the high wing loading and use a high lift flap system to take care of the low speed flight requirement. This must be combined with high aspect ratio if a low sink rate is to be achieved. The Gemini makes use of a full span slotted flap for low speed flight with outboard sections serving the dual purpose of flap and ailerons and inboard sections being deflected 90 deg for approach control. Flight experience to date has shown handling and performance in circling flight to be excellent, even at a wing loading of 8.6 lb/sq ft. (Author)

A74-42050 # **Application of sailplane and low-drag underwater vehicle technology to the long-endurance drone problem.** B. H. Carmichael (Rockwell International Corp., Anaheim, Calif.). *AIAA, MIT, and SSA, International Symposium on the Technology and Science of Low Speed and Motorless Flight, 2nd, Cambridge, Mass., Sept. 11-13, 1974, AIAA Paper 74-1036.* 10 p.

Theoretical and experimental contributions to the science of drag reduction through extensive laminar flow are reviewed. Airfoils with high L/D and high L to the 3/2 power/D at a Reynolds number of 1 million are described. The very low drag coefficients of five laminar fuselages are compared with typical turbulent values. A scheme is revealed to eliminate wing-fuselage intersection drag and to avoid turbulent wedges in the intersections. Solutions to practical laminar aircraft problems such as surface roughness, waviness, insect contamination, atmospheric turbulence, noise, and vibration are presented. A drone aircraft of outstanding performance, based on the above accumulated technology, is described. (Author)

A74-42051 * # **Determination of stability derivatives of isolated rigid tail assemblies in sideslip and steady roll.** D. R. Riley (NASA, Langley Research Center, Flight Dynamics and Control Div., Hampton, Va.). *AIAA, MIT, and SSA, International Symposium on the Technology and Science of Low Speed and Motorless Flight, 2nd, Cambridge, Mass., Sept. 11-13, 1974, AIAA Paper 74-1038.* 10 p. 5 refs.

A74-42052 # **An improved-performance control system for low-speed flight.** M. Kesselyak (Agrartudomanyi Foiskola, Nyiregyhaza, Hungary). *AIAA, MIT, and SSA, International Symposium on the Technology and Science of Low Speed and Motorless Flight, 2nd, Cambridge, Mass., Sept. 11-13, 1974, AIAA Paper 74-1039.* 12 p.

The new control aircraft is equipped with rigid stabilizer and stick controlled flap along the external wing span. This flap functions as an elevator and aileron, in addition to functioning as a flap per se. The new system guarantees by its simple structure, in a wide speed range, the aerodynamic optimum of airfoil-induced, fuselage, stabilizer, and interference drag. Interlocking of the profile camber and speed provides for a greater ultimate speed. The new system greatly improves racing gliders and agricultural aircraft, but not aerobatics. (Author)

A74-42055 # **The feasibility of an aircraft propelled by solar energy.** F. G. Irving and D. Morgan (Imperial College of Science and Technology, London, England). *AIAA, MIT, and SSA, International Symposium on the Technology and Science of Low Speed and Motorless Flight, 2nd, Cambridge, Mass., Sept. 11-13, 1974, AIAA Paper 74-1042.* 10 p. 14 refs.

In 1954, Raspet proposed that a solar-powered aircraft might be possible: solar cells would be incorporated in the wing and the electrical output used for propulsion. This proposal is reexamined in the light of current technology and it is concluded that machines with power requirements less than 100 W/sq m of wing area are feasible. For a given power per unit wing area, there is an optimum combination of span and aspect ratio giving minimum total power. Optimum aspect ratios all lie between 12.5 and 15. Likely configurations would have large wing spans, upward of 25 m. A machine capable of flying for several hours per day under favorable conditions is feasible, but the cost would be high and the payload small. The performance of sailplanes of more normal size could be improved significantly by the use of solar energy. Thermal-cycle power plants do not seem to offer any advantage compared with electrical systems. (Author)

A74-42058 # **A variable drag drogue chute for use as the aerodynamic decelerator in sailplanes.** G. Blonder. *AIAA, MIT, and SSA, International Symposium on the Technology and Science of Low Speed and Motorless Flight, 2nd, Cambridge, Mass., Sept. 11-13, 1974, AIAA Paper 74-1046.* 6 p.

Methods for reducing the glide ratio of a sailplane are presented, and their various limitations are discussed. It is concluded that a drogue chute whose drag may be modulated would yield the greatest benefits, and a suitable system is designed and tested. The chute has its cross-sectional area reduced by involuting the canopy via a control line connected to the apex. Wind-tunnel test data, control linkages, and an emergency release are detailed. (Author)

A74-42059 # **Investigation of a stored energy launch system for gliders.** D. R. Jackson and M. K. Pearson (Connecticut, University, Storrs, Conn.). *AIAA, MIT, and SSA, International Symposium on the Technology and Science of Low Speed and Motorless Flight, 2nd, Cambridge, Mass., Sept. 11-13, 1974, AIAA Paper 74-1047.* 10 p. 6 refs.

The energy required to launch a glider to soaring altitude may be readily stored in the form of compressed air in a package of sufficiently small size and weight to replace the passenger in a two-place glider. Although the candidate propulsion system, a compressed air driven rocket nozzle package chosen for simplicity and light weight, was found to be incapable of providing the full amount of impulse necessary to reach soaring altitude, the concept could find use as a source of impulse-producing ballast capable of an altitude gain of several hundred feet. A computer program to predict glider flight characteristics during propulsor operation was prepared and a 1/4 scale operating propulsion system was fabricated and tested on a thrust stand. The total impulse measured agreed well with that predicted by a thermodynamic analysis of system performance. (Author)

A74-42694 **A two-dimensional aerofoil with a control surface oscillating at low frequency in high subsonic flow.** D. Nixon (Queen Mary College, London, England). *Aeronautical Quarterly*, vol. 25, Aug. 1974, p. 186-198.

A74-42725 **The HS146 - A new dimension in short-haul profitability.** C. L. Mollan (Hawker Siddeley Aviation, Inc., Washington, D.C.). *Shell Aviation News*, no. 424, 1974, p. 22-27.

Probably the first and most important point is that the 146 is designed to achieve its best economic performance over stage lengths up to 200/250 miles. The eight U.S. local service carriers alone fly some 25,000 weekly scheduled departures on stage lengths in this band. It is also intriguing to note that even big trunk airlines, such as Eastern and United, fly in the order of 7000/10,000 weekly departures in the '500-mile-and-under' band. So, leaving aside for the moment the question of aircraft size, the need in the USA for an aircraft with good economics over very short stage lengths is clearly apparent. F.R.L.

A74-42792 # **Differentiation of corrosion damage by the severity of its effects upon the resistance to fatigue and corrosion-fatigue disintegration of aircraft skin elements (O differentsiatsii korrozionnykh porazhenii po stepeni ikh vliianiia na soprotivlenie ustalostnomu i korrozionno-ustalostnomu razrusheniiu elementov obshivki samoleta).** A. V. Karlashov and N. F. Voronkin (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukrainian SSR). *Problemy Prochnosti*, vol. 6, July 1974, p. 106-109. In Russian.

A74-42797 # **The numerical solution of the asymptotic equations of trailing edge flow.** C. E. Jobe (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) and O. R. Burggraf (Ohio State University, Columbus, Ohio). *Royal Society (London), Proceedings, Series A*, vol. 340, no. 1620, Sept. 3, 1974, p. 91-111. 17 refs.

According to Stewartson (1969, 1974) and to Messiter (1970), the flow near the trailing edge of a flat plate has a limit structure for Reynolds number increasing without bound consisting of three layers. In the present work, the asymptotic equations which arise in these layers are solved numerically by means of a Cauchy-integral algorithm for the outer layer and a modified Crank-Nicholson boundary layer program for the displacement-thickness interaction between the layers. Results of the computation compare well with experimental data of Janour and with numerical solutions of the Navier-Stokes equations by Dennis & Chang (1969) and Dennis & Dunwoody (1966). (Author)

A74-42849 # **Analysis, design and test of thrust reverser and thrust vectoring systems for STOL transport aircraft.** J. E. Petit and M. B. Scholey (Boeing Aerospace Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 9th, Las Vegas, Nev., Nov. 5-7, 1973, Paper 73-1218.* 12 p. 17 refs. USAF-sponsored research.

Methods to predict exhaust jet trajectory and spreading characteristics of thrust reverser and thrust vectoring nozzles for STOL transports have been developed. The methods provide simple design tools to evaluate thrust reverser and vectoring performance and determine potential exhaust flow interference and reingestion problems. Design studies included concepts applicable to externally blown flap, vectored thrust, and upper surface blowing lift systems. Results of model tests of a cascade thrust reverser are summarized. (Author)

A74-42872 # **Procedures for recovering flight vehicles (Bergeverfahren von Flugkörpern).** P. Brendel and G. Harms (Dornier GmbH, Friedrichshafen, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Symposium über Start- und Bergeverfahren von Flugkörpern, Höhenraketen und Drohnen, Bremen, West Germany, Apr. 30, 1974, Paper 74-038.* 44 p. In German.

Review of a number of procedures which have been proposed for recovering unmanned flight vehicles. The procedures described include recovery with an uncontrolled parachute and inflatable shock absorbers, the use of a parachute with retrorockets and inflatable shock absorbers, the use of a parachute with midair recovery by helicopter, recovery after hover flight by jet deflection (the aerodyne principle), recovery by means of a jet-powered rotor control with rectractable blade tips blowing hot air bled off from the engine, and recovery through the use of lift-fan engines. Criteria for evaluating these recovery procedures are cited, including the degree of exposure to harassment by the enemy during the recovery process, the landing accuracy, ease of maintenance, the turn-around time, effects on the vehicle design, the reuse rate, the availability, and cost. A.B.K.

A74-42922 **S-61 helicopter as a mobile intensive care unit.** K. Jessen and J. O. Hagelsten (Royal Danish Air Force, Vaerlose Air Base, Denmark). *Aerospace Medicine*, vol. 45, Sept. 1974, p. 1071-1074.

Since the Sikorsky S-61 helicopter was introduced into the Royal Danish Air Force in 1966, more than 1800 missions have been carried out. The cabin in the S-61 helicopter has ample space for observation and treatment of the patient. The results of 190 missions during the last 24 months are evaluated. Patients suffering from heart-lung, abdominal, or intracranial diseases, and from burns or poisoning represent about 70% of these missions. Since vital functions cannot be monitored in the usual way in a helicopter, it was necessary to develop a dependable and safe method for continuous observation of the heart function via an ECG on an oscilloscope. The described system is relatively simple and makes continuous ECG casette-recordings during flight for telemetry, later study, and interpretation possible. (Author)

A74-43125 # **Technology for the reduction of aircraft turbine engine pollutant emissions.** D. W. Bahr (General Electric Co., Aircraft Engine Group, Cincinnati, Ohio) and C. C. Gleason (General Electric Co., Aircraft Engine Group, Lynn, Mass.). *International Council of the Aeronautical Sciences, Congress, 9th, Haifa, Israel, Aug. 25-30, 1974, Paper 74-31.* 27 p. 10 refs.

The exhaust pollutant emissions characteristics of aircraft turbine engines are described. Also, the basic approaches for reducing the levels of these pollutant emissions are reviewed. The results of specific development efforts to define engine combustor design features and operational methods for attaining these more favorable emissions characteristics are presented. Based on these development results and trends, it is concluded that future engines will be developed with significantly more favorable exhaust emissions characteristics than those of current engines. The possible effects of obtaining the low exhaust pollutant emissions levels, required to meet the U.S. Environmental Protection Agency standards, on engine designs and their operating characteristics are also briefly considered. (Author)

A74-43132 # **Study of flow in axial compressors (Issledovanie techeniia v osevykh kompressorakh).** Iu. I. Shvets, T. M. Shan'ko, and Iu. N. Zdorenko (Akademiia Nauk Ukrainskoi SSR, Institut Tekhnicheskoi Teplofiziki, Kiev, Ukrainian SSR). *Teplofizika i Teplotekhnika*, no. 26, 1974, p. 52-54. In Russian.

An algorithm is proposed for calculating flow density in a compressor of a turbine engine which has a device for initially swirling the air flow before it reaches the rotor either in the direction of the blade rotation or in the opposite direction. Calculation applies to steady flow of a compressible ideal gas. P.T.H.

A74-43143 # **High lift characteristics of an airfoil placed in a narrow channel.** K. Suzuki (Nippon Kokan K.K., Ltd., Kawasaki, Japan), A. Mizuno (Osaka Gas Co., Ltd., Osaka, Japan), and H. Ohashi (Tokyo, University, Tokyo, Japan). *JSME, Bulletin*, vol. 17, July 1974, p. 912-919. 14 refs.

A74-43164 * **Composite materials inspection.** R. K. Erf (United Aircraft Research Laboratories, East Hartford, Conn.). In: Holographic nondestructive testing. New York, Academic Press, Inc., 1974, p. 323-332. Contracts No. NAS1-9926; No. F33615-71-C-1874.

Investigation of the application requirements, advantages, and limitations of nondestructive testing by a technique of ultrasonic-vibration holographic-interferometry readout used in a production control facility for the inspection of a single product such as composite compressor blades. It is shown that, for the detection and characterization of disbonds in composite material structures, this technique may represent the most inclusive test method. M.V.E.

A74-43201 **Symposium on the Application of Electrical Control to Aircraft Propulsion Systems, London, England, February 20, 21, 1974, Proceedings.** Symposium sponsored by the Royal Aeronautical Society and Institution of Electrical Engineers. London, Royal Aeronautical Society, 1974. 204 p. $11.90.

Arguments stressing the advantages of the use of electronic control systems for aircraft powerplant control are presented, and the main techniques for implementing electrical control are described. The works presented can serve as a general guide for system design and engineering. Some of the topics covered include overall safety objectives for integrated propulsion system, the architecture of turbine engine control, control system considerations for helicopter gas turbines, an electronic full-authority engine fuel control system, the case for digital techniques applied to powerplant controls, and the turbine blade pyrometer system in the control of the Concorde engine.

P.T.H.

A74-43202 # **Power plant controls - 'The system'.** C. G. White (Ministry of Defence /Procurement Executive/, London, England). In: Symposium on the Application of Electrical Control to Aircraft Propulsion Systems, London, England, February 20, 21, 1974, Proceedings. London, Royal Aeronautical Society, 1974. 4 p.

Some general considerations on the nature of total jet engine control systems are brought forward. System control by digital means opens the possibility of adaptive control systems using modern control theory. Using truly digital techniques for implementing and adapting control functions and by using new processing methods, enormous improvements can be made in the flexibility and power of the tool that the digital engineer is offering to the accessory engineer. Interplay of ideas between the digital engineer and the accessory designer must inevitably lead to new digitally inspired methods of controlling fuel flow and aerodynamics of engines. P.T.H.

A74-43203 # **The development of electrical systems for powerplant control.** R. Kendell (Ultra Electronics, Ltd., London, England). In: Symposium on the Application of Electrical Control to Aircraft Propulsion Systems, London, England, February 20, 21, 1974, Proceedings. London, Royal Aeronautical Society, 1974. 15 p.

The present work traces the development of electrical control for aircraft engine power from 1946 to the present, summarizing the basic features of some representative designs. The period 1950-1960 saw the use of magnetic amplifiers in speed and temperature limiters. The first full authority electrical control system entered service in 1956. Developmental progress from then on meant increased safety and integrity. Integrated circuits suitable for analog controllers became available in 1963 in the form of monolithic dc amplifiers. By 1967, controllers designed with a mixture of proprietary silicon integrated circuits, tantalum thin-film resistor networks, and conventional components had been demonstrated. The impact of microelectronics has been such that functional packaging densities have increased by an order of magnitude compared with the magnetic amplifier systems which were predominant up until the early 1960's. P.T.H.

A74-43204 # **Overall safety objectives for integrated propulsion system.** P. R. Allison (Civil Aviation Authority, London, England). In: Symposium on the Application of Electrical Control to Aircraft Propulsion Systems, London, England, February 20, 21, 1974, Proceedings. London, Royal Aeronautical Society, 1974. 12 p.

The present work suggests a comprehensive airworthiness approach to the concept of the integrated propulsion system. The broad functions of a generalized propulsion system are pointed out and their implications developed. Primary functions would be to provide steady-state thrust minus drag, thrust minus drag response, all power for services, and cabin conditioning and pressurization. Subsidiary functions would include reading and using of air data, sensing and matching of characteristics, and maintenance of gas producer conditions. Primary airworthiness criteria would include damage due to noncontainment, individual and multiple power unit loss, and influence on flying control system by power source and by

direct effect. Propulsion unit design should take into account the overall behavior of all components and their functions at the earliest stage possible. Then, through sophisticated engineering, fundamental safety objectives should be assured by simple 'back-up' devices, or procedures, associated not only with the particular sub-system being considered, but also with any of the other associated components which together involve a relationship with the propulsion unit.
P.T.H.

A74-43205 # **Aircraft approach - A degree of bias.** J. E. Talbot (British Aircraft Corp., Ltd., Filton, Bristol, England). In: Symposium on the Application of Electrical Control to Aircraft Propulsion Systems, London, England, February 20, 21, 1974, Proceedings. London, Royal Aeronautical Society, 1974. 12 p.

The present work discusses problems arising in the design and development of the control systems for the powerplant of a four-engine supersonic transport aircraft. The powerplant is divided into four components: intake, engine, reheat, and nozzle/reverser. Current interpretations of the airworthiness requirements for supersonic aircraft call for control chains for each individual engine. It would be advisable to cut down the number of control chains, and allow, for example, three self-monitoring function-generating lanes to be employed for combined control of intake, engine, reheat, and nozzle, each unit generating the required functions for all four engines. The improvement in overall system reliability could then well make up for the reduction in the number of control chains. Sufficient flexibility must be incorporated in the design at its inception in order to permit rapid revision of the basic control laws during development and flight test. There is a need for more comprehensive simulation of the total powerplant system as a design aid to shorten the development cycle. P.T.H.

A74-43206 # **Power complex - A suitable case for treatment.** J. W. Howden and A. M. Lewis (Rolls-Royce /1971/, Ltd., Bristol, England). In: Symposium on the Application of Electrical Control to Aircraft Propulsion Systems, London, England, February 20, 21, 1974, Proceedings. London, Royal Aeronautical Society, 1974. 16 p.

The present work examines some of the factors governing the choice of control system for a new aircraft engine. A fully electronic control system is apt to be the most desirable one when the control requirements are complex, where there is high probability of increasing complexity during development, and when the equipment can be aircraft mounted. The problem of complexity growth during development is illustrated by a case in point: the development of the primary nozzle control philosophy for the Olympus 593 engines of the Concorde. Digital controllers are widely hailed as the systems of the future - they offer great advantages such as improved accuracy, simple modification by reprogramming, better safety, and flexibility in the use of space capacity. Several disadvantages of digital systems must, however, be considered. With them, it is not possible to make instant datum adjustments, and electrical interference, both emitted and received, is of far more consequence in digital than in analog equipment. P.T.H.

A74-43209 # **The architecture of a turbine engine control.** T. A. Flanders (United Aircraft Corp., Hamilton Standard Div., Windsor Locks, Conn.). In: Symposium on the Application of Electrical Control to Aircraft Propulsion Systems, London, England, February 20, 21, 1974, Proceedings. London, Royal Aeronautical Society, 1974. 17 p. 6 refs.

The present work reviews some of the requirements to be met by the control system for a multispool, high-bypass ratio 10-ton engine as used in multiengine aircraft in short haul service. The advantages of introducing electronics to fulfill some of the propulsion management functions are examined. Of prime importance for considering the use of electronics in the control of the 10-ton engine is the fact that flight parameters are normally available in electronic form (turbine temperature, fan speed, engine pressure ratio, aircraft Mach number, altitude, and ram number) and that the thrust rating parameter is more complex than simply that defined by core engine speed and compressor inlet temperature. The best solution appears to be to use a hydromechanical unit for basic engine protection and control, with an electronic unit for propulsion management. The tasks done by the electronic unit would be those now done by the flight crew, while those accomplished by hydromechanical control are now also done by hydromechanical control. P.T.H.

A74-43210 # **Control system considerations for helicopter gas turbines.** A. B. Foulds (Hawker Siddeley Dynamics Engineering, Ltd., Hatfield, Herts., England). In: Symposium on the Application of Electrical Control to Aircraft Propulsion Systems, London, England, February 20, 21, 1974, Proceedings.
London, Royal Aeronautical Society, 1974. 21 p.

The present work describes the main characteristics of existing control systems of gas turbine engines for helicopter applications, and indicates how advances in technology are likely to influence future designs. The universal trend in recent years has been to adopt electronics for the computing functions of the control while retaining the hydromechanical elements in their simplest form for the essential fuel handling role. Engine-mounting of controls gives very distinct advantages. Digital techniques in the future will be used principally to improve integrity and interfacing functions such as display, self-test, and health monitoring for the propulsion system.
P.T.H.

A74-43211 # **An electronic full-authority engine fuel control system.** L. D. Lewis (AiResearch Manufacturing Co., Los Angeles, Calif.). In: Symposium on the Application of Electrical Control to Aircraft Propulsion Systems, London, England, February 20, 21, 1974, Proceedings. London, Royal Aeronautical Society, 1974. 16 p.

The present work describes some techniques in the application of full-authority electronic controls to fuel control for gas turbine engines in the 5,000-lb thrust range. An actual system is then described and diagrammed. A general scheme for the development of a digital engine simulation model with full transient capability is described. P.T.H.

A74-43212 # **The case for digital techniques applied to powerplant controls.** J. F. O. Evans (Smiths Industries, Ltd., Wembley, Middx., England). In: Symposium on the Application of Electrical Control to Aircraft Propulsion Systems, London, England, February 20, 21, 1974, Proceedings. London, Royal Aeronautical Society, 1974. 20 p.

The present work argues for the application of digital computing techniques to on-line powerplant control in aircraft. The analysis is based on the cost effectiveness of digital control techniques and hardware solutions in the light of the particular problems associated with aircraft engine control. The use of digital systems with their ability to change programs easily and cheaply during development permits important decisions to be delayed until the necessary data to base them on becomes available. The computer in a digital system can be employed for overall system check-out, thus avoiding the necessity for separate equipment at dispersed sites and additional connectors for ground check equipment. Digital systems reduce the number and frequency of control setting adjustments, thus improving aircraft availability and maintainability. The application of Fault Tree Analysis is illustrated for a hypothetical analysis of a VTOL aircraft. P.T.H.

A74-43214 # **Turbine blade pyrometer system in the control of the Concorde engine.** K. R. Curwen (Kollsman Instrument, Ltd., Southampton Airport, England). In: Symposium on the Application of Electrical Control to Aircraft Propulsion Systems, London, England, February 20, 21, 1974, Proceedings.
London, Royal Aeronautical Society, 1974. 11 p.

The salient features of the pyrometer system for the Concorde's Olympus engine are described. Duplex channels are provided for each engine; these feed the two lanes of the engine control system. The temperature signal is used to limit the engine fuel flow such that excessive blade temperatures are avoided. By the use of pyrometry, the necessity of deducing blade temperature from exhaust gas

thermocouple measurements is eliminated, enabling the engine to be uprated. The average engine thrust and efficiency are thereby increased, which is especially significant for a supersonic transport. (Author)

A74-43451 * # **Iterative solution of transonic flows over airfoils and wings, including flows at Mach 1.** A. Jameson. *Communications on Pure and Applied Mathematics*, vol. 27, May 1974, p. 283-309. 20 refs. Grant No. NGR-33-016-167; Contract No. AT(11-1)-3077.

A new method of calculating transonic flows based on a 'rotated' difference scheme is described. It is suitable for the calculation of both two- and three-dimensional flows without restriction on the speed at infinity and is well adapted to computer use. The Murman procedure is modified to eliminate any assumptions about the direction of flow when constructing the difference scheme. The proper directional property is obtained by rotating the difference scheme to conform with the local stream direction. In the hyperbolic region retarded difference formulas are used for all contributions to the streamwise second derivative, producing a correctly oriented positive artificial viscosity. In the absence of a simple implicit scheme in the hyperbolic and elliptic regions, the concept of iterations as steps in artificial time is introduced. Computer testing of this procedure provides numerical confirmation of the existence and uniqueness of weak solutions of the potential equation when a suitable entropy inequality is enforced. J.K.K.

A74-43457 **Signal-to-noise ratio in the inspection penetrant process.** J. R. Alburger (Shannon-Glow, Inc., Los Angeles, Calif.). *(American Society for Nondestructive Testing, National Fall Conference, Chicago, Ill., Oct. 1-5, 1973.) Materials Evaluation*, vol. 32, Sept. 1974, p. 193-200. 26 refs.

The ability of a penetrant to remain in large cracks so as to show crack indications, while being effectively removed from surface porosities leaving a relatively clean background, is known as Indication Signal-to-Noise ratio. The various important penetrant performance parameters of brightness, dye performance sensitivity, flaw entrapment efficiency, and signal-to-noise ratio are discussed. It is shown how signal-to-noise ratio relates to the effectiveness of a penetrant in yielding useful inspection results. A description is given of test apparatus suitable for evaluating the signal vs noise parameter. F.R.L.

A74-43470 **Alcor - A high altitude pressurized sailplane /1/.** R. T. Lamson. *(Organisation Scientifique et Technique Internationale du Vol à Voile, Congress, 14th, Waikerie, Australia, Jan. 12-27, 1974.) Aero-Revue*, Aug. 1974, p. 482.

Alcor is a research sailplane which has utilized unusual design concepts and manufacturing techniques to enable comfortable and safe flying at high altitude. There are three basic design objectives which were pursued in the development of the sailplane. They are (1) the use of new materials and, when needed, an adjusted sandwich cross section to optimize structural capability; (2) the use of a new oxygen management system which, with safety, will allow high dry oxygen concentrations in the cabin environment with a simple and reliable pressure regulating system; and (3) the provision of a simple and reliable means of cabin temperature control at all flight levels. P.T.H.

A74-43471 **Alcor - A high altitude pressurized sailplane /2/.** R. T. Lamson. *(Organisation Scientifique et Technique Internationale du Vol à Voile, Congress, 14th, Waikerie, Australia, Jan. 12-27, 1974.) Aero-Revue*, Sept. 1974, p. 542-545.

The present work discusses some of the physiological and aerodynamic considerations in the design of the Alcor sailplane, and then describes the structural design, the oxygen and pressure regulating system and operation, and cockpit heat control. The use of glass fibers with varying foam sandwich cores gave improvements in compression and torsional stiffness. This resulted in a high ratio of wing torsional stiffness to wing bending, which should provide gust loading relief in turbulent air and extend the critical flutter speed. The pressurization system features zero cabin leakage, cabin structure capability to a cabin differential to 10 lb per square inch at ambient temperature to -70 F, and a cabin oxygen level readout instrument allowing pilot monitoring of oxygen levels at all times. P.T.H.

A74-43601 **Advancements in flight test engineering; Proceedings of the Fifth Annual Symposium, Anaheim, Calif., August 7-9, 1974.** Symposium sponsored by the Society of Flight Test Engineers. Lancaster, Calif., Society of Flight Test Engineers, 1974. 398 p.

The development of short takeoff and landing (STOL) operational criteria, demonstration of the feasibility of a scanning beam microwave landing system, automatic avionics system checkout and monitoring in a flight test environment are among the topics covered in papers concerned with recent advances in flight test engineering. Other topics covered include automatic avionics system checkout and monitoring in a flight test environment, effective data monitoring during airplane flyover noise tests, and airborne testing of advanced multisensor aircraft. M.V.E.

A74-43602 **Developing STOL operational criteria.** R. M. Spangler (FAA National Aviation Facilities Experimental Center, Atlantic City, N.J.). In: Advancements in flight test engineering; Proceedings of the Fifth Annual Symposium, Anaheim, Calif., August 7-9, 1974. Lancaster, Calif., Society of Flight Test Engineers, 1974, p. 1-1 to 1-62. 14 refs.

A DeHavilland DHC-6, Series 100 Twin Otter was flown by a representative group of pilots on various steep-gradient approaches onto a ground-level STOL runway. Approximately 800 approaches and landing were accomplished to provide a data base to approve a first-generation STOL operation. Areas investigated included: aircraft handling and response on steep-gradient approaches with various approach electronic beam sensitivities; location of the ground point of intercept; co-located versus split localizer/glideslope signal source; obstacle clearance requirements; field length requirements; and influence of command-steering on aircraft/pilot performance. (Author)

A74-43603 * **NASA Flight Research Center scale F-15 remotely piloted research vehicle program.** G. P. Layton (NASA, Flight Research Center, Research Projects Div., Edwards, Calif.). In: Advancements in flight test engineering; Proceedings of the Fifth Annual Symposium, Anaheim, Calif., August 7-9, 1974. Lancaster, Calif., Society of Flight Test Engineers, 1974, p. 1-63 to 1-76. 5 refs.

The NASA Flight Research Center undertook a remotely piloted research vehicle (RPRV) program with a 3/8-scale model of an F-15 aircraft to determine the usefulness of the RPRV testing technique in high-risk flight testing such as spin testing. The results of the first flights of the program are presented. The program has shown that the RPRV technique, including the use of a digital control system, is a viable method for obtaining flight research data. Also presented are some negative aspects that have been learned about the RPRV technique in terms of model size, command frequency, and launch technique. (Author)

A74-43604 **Advancements in the test and evaluation of naval weapon systems.** T. P. Perry and R. J. Warnagieris (U.S. Navy, Naval Missile Center, Point Mugu, Calif.). In: Advancements in flight test engineering; Proceedings of the Fifth Annual Symposium, Anaheim, Calif., August 7-9, 1974. Lancaster, Calif., Society of Flight Test Engineers, 1974, p. 1-77 to 1-89.

Naval Air Systems Command, the responsible agency for research development test and evaluation and procurement of naval aircraft and weapon systems, is in the process of architecting its structure, methodologies, and long-range plans. The authors, employed by a leading test and evaluation (T&E) field activity of the Command, make a case for the role of T&E in these future plans and

outline objectives applicable to the T&E community at large. The paper highlights the T&E concepts pioneered by naval aviation, gives examples of current system capabilities which have enhanced the state of the T&E, and provides conceptual suggestions for the future. (Author)

A74-43612 Airborne testing of advanced multisensor aircraft. L. Chabot, R. Wengler, and A. Mallow (Grumman Aerospace Corp., Bethpage, N.Y.). In: Advancements in flight test engineering; Proceedings of the Fifth Annual Symposium, Anaheim, Calif., August 7-9, 1974. Lancaster, Calif., Society of Flight Test Engineers, 1974, p. 2-95 to 2-128.

Recent attack aircraft designs, such as the A-6E, incorporate modern electro-optical sensors which, when combined with previous equipment, such as radar, provide multisensor aircraft. The electro-optical sensors involved include: forward-looking infrared (FLIR) devices, low-light-level television (LLLTV) units, and laser transmitters and receivers. Typical flight test objectives for these devices included measurement of resolution and sensitivity of the FLIR and LLLTV, and measurement of range and range accuracy using the laser transceiver. The necessary flight testing has involved the use of special preliminary ground tests, complex instrumentation and data processing, special targetry, and appropriate flight techniques. The special targetry was designed to allow evaluation of resolution, sensitivity, boresight, and other parameters. (Author)

A74-43613 A new jet engine thrust measuring system - An advancement in flight test engineering. J. A. Gravelle (Computing Devices Co., Propulsion Group, Ottawa, Canada). In: Advancements in flight test engineering; Proceedings of the Fifth Annual Symposium, Anaheim, Calif., August 7-9, 1974.
Lancaster, Calif., Society of Flight Test Engineers, 1974, p. 3-1 to 3-12.

A new thrust measuring system for the General Electric J85-CAN-15 turbojet engine has been designed and built. An advanced development model of the system was flight tested in a CF-5D aircraft and evaluated by the Aerospace Engineering Test Establishment of the Canadian Armed Forces. The system was developed and flight tested in order to demonstrate a concept of in-flight thrust measurement which uses engine gas pressure and air data computer measurements only. The system is believed to be the first of its kind to use a digital computer to solve engine gross thrust in real time. The system also computes a reference gross thrust which is compared with the engine gross thrust. (Author)

A74-43621 * Hot-wire anemometry for in-flight measurement of aircraft wake vortices. R. A. Jacobsen (NASA, Ames Research Center, Flight Systems Research Div., Moffett Field, Calif.). In: Advancements in flight test engineering; Proceedings of the Fifth Annual Symposium, Anaheim, Calif., August 7-9, 1974. Lancaster, Calif., Society of Flight Test Engineers, 1974, p. 4-13 to 4-24. 20 refs.

An airborne hot-wire anemometry system capable of providing data concerning the vortex structure in the wake of a preceding aircraft has been used in several flight studies. The design features of this technique and the operational experience with it are described. This development program has resulted in a flight-test technique that can make accurate velocity measurements in flow regimes where large velocity gradients occur. (Author)

A74-43623 US Army helicopter icing tests. W. E. Griffith, II and M. L. Hanks (U.S. Army, Edwards AFB, Calif.). In: Advancements in flight test engineering; Proceedings of the Fifth Annual Symposium, Anaheim, Calif., August 7-9, 1974. Lancaster, Calif., Society of Flight Test Engineers, 1974, p. 4-47 to 4-61. 16 refs.

Limited testing of Army helicopters has been conducted in both artificial and natural icing environments. To provide for artificial icing tests, a helicopter icing spray system was developed which has the capability of providing a closely controlled in-flight artificial icing environment. Natural icing tests were conducted to verify that artificial icing characteristics are representative of natural icing characteristics. The test technique utilized was a buildup program in accretion, static temperature, and accretion rate. Of the helicopters tested (UH-1H, AH-1G, AH-1Q, and CH-47C), general problem areas have been identified. Engine ice ingestion, rotor blade impact damage, degraded autorotational capability, high vibration levels due to asymmetric ice shedding, and restricted forward visibility are a few of these problem areas. (Author)

A74-43767 # Adaptation of measuring and inspection instruments to the measurement of standard blades of aircraft-engine turbines and compressors (Przystosowanie aparatury pomiarowo-kontrolnej do pomiarow lopatek wzorcowych turbin i sprezarek silnikow lotniczych). M. Krawczyk (Wyzsza Szkola Inzynierska, Rzeszow, Poland). In: Technology of rotor-type flow machines; Scientific-Technological Conference, 3rd, Rzeszow, Poland, September 21, 22, 1973, Proceedings. Warsaw, Stowarzyszenie Inzynierow i Technikow Mechanikow Poliskich, 1973, p. 409-424. In Polish.

The problem of determining the optimum measurement conditions for achieving a prescribed accuracy is discussed. The application of contour masters and other inspection and measurement techniques to standard turbine and compressor blades is examined, and the range of their applicability in the industry is assessed. V.P.

A74-43768 # New structural materials for jet engine components (Nowe materialy konstrukcyjne na elementy silnikow odrzutowych). E. Gruszczynski (Instytut Techniczny Wojsk Lotniczych, Warsaw, Poland). In: Technology of rotor-type flow machines; Scientific-Technological Conference, 3rd, Rzeszow, Poland, September 21, 22, 1973, Proceedings.
Warsaw, Stowarzyszenie Inzynierow i Technikow Mechanikow Poliskich, 1973, p. 425-441. 15 refs. In Polish.

The current status and developmental trends of titanium alloys for use in aviation are examined, along with factors of importance in the development of turbine engines, such as high compression ratios, high thrust to weight ratios, high temperatures, low losses, and light weight. The properties of representative alpha-Ti, alpha + beta - Ti, and beta-Ti alloys are tabulated, along with the chemical compositions of heat resistant nickel-, cobalt-, and chromium-base alloys. Materials used to manufacture fan and compressor blades and disks, exhaust-pipe and combustion-chamber elements, turbine blades, and fuselage components are examined. V.P.

A74-43913 The F-15 air superiority fighter electromagnetic compatibility program. P. R. McBrayer (McDonnell Douglas Corp., St. Louis, Mo.) and D. Lockie (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: Electromagnetic Compatibility Symposium, 16th, San Francisco, Calif., July 16-18, 1974, Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1974. 4 p.

The F-15 EMC engineering task was divided into six major categories, related to grounding, shielding, bonding, noise and susceptibility control, antenna system compatibility, and lightning and precipitation static protection. The F-15 EMC program was initiated during the concept formulation phase and was an integral part of contract definition, system development, and the acquisition phase. G.R.

A74-44069 # Corrosion on aircraft - Evaluation, examination, and elimination. II (Korrosion an Luftfahrzeugen - Ihre Beurteilung, Prüfung und Behebung. II). H. Ebert (Staatliche Luftfahrtinspektion, Berlin, East Germany), R. Hermann, and A. Römer (VEB Kombinat Spezialtechnik, Dresden, East Germany). *Technisch-ökonomische Informationen der zivilen Luftfahrt*, vol. 10, no. 4, 1974, p. 206-214. 8 refs. In German.

The occurrence of corrosion on the various sections and components of an aircraft is considered. Visual inspection regarding corrosion attack is supplemented by measurements of corrosion depth. Approaches for periodic corrosion control measures are discussed together with the determination of the causes of corrosion and decisions regarding the remaining operational life of components before corrective action must be taken. Procedures are described for the elimination of corrosion damage in the case of aluminum, magnesium, and iron materials. G.R.

A74-44071 # The Soviet radio navigation procedure RSBN (Das sowjetische Funknavigationsverfahren RSBN). P. Korrell (Hochschule für Verkehrswesen, Dresden, East Germany). *Technisch-ökonomische Informationen der zivilen Luftfahrt,* vol. 10, no. 4, 1974, p. 223-228. 8 refs. In German.

The RSBN system of navigation, which was introduced in civil and military aviation of the Soviet Union, satisfies many of the requirements desired in an ideal international navigational system. During the approach for landing the polar coordinate system used provides the pilot with continuous data concerning the distance of the aircraft from the airport. The further development of RSBN provides possibilities for guiding the approach of vertically landing aircraft. Operational and design details of the RSBN system are considered, giving attention also to the employment of digital approaches in the most recent system developments. G.R.

A74-44073 # Dolphin airship with undulating propulsion - Action of the elastic drive blades (Delphinluftschiff mit Wellantrieb - Wirkung elastischer Wellerblätter). W. Schmidt (Gesellschaftliche Forschungs- und Entwicklungsbüro für Luftschiffahrt, Dresden, East Germany). *Technisch-ökonomische Informationen der zivilen Luftfahrt,* vol. 10, no. 4, 1974, p. 240-242. 6 refs. In German.

A study of the operational characteristics of rigid and of elastic drive blades was conducted. Thrust, stress, and electrical parameters obtained in both cases are presented in a graph. The evaluated results show that thrust performance values are twice as high for the elastic drive blades. Relations between driving velocity, motor performance, and rotational speed are also considered. G.R.

A74-44161 * Effect of frictional heating on brake materials. T.-L. Ho, M. B. Peterson, and F. F. Ling (Rensselaer Polytechnic Institute, Troy, N.Y.). *Wear,* vol. 30, Oct. 1974, p. 73-91. 6 refs. Grant No. NGR-33-018-152.

An exploratory study of the properties of aircraft brake materials was made to determine ways of improving friction and wear behavior while minimizing surface temperatures. It is found that frictional variation at high temperature involves material softening and metal transfer, formation of oxides, and surface melting. The choice of proper materials to combat these effects is discussed. Minimum surface temperatures are found to result from use of materials with large density-specific heat and density-specific heat-conductivity factors, use of a higher load-lower friction system, and maximization of the contact area. Some useful trade-off criteria for the size of brake disks against weight considerations are suggested. Additional information on material behavior and peak braking temperatures was gathered from an inspection of used brake pads and rotor disks. J.K.K.

A74-44314 * Analysis of acoustic radiation in a jet flow environment. P. Mungur (NASA, Langley Research Center, Joint Institute for Acoustics and Flight Sciences, Hampton, Va.; George Washington University, Washington, D.C.), H. E. Plumblee (Lockheed-Georgia Co., Marietta, Ga.), and P. E. Doak (Southampton, University, Southampton, England). *Journal of Sound and Vibration,* vol. 36, Sept. 8, 1974, p. 21-52. 20 refs. Research supported by the Science Research Council of England, Lockheed Georgia Co., and NASA.

The analysis of sound fields from arbitrary source distributions in terms of Legendre and spherical Hankel functions is well known. The purpose of this paper is to extend this classical method of analysis to environments such as jet flows where flow and flow gradients are inherently present. The wave-equation governing the radiation of sound in such an environment is derived. The steady state flow and flow gradients in the axial and transverse directions appear as coefficients in the terms of the wave-equation. A semi-numerical method is used to solve the wave-equation in terms of modified spherical harmonics yielding the phase velocities and the directivities of an infinite set of modes. The directivity of each mode is obtained in terms of modified Legendre functions by numerical integration. Some results of these directivity and phase-velocity calculations are presented for a limited number of frequency and flow parameters. Both convective and shear refraction are shown to be important. (Author)

STAR ENTRIES

N74-31414*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
THEORETICAL AND EXPERIMENTAL LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF AN ASPECT RATIO 0.25 SHARP-EDGE DELTA WING AT SUBSONIC, SUPERSONIC, AND HYPERSONIC SPEEDS
Charles H. Fox, Jr. and John E. Lamar Washington Aug. 1974 45 p refs
(NASA-TN-D-7651; L-9328) Avail: NTIS HC $3.25 CSCL 01A

The suction analogy concept of Polhamus for predicting vortex lift in conjunction with an appropriate potential-flow solution is called the present method. This method is applied to an aspect ratio 0.25 sharp-edge delta wing from a Mach number of 0.143 to 10.4 in free air and at 0.074 in ground effect, and also to an aspect ratio 0.35 triangular crosssectional body at a Mach number of 6.9. The models had subsonic leading edges at the test Mach numbers. Vortex-flow effects could be neither confirmed nor denied to exist at high speeds because of the lack of flow visualization above a Mach number of 0.143. The data, however, could be better predicted by including a vortex-flow effect, although not always to the extent predicted from the present method because of the presence of actual and hypothesized unmodeled flow situations. The method of Nenni and Tung (NASA CR-1860) tended to confirm the existence of vortex flow at hypersonic speeds. The hypersonic-tangent-cone method predicted best the delta-wing results over the test angle-of-attack range and hypersonic Mach number range and did equally as well as the present method for the triangular body. Author

N74-31416*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AERODYNAMIC CHARACTERISTICS OF THREE SLENDER SHARP-EDGE 74 DEGREES SWEPT WINGS AT SUBSONIC, TRANSONIC, AND SUPERSONIC MACH NUMBERS
Edwin E. Davenport Washington Aug. 1974 77 p refs
(NASA-TN-D-7631; L-9433) Avail: NTIS HC $4.00 CSCL 01A

Slender sharp-edge wings having leading-edge sweep angles of 74 deg have been studied at Mach numbers from 0.60 to 2.80, at angles of attack from about minus 4 deg to 22 deg, and at angles of sideslip from 0 deg to 5 deg. The wings had delta, arrow, and diamond planforms. The experimental tests were made in the Langley 8-foot transonic pressure tunnel and the Langley Unitary Plan wind tunnel test section number 1. The theoretical predictions were made using the theories of NASA TN D-3767 and NASA TN D-6243. The results of the study indicated that the lift and drag characteristics as affected by planform and Mach number could be reasonably well predicted for the delta wing in the subsonic and transonic Mach number range. In the supersonic range, the delta and diamond wings were about equally good in the degree of agreement between experiment and theory. In making drag-due-to-lift predictions the vortex lift effects must be taken into account if reasonable results are to be obtained at moderate or high lift coefficients. Author

N74-31419*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
SUBSONIC AND SUPERSONIC LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF AN AFT TAIL FIGHTER CONFIGURATION WITH CAMBERED AND UNCAMBERED WINGS AND UNCAMBERED FUSELAGE
Samuel M. Dollyhigh Washington Aug. 1974 98 p refs
(NASA-TM-X-3078; L-9463) Avail: NTIS HC $4.00 CSCL 01C

An investigation has been made in the Mach number range from 0.20 to 2.16 to determine the longitudinal aerodynamic characteristics of a fighter airplane concept. The configuration concept employs a single fixed geometry inlet, a 50 deg leading-edge-angle clipped-arrow wing, a single large vertical tail, and low horizontal tails. The wing camber surface was optimized in drag due to lift and was designed to be self-trimming at Mach 1.40 and at a lift coefficient of 0.20. An uncambered or flat wing of the same planform and thickness ratio was also tested. However, for the present investigation, the fuselage was not cambered. Further tests should be made on a cambered fuselage version, which attempts to preserve the optimum wing loading on that part of the theoretical wing enclosed by the fuselage. Author

N74-31421*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
LATERAL-DIRECTIONAL STABILITY CHARACTERISTICS OF A WING-FUSELAGE CONFIGURATION AT ANGLES OF ATTACK UP TO 44 DEG
William P. Henderson and Jarrett K. Huffman Washington Sep. 1974 36 p refs
(NASA-TM-X-3087; L-9541) Avail: NTIS HC $3.25 CSCL 01B

An investigation has been conducted to determine the effects of configuration variables on the lateral-directional stability characteristics of a wing-fuselage configuration. The variables under study included variations in the location of a single center-line vertical tail and twin vertical tails, wing height, fuselage strakes, and horizontal tails. The study was conducted in the Langley high-speed 7-by 10-foot tunnel at a Mach number of 0.30, at angles of attack up to 44 deg and at sideslip angles of 0 deg and plus or minus 5 deg. Author

N74-31427*# Massachusetts Inst. of Tech., Cambridge.
FLIGHT CONTROL SYSTEMS RESEARCH Annual Report, 1 Sep. 1972 - 1 Sep. 1973
H. P. Whitaker, Y. Baram, and Y. Cheng Nov. 1973 50 p refs
(Grant NGL-22-009-548)
(NASA-CR-139595; RE-89) Avail: NTIS HC $5.50 CSCL 01C

Theoretical development is reported for the parameter optimization design technique needed for digital flight control system design. The results of an example case study applying the optimization technique for continuous systems to an F-8 aircraft feedback control system are presented. The concept of evolving the simplest system configuration that is capable of meeting a specified set of performance requirements is illustrated in this work. Author

N74-31442 Royal Aircraft Establishment, Farnborough (England). Controls and Displays Div.
ON THE DESIGN AND EVALUATION OF FLIGHT CONTROL SYSTEMS
F. R. Gill *In* AGARD Advan. in Control Systems May 1974 13 p refs

An analysis of flight test results of control systems for fighter and transport aircraft is presented. The systems under consideration employ conventional linear control policies with the design being based on a parameter optimization technique. The two modes which are discussed are a pitch rate maneuver demand system for the fighter aircraft and an ILS glide path and flare system for the transport aircraft. Studies to replace

linear control by variable gain policies are discussed. The reasons for and the principles of the variable gain control policies are outlined. The principles of flight evaluation methods employed with the control system tests are included. Author

N74-31443 Honeywell, Inc., Minneapolis, Minn.
A FLY-BY-WIRE FLIGHT CONTROL SYSTEM FOR DECOUPLED MANUAL CONTROL
A. J. VanDierendonck, K. Bassett (AFFDL), and E. E. Yore *In* AGARD Advan. in Control Systems May 1974 7 p refs

(Contract F33615-72-C-1266)

A sight line autopilot (SLAP) was designed for the AC-130 Gunship to improve the gun pointing ability. This paper presents the unique design procedure and development philosophy that was used. It emphasizes the peculiarities of this weapon delivery concept, the problem areas and the results of the design. Multi-axes coupling, digital computer control, available measurements, and optimistic performance requirements prompted the use of modern control design techniques. Optimal control laws were generated for all modes and submodes. No classical analysis was performed. Proportional-plus-integral control was included to reduce nonlinear effects. Both linear and nonlinear simulation results verified that the autopilot met the optimistic performance requirements in spite of poor performing servo-actuators, which limited the bandwidth of control laws. More recently, ground and flight tests have been performed. Author

N74-31447 Bodenseewerk Geraetetechnik G.m.b.H., Ueberlingen (West Germany).
REALIZATION AND FLIGHT TESTS OF AN INTEGRATED DIGITAL FLIGHT CONTROL SYSTEM
Robert K. Zach *In* AGARD Advan. in Control Systems May 1974 20 p refs

The introduction of digital computers into modern aircraft control systems for the integration of all the functions in a complex automatic flight control system is discussed. In order to realize such practical systems economically, the functional requirements for the computer and interface were first derived by the analysis of the tasks and by the hybrid simulation of the functions, where the aircraft and actuators were simulated on an analog computer and the AFCS on a general purpose digital computer. Based on these requirements, a free programmable in-flight simulator was designed, built and flown in the test aircraft. This equipment is compatible with the laboratory hybrid simulation equipment. The in-flight simulator allows experiments of different control laws, and was used to check and prove the required control form for a special digital system developed for flight control. As is shown, this latter system fulfills all the functional requirements and consists of a small digital computer, an interface for signal conversion and a pilots control panel. All functions of a modern AFCS, such as stabilizer, automatic approach, automatic landing and other autopilot functions as well as preflight and inflight tests were integrated, by programming the semiconductor mermory. The flight trials of this system in the test aircraft showed the satisfactory functioning of the system over the whole aircraft flight envelope. The good control characteristics were confirmed with the measured responses in flight. Author

N74-31450* National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
DESIGN AND FLIGHT EXPERIENCE WITH A DIGITAL FLY-BY-WIRE CONTROL SYSTEM IN AN F-8 AIRPLANE
Dwain A. Deets and Kenneth J. Szalai *In* AGARD Advan. in Control Systems May 1974 10 p refs

CSCL 01C

A digital fly-by-wire flight control system was designed, built, and for the first time flown in an airplane. The system, which uses components from the Apollo guidance system, is installed in an F-8 airplane as the primary control system. A lunar module guidance computer is the central element in the three-axis, single-channel, multimode, digital control system. A triplex electrical analog system which provides unaugmented control of the airplane is the only backup to the digital system. Flight results showed highly successful system operation, although the trim update rate was inadequate for precise trim changes, causing minor concern. The use of a digital system to implement conventional control laws proved to be practical for flight. Logic functions coded as an integral part of the control laws were found to be advantageous. Although software verification required extensive effort, confidence in the software was achieved. Author

N74-31451 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany).
DIGITAL FLY-BY-WIRE CONTROL SYSTEM WITH SELF-DIAGNOSING FAILURE DETECTION
R. Onken, H. P. Joenck, L. Tacke, and M. Gottschlich *In* AGARD Advan. in Control Systems May 1974 7 p refs

A solution is presented to the problem of achieving real fail-safe behaviour for fly-by-wire systems, no longer depending on the reliability of the monitor/voter device and the probability of the occurrence of dormant errors. This is accomplished by the use of stand-by redundancy in conjunction with selfdiagnosing failure detection which is independant of the control signal state. Each redundant unit is autonomous with respect to the failure detection, such that, depending on the inspection rate, perfect information about the reliability status of the system, including the failure detection itself, is available at any time. The feasibility of this approach is demonstrated by the fly-by-wire system which is installed and successfully flown in a HFB 320 jet aircraft. Author

N74-31452 Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
B-52 CONTROL CONFIGURED VEHICLES PROGRAM
R. P. Johannes and G. O. Thompson *In* AGARD Advan. in Control Systems May 1974 10 p refs Prepared in cooperation with Boeing Co.

A test program to evaluate the control configured vehicles (CCV) program is discussed. The purpose of the program is to validate achievable results of the CCV system concepts on large flexible aircraft, such as the B-52. The four concepts which are involved in the flight test are: (1) ride control, (2) flutter mode control, (3) maneuver load control, and (4) augmented stability. The potential benefits of the CCV concept and the results of the ride control system flight tests are analyzed. Author

N74-31455 Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
V/STOL AIRCRAFT CONTROL/DISPLAY CONCEPT FOR MAXIMUM OPERATIONAL EFFECTIVENESS
Kenneth W. McElreath, James A. Klein (Collins Radio Co.), and Ralph C. Thomas (Collins Radio Co.) *In* AGARD Advan. in Control Systems May 1974 8 p refs

Vertical/Short Takeoff and Landing (V/STOL) aircraft and their unique missions define four requirements for a practical and suitable IFR control/display system: (1) maximum flight profile flexibility, (2) flight control precision, (3) low pilot workload, and (4) simplicity at low cost. A system concept which has made significant progress in meeting these requirements is described. The system concept is that of retaining the human pilot as an active control element, augmented by an integrated system of displays, steering computation, and automatic control elements. The task allocation between the pilot and the automatic portion of the system optimizes the pilot's flexibility and control effectiveness in the control tasks for which he is most suited, complemented by the precision and reduction in workload afforded by automatic control techniques. The approach taken in the development of the system was to first define the mission tasks to be performed and the system constraints. Analysis and pilot-in-the-loop simulation determined the most effective control scheme and the optimum human-automatic interface. Flight testing then validated the system concepts in hardware form aboard a CH-3E helicopter test bed. Author

N74-31456 Royal Aircraft Establishment, Bedford (England).
AUTOSTABILIZATION IN VTOL AIRCRAFT: RESULTS OF FLIGHT TRIALS WITH SC 1
H. W. Chinn *In* AGARD Advan. in Control Systems May 1974 16 p refs

The flight control system developed for the SC 1 jet lift VTOL research aircraft is described and an account given of its behaviour throughout the flight envelope: vertical take-off and landing, transition and conventional flight. The system, which provided artificial directional stability in the yaw and maneuver demand in the pitch and roll axes, gave a stable aircraft while retaining a high degree of maneuverability. Comparison is made with existing handling criteria and the ways in which demand systems inevitably contravene certain of these criteria are discussed. Author

N74-31458# Advisory Group for Aerospace Research and Development, Paris (France).
AIRCRAFT DESIGN INTEGRATION AND OPTIMIZATION, VOLUME 1
Jun. 1974 347 p refs In ENGLISH; partly in FRENCH Conf. held at Florence, Italy, 1-4 Oct. 1973
(AGARD-CP-147-Vol-1) Avail: NTIS HC $20.50

The proceedings of a conference on aircraft design integration and optimization are presented. The subjects discussed include the following: (1) the preliminary design process and its impact on cost, (2) methods and approaches for balancing requirements, capabilities, and costs in aircraft design, (3) analysis, optimization, and validation testing techniques, and (4) the integration of subsystems and application of new technology.

N74-31459 Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
THE ROLE OF PRELIMINARY DESIGN IN REDUCING DEVELOPMENT, PRODUCTION AND OPERATIONAL COSTS OF AIRCRAFT SYSTEMS
William E. Lamar *In* AGARD Aircraft Design Integration and Optimization, Vol. 1 Jun. 1974

Methods for reducing the development, production, and operational costs of aircraft systems through preliminary design procedures are discussed. The manner in which the preliminary design process is conducted is analyzed. The critical program decisions which are made on the basis of the preliminary design process are identified. The preliminary process is further defined to show the application for assessing the payoff of technical innovations and emerging technologies on system capabilities. Diagrams are provided to show the preliminary design flow chart, system program phases, preliminary design process uses, and cost reduction methodologies. Author

N74-31460 General Dynamics/Fort Worth, Tex.
PRELIMINARY DESIGN ASPECTS OF DESIGN-TO-COST FOR THE YF-16 PROTOTYPE FIGHTER
William C. Dietz *In* AGARD Aircraft Design Integration and Optimization, Vol. 1 Jun. 1974 16 p

Methods for reducing the development costs of the YF-16 aircraft are discussed. The YF-16 prototype aircraft was conceived and is being developed as a low-cost, exceptionally high-maneuvering-performance fighter aircraft. To meet the cost/performance objectives, a number of advanced technology features, including vortex lift, variable wing camber, wing/body blending, relaxed static stability/fly-by-wire, and high-performance normal-shock inlet, were optimized and integrated during the preliminary design phase. The basic design concept was to apply these advanced technologies in a way, first, to produce a small-size aircraft and, second to achieve simplicity - both of these design objectives having a direct beneficial effect on the development, acquisition, and life-cycle cost. The resulting configuration is predicted to meet all program cost/performance objectives. Author

N74-31468 Boeing Commercial Airplane Co., Seattle, Wash.
DESIGN EVOLUTION OF THE BOEING 2707-300 SUPERSONIC TRANSPORT. PART 2: DESIGN IMPACT OF HANDLING QUALITIES CRITERIA, FLIGHT CONTROL SYSTEM CONCEPTS, AND AEROELASTIC EFFECTS ON STABILITY AND CONTROL
W. T. Kehrer *In* AGARD Aircraft Design Integration and Optimization, Vol. 1 Jun. 1974 10 p refs

The intensive efforts undertaken to develop an economically competitive SST are discussed. New design approaches in the areas of airplane longitudinal control and stability and flight control systems design were developed. Extensive research work was conducted to push the state of the art as hard as possible in the development of handling qualities criteria and in the design evolution of the stability augmentation system. The end product was a control-configured vehicle employing multiple redundant electronic stability augmentation systems to meet design requirements for both normal handling qualities and minimum-safe handling qualities. This design approach contributed substantial gains in range/payload capability over that attainable through the conventional approach that inhibits airplane design through the requirement to provide inherent aerodynamic stability. Throughout all of the design development work the effects of structural aeroelastics on aircraft stability and control played a major role in configuration design decisions. The complex engineering work involved in the aeroelastic analyses paced the configuration development design cycles and contributed substantially to the total engineering costs. The experience gained in these areas has identified the need for improved quality, automated aeroelastic analysis methods to speed the design development work and reduce the engineering costs and design risks. Author

N74-31469 British Aircraft Corp., Preston (England). Military Aircraft Div.
RECENT EXPERIENCE FROM BAC AIRCRAFT FOR NATO
P. J. Midgley *In* AGARD Aircraft Design Integration and Optimization, Vol. 1 Jun. 1974 10 p ref

An analysis of trends in total cost of ownership of combat aircraft was developed. The life cycle cost analysis is related to the Air Force budget and ways are considered in which the rising costs of Air Force operations may be alleviated. The subjects discussed include the following: (1) Air Force budget trends, (2) the procurement process, (3) life cycle costs, (4) launch and acquisition costs, (5) development philosophy, (6) operating costs, and (7) training costs. Charts, graphs, and diagrams are included to illustrate the contents of the text. Author

N74-31470 Aeronautical Systems Div., Wright-Patterson AFB, Ohio.
THE F-15 DESIGN CONSIDERATIONS
Harry E. Rifenbark and Richard D. Highet *In* AGARD Aircraft Design Integration and Optimization, Vol. 1 Jun. 1974 11 p

The major design considerations of the F-15 air superiority aircraft are traced from the initial requirements, through the design, and into the flight testing. Selection of the overall configuration is discussed with particular emphasis on the wing, inlet, and secondary power design. The ground and flight test programs are briefly reviewed. Author

N74-31477 Royal Aircraft Establishment, Farnborough (England).
INITIAL-DESIGN OPTIMISATION ON CIVIL AND MILITARY AIRCRAFT
D. L. I. Kirkpatrick and M. J. Larcombe *In* AGARD Aircraft Design Integration and Optimization, Vol. 1 Jun. 1974 18 p refs

The development of a computer program which can optimize the preliminary design of a subsonic, swept-wing, jet transport aircraft is discussed. The program can be used to assess rapidly the effects on the optimum design of changes in the specified performance or of advances in aerodynamic, structural, or engine technology. Compound optimization functions, including several

of the aircraft characteristics, with different weighting factors can be used to produce designs in which large improvements in some characteristics have been obtained with small penalties in others. Author

N74-31478 Societe Nationale Industrielle Aerospatiale, Paris (France).
NEW TECHNOLOGIES AND MAINTENANCE OF HELICOPTERS
Jacques Andres *In* AGARD Aircraft Design Integration and Optimization, Vol. 1 Jun. 1974 13 p In FRENCH

Two fundamental criteria are proposed to study helicopter maintenance: specific costs which constitute the reference for the purchase price of the helicopter and the specific operational price which constitutes the reference cost in helicopter utilization. Data are also given on the problem of cost of performance, security, and comfort in helicopter design. The contribution of new technologies to actual helicopter cost effectiveness was evaluated. Transl. by E.H.W.

N74-31479 Vereinigte Flugtechnische Werke G.m.b.H., Bremen (West Germany).
DESIGN OPTIMIZATION OF THE VAK 191B AND ITS EVALUATION BASED ON RESULTS FROM THE HARDWARE REALISATION AND TEST DATA
Rolf Riccius and Bernhard Wolf *In* AGARD Aircraft Design Integration and Optimization, Vol. 1 Jun. 1974 19 p refs

The design optimization procedure for the VAK 191B fighter aircraft is discussed. The procedure of design optimization is evaluated based on the results obtained from ground and flight tests. The emphasis in the original planning was placed on aircraft performance. The results of the tradeoff studies in combination with point design studies are reported. The different approaches to the power plant selection are defined. The rationale behind the final selection of the aerodynamic configuration is explained. Author

N74-31480 Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
CONCEPT CCV AND SPECIFICATIONS
Jean-Claude Wanner *In* AGARD Aircraft Design Integration and Optimization, Vol. 1 Jun. 1974 6 p In FRENCH; ENGLISH summary

The application of the control configured vehicle (CCV) concept to the design stage of new aircraft is discussed. The systems considered under the CCV concept are: (1) static stability compensation, (2) maneuver load control, (3) active ride control, and (4) active flutter control. The overall goal of the CCV concept is to take advantage of the most recent technological progress in electronics and to make use of new types of control actuators in order to satisfy the compromise between performance, handling qualities, lifetime, and cost. Author

N74-31481 Boeing Co., Wichita, Kans.
INTRODUCTION OF CCV TECHNOLOGY INTO AIRPLANE DESIGN
Richard B. Holloway *In* AGARD Aircraft Design Integration and Optimization, Vol. 1 Jun. 1974 16 p refs

The control configured vehicle (CCV) aircraft design process is compared with conventional design procedures. The CCV procedure capitalizes on the potential of considering advanced flight control concepts during the initial parametric studies and trades. Formulation of the parametric aircraft can also be altered by the CCV approach, since traditional empirical design procedures no longer necessarily apply. CCV studies indicate that the most significant performance improvements are achieved in the following functions: (1) augmented stability, (2) gust load alleviation, (3) maneuver load control, (4) fatigue reduction, (5) ride control, and (6) flutter mode control. Author

N74-31483 Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany).
ADVANCEMENTS IN FUTURE FIGHTER AIRCRAFT
Wolfgang Herbst *In* AGARD Aircraft Design Integration and Optimization, Vol. 1 Jun. 1974 7 p refs

An analysis of advanced design technology as applied to future fighter aircraft was conducted. The following conclusions were reached: (1) a new aircraft development can be justified if the performance of the new aircraft exceeds that of the old by 15 to 20 percent, (2) foreseeable technological air frame advances, such as CCV and composites, do not justify the development of new weapon systems, per se, (3) refent engine technology advances allows a performance improvement which will justify new aircraft design, and (4) foreseeable air frame advances will pay off if applied to new aircraft development. Author

N74-31485*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
LOW-SPEED AERODYNAMIC CHARACTERISTICS OF A HYPERSONIC RESEARCH AIRPLANE CONCEPT HAVING A 70 DEG SWEPT DELTA WING
Theodore R. Creel, Jr. and Jim A. Penland Aug. 1974 78 p refs
(NASA-TM-X-71974) Avail: NTIS HC $4.00 CSCL 01C

An experimental investigation of the low-speed static longitudinal, lateral and directional stability characteristics of a hypersonic research airplane concept having a 70 deg swept delta wing was conducted in a low-speed tunnel with a 12-foot (3.66 meter) octagonal test section. Aircraft component variations included: (1) fuselage shape modifications, (2) tip fins, (3) center vertical fin, (4) wing camber, and (5) wing planform. This investigation was conducted at a dynamic pressure of 262.4 Pa (5.48 psf), a Mach number of 0.06, and a Reynolds number of 2.24 million, based on body length. Tests were conducted through an angle-of-attack range of 0 deg to 30 deg with elevon deflections from +5.0 deg to minus 30.0 deg. The complete configuration exhibited positive static longitudinal, lateral and directional stability up to angles of attack of at least 20 deg and was trimmable to lift coefficients of at least 0.70 with elevon deflections of minus 30 deg. Author

N74-31486*# Douglas Aircraft Co., Inc., Santa Monica, Calif.
PARAMETRIC STUDY OF STOL SHORT-HAUL TRANSPORT ENGINE CYCLES AND OPERATIONAL TECHNIQUES TO MINIMIZE COMMUNITY NOISE IMPACT Final Report
E. P. Schuld, J. P. Crovello, J. H. Lindley, L. H. Quick, F. S. LaMar, and R. H. Young Jun. 1974 418 p refs
(Contract NAS2-6994)
(NASA-CR-114759; MDC-J4437) Avail: NTIS HC $24.00 CSCL 01C

The effect of aircraft operational techniques in the terminal area on community noise impact of future short-haul aircraft was studied. One mechanical-flap (MF) aircraft and one externally-blown-flap (EBF) aircraft were used to study the noise impact at four U.S. airports: Hanscom Field (Boston); Washington National; Midway (Chicago); and Orange County (California). The EBF aircraft was the final design E-150-3000 aircraft developed during the NASA STOL Systems Study. With the exception of Washington National (DCA), the study showed that a reduction of approximately 40 percent in the number of people highly annoyed (as defined in the study) can be obtained by using these operational techniques. At DCA the number of people highly annoyed using the standard procedure was quite low, but it is significant that the minimum-impact case for Runway 36 reduced the number of people highly annoyed to zero by using a power cutback and a turning departure path. The evaluation procedures and methodology developed in this study represents an advance in acoustical state-of-the-art and should provide an effective and useful tool for determining aircraft noise impact upon the airport community. Author

N74-31490# Cranfield Inst. of Technology (England).
AIRCRAFT DESIGN STUDIES: E67 TILT-WING EXECUTIVE AIRCRAFT
D. Howe Aug. 1973 54 p refs
(Cranfield-Aero-23) Avail: NTIS HC $5.75

The E67 configuration design is for a vertical take off and landing aircraft for executive use whose vertical flight capability was achieved by using the tilt wing concept. The initial version of the design power provided for two Rolls Royce H1400 Gnome turboshaft engines driving two 16 ft diameter propellers. Cross shaft interconnection between the propellers was included in the layout, although the need for four engines to cater for an engine failure condition in vertical flight became apparent. The pressurized cabin is designed to accommodate up to 18 passengers in a high density feeder role. Conventional design techniques were used throughout. A market survey showed that the design had significant advantages relative either to a helicopter or a twin jet executive type. Author

N74-31493*# Scientific Translation Service, Santa Barbara, Calif.
PROPELLERS AND HELICOPTER BLADES OF FIBER-REINFORCED SYNTHETIC RESIN MATERIALS
Ulrich Huetter Washington NASA Aug. 1974 27 p refs Transl. into ENGLISH from Jahrbuch 1960 der. WGL (West Ger.), 1960 p 374-381 Presented at 4th European Aerodyn. Congr., Cologne, 18-22 Sep. 1960
(Contract NASw-2483)
(NASA-TT-F-15859) Avail: NTIS HC $4.50 CSCL 01C

Shell structures for propellers and helicopter blades are predominantly under centrifugal loads and therefore essentially subjected to such extensive radial stresses that full advantage can be taken of the high tensile strength of strand-reinforced synthetic resin materials. Great difficulties have been encountered in the past with the diffusion of end loads into fiberglass reinforced compound materials. These difficulties, however, can be overcome by applying the loop method, a method by which the diffusion into various strands is accomplished by means of loops formed by continuous layers of strands. By special treatment of the strands before being placed into the mould, any arbitrary distribution of thickness of the shells can be achieved without using special jigs. The application of various manufacturing techniques to the manufacture of aerofoils in large interval flow engines, propellers and helicopter blades is illustrated. Author

N74-31494*# Scientific Translation Service, Santa Barbara, Calif.
GUST MEASUREMENTS ON CONCORDE
R. Dieudonne Washington NASA Aug. 1974 37 p Transl. into ENGLISH from AAAF 10th Colloq. d'Aerodyn. Appliquee (Lille), 7-9 Nov. 1973 29 p
(Contract NASw-2483)
(NASA-TT-F-15837) Avail: NTIS HC $5.00 CSCL 01C

Scale models of wing, wing and fuselage and complete SST Concorde models have been tested for gust effects on trajectory, velocity and acceleration for free flight conditions. The trajectory measures 20 chords and the gust is simulated with blowers. Experimental results are compared with calculations of stall conditions and suggestions for improvement are given. Author

N74-31495*# Boeing Commercial Airplane Co., Seattle, Wash.
V/STOL LIFT FAN COMMERCIAL SHORT HAUL TRANSPORTS: CONTINUING CONCEPTUAL DESIGN STUDY
J. M. Zabinsky, W. F. Minkler, J. G. Bohn, T. Derbyshire, J. E. Middlebrooks, J. P. McBarron, B. Williams, and C. W. Miller Washington NASA Jul. 1974 104 p refs
(Contract NAS2-6563)
(NASA-CR-2437; D6-41537) Avail: NTIS HC $4.50 CSCL 01C

A design study of commercial V/STOL transport airplanes for a 1985 operational time period has been made. The baseline mission considered was 400 nmi at a cruise speed of M = 0.75 and a 100-passenger payload with VTOL. Variations from the baseline included mission distance, payload, cruise speed, and propulsion system failure philosophy. All designs used propulsion systems consisting of multiple gas generators driving remote tip turbine lift and lift/cruise fans. By considering the fan to be designed for operational reliability, significant simplication of the airplane systems and reduction in airplane size and cost can be achieved. Author

N74-31498*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ANALYTICAL MODEL FOR TILTING PROPROTOR AIRCRAFT DYNAMICS, INCLUDING BLADE TORSION AND COUPLED BENDING MODES, AND CONVERSION MODE OPERATION
Wayne Johnson Aug. 1974 160 p refs Prepared in cooperation with Army Air Mobility R and D Lab., Moffett Field, Calif.
(NASA-TM-X-62369) Avail: NTIS HC $5.00 CSCL 01C

An analytical model is developed for proprotor aircraft dynamics. The rotor model includes coupled flap-lag bending modes, and blade torsion degrees of freedom. The rotor aerodynamic model is generally valid for high and low inflow, and for axial and nonaxial flight. For the rotor support, a cantilever wing is considered; incorporation of a more general support with this rotor model will be a straight-forward matter. Author

N74-31499*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
PROGRESS IN AIRCRAFT DESIGN SINCE 1903
1974 97 p
(NASA-TM-X-70319; L-9866) Avail: NTIS HC $8.00 CSCL 01C

Significant developments in aviation history are documented to show the advancements in aircraft design which have taken place since 1903. Each aircraft is identified according to the manufacturer, powerplant, dimensions, normal weight, and typical performance. A narrative summary of the major accomplishments of the aircraft is provided. Photographs of each aircraft are included. Author

N74-31501*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
PERTURBATION SOLUTIONS FOR THE INFLUENCE OF FORWARD FLIGHT ON HELICOPTER ROTOR FLAPPING STABILITY
Wayne Johnson Aug. 1974 109 p refs Prepared in cooperation with Army Air Mobility R and D Lab., Moffett Field, Calif.
(NASA-TM-X-62361) Avail: NTIS HC $8.50 CSCL 01C

The stability of the flapping motion of a helicopter rotor blade in forward flight is investigated, using a perturbation technique which gives analytic expressions for the eigenvalues, including the influence of the periodic aerodynamic forces in forward flight. The perturbation solutions are based on small advance ratio (the ratio of the helicopter forward speed to the rotor tip speed). The rotor configurations considered are a single, independent blade; a teetering rotor; a gimballed rotor with three, four, and five or more blades; and a rotor with N independent blades. The constant coefficient approximation with the equations and degrees of freedom in the nonrotating frame represents the flap dynamic reasonably well for the lower frequency modes, although it cannot, of course, be completely correct. The transfer function of the rotor flap response to sinusoidal pitch input is examined, as an alternative to the eigenvalues as a representation of the dynamic characteristics of the flap motion. Author

N74-31504*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
BONDED COMPOSITE TO METAL SCARF JOINT PERFORMANCE IN AN AIRCRAFT LANDING GEAR DRAG STRUT
William E. Howell Jul. 1974 25 p refs Presented at Army Symp. on Solid Mech., 1974, the Role of Mech. in Design - Structural Joints, Cape Cod, Maine, 10-12 Sep. 1974
(NASA-TM-X-71995) Avail: NTIS HC $3.00 CSCL 01C

The structural performance of a boron-epoxy reinforced titanium drag strut, which contains a bonded scarf joint and was designed to the criteria of the Boeing 747 transport, was evaluated. An experimental and analytical investigation was

conducted. The strut was exposed to two lifetimes of spectrum loading and was statically loaded to the tensile and compressive design ultimate loads. Throughout the test program no evidence of any damage in the drag strut was detected by strain gage measurements, ultrasonic inspection, or visual observation. An analytical study of the bonded joint was made using the NASA structural analysis computer program NASTRAN. A comparison of the strains predicted by the NASTRAN computer program with the experimentally determined values shows excellent agreement. The NASTRAN computer program is a viable tool for studying, in detail, the stresses and strains induced in a bonded joint. Author

N74-31514# Notre Dame Univ., Ind.
PERFORMANCE ESTIMATES FOR POWERED PARAFOIL SYSTEMS Final Report
John D. Nicolaides Feb. 1974 67 p refs
(Contract F33615-71-C-1093; AF Proj. 6065)
(AD-779926; AFFDL-TR-74-12) Avail: NTIS CSCL 01/3

The estimated flight performance of powered parafoil systems are presented for various system weights ranging from 10 pounds to 10,000 pounds. Special attention is given to level flight, climbing and descending flight, and take-off distance. The equations of motion are summarized and the effect of the thrust pitch angle is evaluated. Various system designs such as manned flight, cargo and weapon delivery, and decoy and jammer vehicles are considered as examples for using the performance curves and equations. Author (GRA)

N74-31515# United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft Div.
CONTINUOUS SEAM DIFFUSION BOND TITANIUM SPAR EVALUATION Final Report, 20 Jun. 1972 - 20 Jan. 1974
Maron J. Bonassar and John J. Lucas Apr. 1974 73 p
(Contract DAAG46-72-C-0175)
(AD-780029; AMMRC-CTR-74-37) Avail: NTIS CSCL 01/3

The objectives of this program were establishment of a technology to fabricate helicopter titanium main rotor blade spars cut from sheet material and joined by continuous seam diffusion bonding (CSDB) and the eventual application of this technology in the manufacturing of various components at reduced overall cost. The effects of different thermal treatments after bonding were determined by tensile and fatigue testing of small test specimens fabricated from titanium sheet flat panels joined by CSDB. Three 9-foot long spar sections were then fabricated, and two were tested in fatigue. The results indicate that continuous seam diffusion bonding has fatigue strength characteristics as good as, or better than, present fusion welded main rotor blade spar specimens and should be further evaluated for this application. (Modified author abstract) GRA

N74-31518# Army Engineer Waterways Experiment Station, Vicksburg, Miss.
HELICOPTER DOWNWASH DATA
Grady W. Leese and John T. Knight, Jr. Jun. 1974 49 p
(DA Proj. 1T0-62013-A-046)
(AD-780754; AEWES-Misc-Paper-S-74-17) Avail: NTIS CSCL 01/3

The report describes an investigation involving measurement of horizontal velocities, along and up to six feet above the ground surface, generated by the rotor systems of various Army helicopters during takeoff, hover, and fly-by operations. Measurements of ground-wash velocities during various operational modes were collected for OH-58A, OH-6A, AH-1G, UH-1H, UH-1M, CH-47, and CH-54 helicopters. (Modified author abstract) GRA

N74-31617*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
PROPELLER MODULATION EFFECTS ON A SCANNING BEAM MICROWAVE LANDING SYSTEM
Jack M. Pope and William H. Staehle Jul. 1974 42 p refs Prepared in cooperation with Raytheon Co., Wayland, Mass.
(NASA-TM-X-62368) Avail: NTIS HC $3.25 CSCL 20N

An investigation to assess the modulation effects on microwave signals transmitted through rotating propeller blades. Interruption of the antenna line-of-sight signal by the rotating propeller causes a variation of path loss, which produces essentially an amplitude modulation of the received signal. This interruption or blockage effect is generally only partial because of edge diffraction around the particular interfering propeller blade. Signals reflected from the rotating propeller will also cause Doppler frequency shifts to be present in the received signals. A scanning beam microwave landing system (MLS) known as MODILS (modular instrument landing system) was used to process the received signals for display. The effects of propeller modulation were studied by varying the following parameters: (1) spacing between propeller and receiving antenna, (2) propeller dimensions, (3) propeller speed (rpm), (4) number of propeller blades, (5) system data rate, (6) receiver response time, and (7) receiver antenna aperture. Author

N74-31667# Advisory Group for Aerospace Research and Development, Paris (France).
ANTENNAS FOR AVIONICS
Jun. 1974 526 p refs In ENGLISH and partly in French Presented at the 26th meeting of the Avionics Panel Symp., Munich, 26-30 Nov. 1973
(AGARD-CP-139) Avail: NTIS HC $29.50

The application of avionics antennas in Aerosat systems is considered by analyzing the feasibility of realizing required radiation patterns either on the aircraft, on the satellite, or on the ground.

N74-31680 Chelton (Electrostatics) Ltd., Marlow (England).
AIRBORNE LOW-VHF ANTENNAS
Charles E. Cooper *In* AGARD Antennas for Avionics Jun. 1974 8 p

A blade type antenna design is considered for airborne transmission and reception, with variants covering major sections of the overall frequency band from 26 to 100 MHz. It uses miniature high vacuum relays to tune via pre-selection of up to six binary related inductors, providing up to sixty four tuning combinations, with individual band widths varying from about + or - 0.5 to 5.0 MHz. The relays are remotely controlled either manually or automatically, and the retune process can be virtually instantaneous upon both receive and ready to transmit modes, without having to be incepted by any period of transmission. Incorporation of a variable tuning system was compelled by the specified combination of total frequency coverage and maximum allowable dimensions for the antenna. However, experimental investigations into the practical limits of broadbanding produced an antenna design fixed tuned to cover 38 to 46 MHz, which is briefly described. A brief outline of a wideband VHF homing antenna which uses elements formed out of transparent metallic-film depositions upon the acrylic canopy of the Gazelle helicopter is included. Author

N74-31684 Royal Radar Establishment, Malvern (England).
PROBLEMS OF LONG LINEAR ARRAYS IN HELICOPTER BLADES
R. H. J. Cary *In* AGARD Antennas for Avionics Jun. 1974 18 p refs

Helicopter blades offer sites for the inclusion of long microwave antennas to give narrow azimuthal beams scanned by the rotation of the blades. The variation of blade attitude as it rotates is such that it may lag, lead, bend in vertical and horizontal planes and twist, and in consequence places limits on the practical length of a linear array. The choice of location for antennas, either in the front or trailing edge, or out or inboard is discussed. Certain advantages accrue from a design where the antenna is located near the center of gravity of the blade section, and radiating rearwards through the trailing edge, which requires to be of dielectric material. The length of the section of the trailing edge can be employed as a dielectric tapered

slab antenna to shape the beam in the vertical plane and give more gain and direct the beam in a given direction. Theoretical discussion of the mechanism of this antenna and the choice of permittivity for the dielectric slab is discussed. Author

N74-31685 Societe Technique d'Application et de Recherche Electronique, Massy (France).
A COMMUTATION ON ANTENNA SYSTEMS COVERING STANDARD AIRCRAFT AND BALLOONS [SYSTEME D'ANTENNES A COMMUTATION REALISANT UNE COUVERTURE AVION AUX NORMES AEROSAT]
C. Ancona and P. Froidure *In* AGARD Antennas for Avionics Jun. 1974 8 p refs In FRENCH

Aeronautical satellite design, utilizing aircraft antenna systems, to assure hemispheric coverage with a minimum of gain was discussed. Three types of systems were considered: the electric scanner network, mechanical orientation solutions, and commutable antenna systems. Several theoretical aspects of the problem including angular relations, gain of antenna axis assuring such coverage, and the minimum gain in the angular zone considered, were examined. Transl. by E.H.W.

N74-31686 National Aerospace Lab., Amsterdam (Netherlands).
A LINEAR ARRAY OF BLADE ANTENNAS AS AN AIRCRAFT ANTENNA FOR SATELLITE COMMUNICATION
O. B. M. Pietersen, J. P. B. Vreeburg, and F. Klinker *In* AGARD Antennas for Avionics Jun. 1974 13 p refs

In a ground-satellite-aircraft communication system the aircraft antenna is a critical part since it has to meet the typical environmental requirements and possess a rather high gain. This paper describes a suitable antenna system, installed on a Fokker Friendship aircraft. It consists of a linear array of blade antennas, a power division and phase shifting network in coax technique and a manual controlled beam selector/indicator. The design of the array is based on a mathematical model that has been constructed from theoretical considerations and experimental results. Mutual coupling effects are accounted for by using scattering coefficients. With the aid of a computer the spacings between the antennas were determined in such a way that a nearly constant directivity in the yaw plane of the aircraft could be expected. The performance of the array was evaluated in several flights in which radiation patterns were measured in the receive and the transmit mode. From these measurements it is concluded that with the linear phased array of eight blade antennas a gain of 10 db can be achieved. Author

N74-31688 Transportation Systems Center, Cambridge, Mass.
A COMPARISON OF TWO L-BAND AIRCRAFT ANTENNAS FOR AERONAUTICAL SATELLITE APPLICATIONS
Robert G. Bland and John M. Clarke *In* AGARD Antennas for Avionics Jun. 1974 24 p refs

A comparison is made of the measured performance characteristics of two circularly polarized flush mounted L-band aircraft antennas for aeronautical satellite applications. In order to facilitate radiation pattern measurements, the previously validated technique of using a scale model aircraft antenna was employed. One of the candidate antennas under comparison is a cavity backed dipole fed slot configuration. Measurements were conducted on a 1/10th scale model of a Convair 880 aircraft. The other antenna is an orthogonal mode crossed-slot configuration. In this case measurements were conducted on a 1/20th scale model of a Boeing 707 aircraft which is almost identical in size to the Convair 880. The basic requirements of this class of antenna are to provide moderate gain of +4 above istropic at L-band over the upper hemispheric region of the aircraft. A diversity combination technique study for the two antennas under comparison considers a switched multiple element system in which various fuselage placement and combination arrangements of elements are evaluated. Author

N74-31702 Naval Research Lab., Washington, D.C.
DYNAMIC MEASUREMENT OF AVIONIC ANTENNAS **c07**
I. D. Olin and E. E. Maine, Jr. *In* AGARD Antennas for Avionics Jun. 1971 14 p refs (For availability see N74-31667 21-09)

The equipment, data handling, flight control and some of the results obtained with a system specifically designed for dynamic measurements is described. The determination of aircraft aspect angle uses an approach based on measurements made at the ground radar site with the aircraft flying straight line courses. Then making certain assumptions regarding flight attitude, a proper coordinate transformation can be effected and principal plane measurements plotted. The antenna signal source is provided by a delayed beacon triggered by an illuminating radar and driving the antenna under tests. To illustrate the results patterns for a X-band installation are shown. Coverage can be provided for an azimuth profile from nose-on (0 deg) to tail-on (180 deg) and for an elevation profile beam 0 deg to 30 deg below the aircraft for fixed azimuth aspects of nose-on and tail-on. Angle accuracy is + or - 2 degrees and the accuracy of antenna gain measurements is estimated to be + or - db. Author

N74-31704 Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Inst. fuer Flugfunk und Mikrowellen.
DETERMINATION OF THE MOVEMENT OF THE APPARENT PHASE CENTERS OF AIRCRAFT ANTENNAS FOR CALIBRATING THE ZDBS INTERFEROMETER **c07**
A. Ischrott and S. Modabber *In* AGARD Antennas for Avionics Jun. 1974 26 p refs

A new method for the determination of the curve on which the apparent phase centers for an aircraft antenna moving with respect to aspect angles is presented. The definition of the apparent phase center is discussed. The test equipment is explained by means of a schematic diagram. Sources of error and the accuracy of the approximation method for analytical determination of the phase function are also discussed. An ALGOL computer program is developed for the calculation of apparent phase centers from measured data. Finally, the development and the optimization of the radiators meeting the requirements are described. Author

N74-32356*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FLUTTER ANALYSIS OF SWEPT-WING SUBSONIC AIRCRAFT WITH PARAMETER STUDIES OF COMPOSITE WINGS
J. M. Housner and Manuel Stein Washington Sep. 1974 108 p refs
(NASA-TN-D-7539; L-9260) Avail: NTIS HC $4.50 CSCL 01C

A computer program is presented for the flutter analysis, including the effects of rigid-body roll, pitch, and plunge of swept-wing subsonic aircraft with a flexible fuselage and engines mounted on flexible pylons. The program utilizes a direct flutter solution in which the flutter determinant is derived by using finite differences, and the root locus branches of the determinant are searched for the lowest flutter speed. In addition, a preprocessing subroutine is included which evaluates the variable bending and twisting stiffness properties of the wing by using a laminated, balanced ply, filamentary composite plate theory. The program has been substantiated by comparisons with existing flutter solutions. The program has been applied to parameter studies which examine the effect of filament orientation upon the flutter behavior of wings belonging to the following three classes: wings having different angles of sweep, wings having different mass ratios, and wings having variable skin thicknesses. These studies demonstrated that the program can perform a complete parameter study in one computer run. The program is designed to detect abrupt changes in the lowest flutter speed and mode shape as the parameters are varied. Author

N74-32412*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

THE EFFECT OF CANARD AND VERTICAL TAILS ON THE AERODYNAMIC CHARACTERISTICS OF A MODEL WITH A 59 DEG SWEPTBACK WING AT A MACH NUMBER OF 0.30

William P. Henderson Washington Sep. 1974 35 p refs
(NASA-TM-X-3088; L-9662) Avail: NTIS HC $3.25 CSCL 01B

An investigation has been conducted to determine the effects of canard, canard location, vertical tails, and vertical-tail location on the aerodynamic characteristics of a model having a 59 deg sweptback wing. The investigation was conducted at a Mach number of 0.30, at angles of attack up to 22 deg and at sideslip angles of 0 deg and plus or minus 5 deg. The results of the study indicate that adding the canard to the model had only a slight effect on the lift at the lower angles of attack. At the higher angles of attack there is a significant effect of canard height on lift, canard in the high location (above the wing chord plane) resulting in the highest lifts. The lift drag characteristics are predicted well for the configuration with the mid or high canard locations by combining a potential flow solution on the canard with a potential plus vortex solution on the wing. Variations in the height significantly affect the pitching-moment characteristics of the configuration; the configuration with the low or mid canard location exhibits an increase in stability at the higher lift coefficients, whereas the configuration with the high canard exhibits pitch-up. Adding the vertical tails in the outboard location caused a significant loss in lift at the higher angles of attack; this lift loss was eliminated by moving the vertical tails inboard. Author

N74-32413*# Flow Research, Inc., Kent, Wash.

A VISCOUS POTENTIAL FLOW INTERACTION ANALYSIS METHOD FOR MULTI-ELEMENT INFINITE SWEPT WINGS, VOLUME 2

F. A. Dvorak and F. A. Woodward Apr. 1974 126 p
(Contract NAS2-7048)
(NASA-CR-137550; Rept-20) Avail: NTIS HC $9.50 CSCL 01A

The program input and output are described, and the program listing is presented. A sample program output for an infinite swept wing calculation is shown. F.O.S.

N74-32414*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

SUBSONIC ANNULAR WING THEORY WITH APPLICATION TO FLOW ABOUT NACELLES

Michael J. Mann Washington Sep. 1974 93 p refs
(NASA-TN-D-7630; L-9274) Avail: NTIS HC $4.00 CSCL 01A

A method has recently been developed for calculating the flow over a subsonic nacelle at zero angle of attack. The method makes use of annular wing theory and boundary-layer theory and has shown good agreement with both experimental data and more complex theoretical solutions. The method permits variation of the mass flow by changing the size of a center body. Author

N74-32416*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

A STREAMLINE CURVATURE METHOD FOR DESIGN OF SUPERCRITICAL AND SUBCRITICAL AIRFOILS

Raymond L. Barger and Cuyler W. Brooks, Jr. Washington Sep. 1974 16 p refs
(NASA-TN-D-7770; L-9747) Avail: NTIS HC $3.00 CSCL 01B

An airfoil design procedure, applicable to both subcritical and supercritical airfoils, is described. The method is based on the streamline curvature velocity equation. Several examples illustrating this method are presented and discussed. Author

N74-32417# Mississippi State Univ., State College. Dept. of Aerophysics and Aerospace Engineering.

THREE-DIMENSIONAL MEASUREMENTS OF THE VELOCITY IN THE NEAR FLOW FIELD OF A FULL-SCALE HOVERING ROTOR Interim Report

Donald W. Boatwright Jan. 1974 150 p refs
(Contract DAHC04-68-C-0003)
(AD-781547; EIRS-ASE-74-4; AROD-T-3-27-E) Avail: NTIS CSCL 01/1

An experimental investigation of the flow field of a hovering helicopter rotor was initiated at Mississippi State University in 1970. The initial results of this work were reported in USAAMRDL TR 72-33. The current report presents additional experimental results obtained during a continuation of the rotor flow study. The experimental measurements were performed on the Mississippi State University rotor whirl tower which was equipped with a 33.5-foot diameter, OH-23B two-bladed rotor. The measurements consisted primarily of velocity surveys of the rotor inflow and wake with measurements below the rotor being confined to the region just below the blades. Some experiments were also performed to determine boundary layer flow phenomena by use of the chemical sublimation technique. (Modified author abstract) GRA

N74-32418* National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

NOISE SUPPRESSOR Patent

William E. Zorumski, inventor (to NASA) Issued 20 Aug. 1974 13 p Filed 14 May 1973 Supersedes N73-22975 (11 - 14, p 1600)
(NASA-Case-LAR-11141-1; US-Patent-3,830,335; US-Patent-Appl-SN-359957; US-Patent-Class-181-33F; US-Patent-Class-181-33C; US-Patent-Class-181-33H; US-Patent-Class-181-33L; US-Patent-Class-181-42) Avail: US Patent Office CSCL 20A

A tuned noise suppressor is described consisting of annular acoustically porous elements for incorporation into the inlet and exhaust ducts of turbofan engines. The apparatus uses sound wave absorption, reflection, and incompatibility for achieving high noise reduction in the short distance. In addition, it has a duct of uniform inner diameter which does not block the duct flow. Official Gazette of the U.S. Patent Office

N74-32420# Advisory Group for Aerospace Research and Development, Paris (France).

PRELIMINARY AIRCRAFT DESIGN

Clem C. Weissman Jun. 1974 189 p refs Partly in ENGLISH and partly in FRENCH Lecture series presented at Brunswick, West Germany, 6-7 May 1974, Breda, Netherlands, 9-10 May 1974, and Cranfield, England, 13-14 May 1974
(AGARD-LS-65) Avail: NTIS HC $12.50

An analysis of preliminary aircraft design procedures was conducted to show the response to a proposed military requirement with the first estimate of a complete aircraft configuration. The decision rationale and the initial estimation of size, weights, lift and drag, performance, and cost is presented with respect to the payload for various aircraft types and classes and the proposed mission. Emphasis is placed on how this small preliminary design team must make the first decisions regarding technical feasibility and operational desirability. An experienced design team can predict with sufficient accuracy the overall weight, configuration, performance, and cost to permit confident decision to proceed with advanced development of the project.

N74-32421 Advisory Group for Aerospace Research and Development, Paris (France).

INTRODUCTION TO PRELIMINARY AIRCRAFT DESIGN

Clem C. Weissman *In its* Prelim. Aircraft Design Jun. 1974 2 p

The satisfaction of military aircraft requirements as it affects the size and performance of aircraft is discussed. The basic boundaries for the new aircraft design are defined as: (1) the operational concept for the dominating mission and physical boundaries, (2) the aircraft performance desired with respect to aircraft speed, range, altitude ceiling, acceleration, and payloads, and (3) physical constraints as determined by ground support facilities. The procedures to be followed in arriving at a three view drawing and a weight and balance statement are briefly explained. Some of the compromises which must be met in aircraft design are explained. Author

N74-32422 Avions Marcel Dassault-Breguet Aviation, Saint-Cloud (France).
PRELIMINARY DESIGN OF CIVIL AND MILITARY AIRCRAFT AT AVIONS MARCEL DASSAULT-BREGUET AVIATION
J. Czinczenheim *In* AGARD Prelim. Aircraft Design Jun. 1974 66 p refs In FRENCH and ENGLISH

The procedures followed by a French aircraft manufacturing company in the design and production of military and civilian aircraft are discussed. The subjects considered include the following: (1) the organization of the preliminary project staff, (2) the responsibilities of the project engineer or program manager, and (3) iterative steps to be followed in arriving at the preliminary aircraft configuration. The design procedures which followed in the development of specific military and civilian aircraft are analyzed. The steps which are taken to predict the performance of the preliminary design configuration are explained. The evaluation of lift and drag characteristics at the preliminary design stage is emphasized. The functions of a weapon system department with respect to the preliminary project phase, the detailed definition phase, integration tests, and the integration of production equipment are outlined. Author

N74-32423 British Aircraft Corp., Preston (England).
PROPULSION/AIRCRAFT DESIGN MATCHING EXPERIENCE
Raymond F. Creasey *In* AGARD Prelim. Aircraft Design Jun. 1974 72 p

The procedures for matching propulsion systems and airframes to obtain specific performance standards are described. The actual experiences of aircraft development for a reconnaissance aircraft, a fighter aircraft, a supersonic transport, and a subsonic transport are reported. Data are presented in the form of graphs to show aircraft performance in terms of speed versus altitude, fuel consumption versus range, and thrust and drag characteristics. The various formulas and mathematical models which are used to obtain the desired match of power plant and airframe for various mission requirements are included. The application of computer techniques for the optimization of aerodynamic configurations is discussed. Author

N74-32424 Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (West Germany).
DESIGNING FOR MANEUVERABILITY: REQUIREMENTS AND LIMITATIONS
Helmut Langfelder *In* AGARD Prelim. Aircraft Design Jun. 1974 18 p

Based in the technology expected to be operationally available in the 1970 time period, the design requirements and relevant design trades to ensure adequate maneuverability of military aircraft are discussed. The basic contradiction of range versus payload and maneuverability requirements are treated from the point of view of preliminary design. Maximum lift and buffet penetration as well as maneuver devices are presented. Reference is made to cost implications. A point design for extreme maneuverability is analyzed with respect to the characteristics of balanced design for fighter aircraft. Author

N74-32425 LTV Aerospace Corp., Dallas, Tex.
MODERN ENGINEERING METHODS IN AIRCRAFT PRELIMINARY DESIGN
W. W. Huff, Jr. *In* AGARD Prelim. Aircraft Design Jun. 1974 16 p refs

The impact of computer technology on modern engineering methods for the preliminary design of aircraft is discussed. Large capacity digital computer systems and their peripheral equipments provide the opportunity to bring all significant technical and managerial disciplines together in an integrated program. Most design synthesis computer programs are constructed in a modular fashion, which are controlled by the technical disciplines responsible for the state-of-the-art in each particular area. In general, these disciplines will apply the input data at a level of detail consistent with the phase of the preliminary design process. The phases of preliminary design which are considered are: (1) program definition, (2) concept formulation, and (3) contract definition. Author

N74-32426 General Dynamics/Fort Worth, Tex. Convair Aerospace Div.
THE TEAM LEADER'S ROLE IN DESIGN TO COST PRELIMINARY DESIGN
Lyman C. Josephs, III *In* AGARD Prelim. Aircraft Design Jun. 1974 9 p

The organization and functions of a typical Air Force weapon systems office involved in aircraft development are discussed. Emphasis is placed on the YF-16 aircraft program. The management approach of the office is described. The contract requirements to accomplish the objectives for the prototype program are defined. Charts are developed to show the schedule for the YF-16 prototype program and the total budget cost versus actual expenditures are shown. The configuration changes which occurred since approval of the contract are discussed to show the effects on expenses and weapon system development. Author

N74-32428*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
APPARATUS FOR SPAN LOADING TO ALLEVIATE WAKE-VORTEX HAZARD BEHIND AIRCRAFT Patent Application
Vernon J. Rossow, inventor (to NASA) Filed 17 Sep. 1974 29 p
(NASA-Case-ARC-10801-1; US-Patent-Appl-SN-506802) Avail: NTIS HC $4.50 CSCL 01C

The aerodynamic configuration of a swept back aircraft wing for alleviating the wake-vortex hazard behind the aircraft is discussed. The airflow behind the wing is altered by deployment of segmented flaps to produce tailored span loading. Sawtooth span loading is used to generate a translating sheet of air flow energy which develops several unequal vortex pairs which break up the turbulent wake. Diagrams of the wing planforms and the resulting wake distribution are provided. NASA

N74-32429# Boeing Co., Seattle, Wash.
THE 727 NOISE RETROFIT FEASIBILITY. VOLUME 3: UPPER GOAL FLIGHT TESTING AND PROGRAM SUMMARY Final Report, Jul. 1971 - Dec. 1972
D. L. Hiatt and M. B. McKaig Jun. 1973 224 p refs
(Contract DOT-FA71WA-2637; FAA Proj. 45334)
(AD-768850; D6-60196-Vol-3; FAA-RD-72-40-Vol-3) Avail: NTIS HC $5.75

Flight tests were conducted on the Boeing 727 aircraft with modified nacelles for reduction of aerodynamic noise. The nacelles consisted of peripheral acoustic lining in all inlets plus double-ring acoustic treatment in the side engine inlets, acoustically treated engine fan ducts, and multilobe variable geometry jet noise suppressors discharging through fixed, acoustically lined ejectors, with provision for automatic closure of the ejector inlets for cruise operation. Acoustic, propulsion, and aerodynamic performance analyses were made, along with a direct operating cost analysis. Author

N74-32430# Boeing Co., Wichita, Kans.
FAA JT3D QUIET NACELLE RETROFIT FEASIBILITY PROGRAM. VOLUME I-1: LOWER GOAL DESIGN, FABRICATION AND GROUND TESTING Final Report, Jul. 1971 - Feb. 1973
J. E. Mayer et al Jun. 1973 152 p refs
(Contract DOT-FA71WA-2628)
(AD-775453; FAA-RD-73-131-Vol-I-1; D3-9042-1) Avail: NTIS HC $10.75

The design, fabrication, and ground testing of a flightworthy quiet nacelle which satisfied the FAA lower goal for noise reduction of JT3D powered 707 aircraft was conducted. The quiet nacelle configuration consisted of a two-ring acoustically treated inlet, new fan thrust reverser, 3/4 length acoustically treated fan ducts, and revised contour aft translating sleeve. The configuration

retained the standard primary thrust reverser and engine tailpipe. The quiet nacelle was ground tested to determine acoustic and performance data. Production JT3D nacelles were similarly tested thus providing a baseline whereby comparisons of acoustic and propulsion performance could be made. Projections of the demonstrated noise reductions to flight conditions indicate that the Phase 1 nacelle will satisfy the maximum noise levels allowed for JT3D powered 707 aircraft. Demonstrated static propulsion performance of the quiet nacelle indicates that no loss in takeoff performance should be expected from these aircraft. Author

N74-32436# Federal Aviation Administration, Atlantic City, N.J.
A SUMMARY OF HELICOPTER VORTICITY AND WAKE TURBULENCE PUBLICATIONS WITH AN ANNOTATED BIBLIOGRAPHY Final Report, Jan. 1965 - Nov. 1973
Jack J. Shrager May 1974 189 p refs
(FAA Proj. 214-531-090)
(AD-780053; FAA-RD-74-48; FAA-NA-73-68) Avail: NTIS HC $4.00

A review of all literature published since 1964 relating to helicopter vortex systems and wake turbulence was made. The results of this review are evaluated and summarized, and conclusions are drawn relative to that review. The documents are grouped in general categories, and this is further supplemented by an annotated bibliography and authors index. Also incorporated in the review is a comparative analysis of rotary-wing versus fixed-wing circulation intensity time-history. Author

N74-32437# Douglas Aircraft Co., Inc., Long Beach, Calif.
DC-9 NOISE RETROFIT FEASIBILITY. VOLUME 1: LOWER GOAL NOISE, PERFORMANCE AND COST EVALUATION Final Report, Jan. 1972 - May 1973
W. R. Dunbar Nov. 1973 178 p refs
(Contract DOT-FA72WA-3116)
(AD-776127; FAR-RD-73-124-Vol-1; MDC-J4355-Vol-1) Avail: NTIS HC $5.50

A flight test program was completed, including noise, performance and flightworthiness tests on the baseline and modified versions of a DC-9-10 test airplane. A Cost study was conducted. Retrofit and production line installation costs and the effects on direct operating costs were estimated. The effects of the modification on block speed, fuel burned, payload range, takeoff field length and initial cruise altitude were determined. Exhaust system development tests were conducted on an engine static test stand to evaluate the lower goal exhaust system. Prototype components of the lower goal (DACO-2) nacelle were designed and fabricated. The prototype components were tested for effect on engine performance and noise, and for effect on the compatibility with the JT8D engine. A 100-hour durability test was performed, cycling the prototype nacelle through an accelerated simulated duty mission. A complete loads and stress analysis of the nacelle/airframe structure was performed.
Author

N74-32438*# Boeing Commercial Airplane Co., Seattle, Wash.
STATIC PERFORMANCE AND NOISE TESTS ON A THRUST REVERSER FOR AN AUGMENTOR WING AIRCRAFT
D. L. Harkonen, C. C. Marrs, and J. V. OKeefe Jul. 1974 86 p refs
(Contract NAS2-7641)
(NASA-CR-137561; D6-41926) Avail: NTIS HC $7.50 CSCL 01C

A 1/3 scale model static test program was conducted to measure the noise levels and reverse thrust performance characteristics of wing-mounted thrust reverser that could be used on an advanced augmentor wing airplane. The configuration tested represents only the most fundamental designs where installation and packaging restraints are not considered. The thrust reverser performance is presented in terms of horizontal, vertical, and resultant effectiveness ratios and the reverser noise is compared on the basis of peak perceived noise level (PNL) and one-third octave band data (OASPL). From an analysis of the model force and acoustic data, an assessment is made on the stopping distance versus noise for a 90,900 kg (200,000 lb) airplane using this type of thrust reverser. Author

N74-32439*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
THE LATERAL/DIRECTIONAL STABILITY CHARACTERISTICS OF A FOUR-PROPELLER TILT-WING V/STOL MODEL IN LOW-SPEED STEEP DESCENT M.S. Thesis - Princeton Univ., N.J.
Daniel J. DiCarlo Jun. 1971 114 p refs
(NASA-TM-X-70242) Avail: NTIS HC $8.75 CSCL 01C

Lateral-directional dynamic stability derivatives are presented for a 0.1-scale model of the XC-142A tilt-wing transport. The tests involved various descending flight conditions achieved at constant speed and wing incidence by varying the vehicle angle of attack. The propeller blade angle and the speed were also changed in the steepest descent case. The experimental data were analyzed assuming that the dynamic motions of the vehicle may be described by linearized equations, with the lateral-directional characteristics of the full-scale aircraft also presented and discussed. Results from this experimental investigation indicated that the full-scale aircraft would have a stable lateral-directional motion in level flight, with the dynamic motion becoming less stable as the descent angle was increased.
Author

N74-32440*# Techtran Corp., Glen Burnie, Md.
A NEW TYPE OF SAIL PLANE
R. Platz Washington NASA Sep. 1974 7 p Transl. into ENGLISH of "Zeitschrift fuer u. Motorluftschiffahrt" W. Ger., v. 15, nos. 1 and 2, 26 Jan. 1974 p 1-2
(Contract NASw-2485)
(NASA-TT-F-15920) Avail: NTIS HC $4.00 CSCL 01C

Some early attempts to construct sail planes are reported. The authors are examining some new designs and new concepts for the flight control of such craft. They note that the prospects for the construction of a light weight, durable, easily disassembled plane of this type are good. Author

N74-32441*# Kanner (Leo) Associates, Redwood City, Calif.
ON THE APPLICATION OF THEORY OF MARKOV PROCESSES TO THE EVALUATION OF STATE OF DYNAMIC SYSTEMS AND TO CONTROL OF AIRCRAFT OSCILLATIONS
V. T. Tarushkin and V. S. Novoselov, ed. Washington NASA Aug. 1974 26 p refs Transl. into ENGLISH from the book "Mekhanika Upravlyayemogo Dvizheniya i Problemy Kosmicheskoy Dinamiki" Leningrad, Leningrad Univ. Press, 1972 p 150-164
(Contract NASw-2481)
(NASA-TT-F-15817) Avail: NTIS HC $4.50 CSCL 12A

The application of Markov processes and stochastic differential equations to the evaluation of state of linear dynamic systems and to control of small oscillations of an aircraft in circular orbit is discussed. Author

N74-32442*# Kanner (Leo) Associates, Redwood City, Calif.
EFFECT OF ARTIFICIAL STABILITY ON AIRCRAFT PERFORMANCE
D. Reich Washington NASA Sep. 1974 16 p ref Transl. into ENGLISH of "Einfluss der Kuenstlichen Stabilitaet auf die Flugleistungen", Rept. DLR-MITT-72-05 Deutsche Gesellschaft fuer Luft- und Raumfahrt, Cologne, W. Ger., Mar. 1972 p 171-186
(Contract NASw-2481)
(NASA-TT-F-15953; DLR-Mitt-72-05) Avail: NTIS HC $4.00 CSCL 01C

Based on the control configured vehicle (CCV) concept, taking account of flight control during the design phase, the effect of an artificial longitudinal stability on the performance of aircraft was investigated. In consequent application of the CCV concept, in the most favorable cases a decrease of about 15% in takeoff weight (for the same radius of action) or an increase of 11% in radius of action (for the same takeoff weight) can be achieved. For a fighter aircraft, it is shown that the advantages of artificial longitudinal stability are obtained for high lift coefficients and for plane wing-body drag polars. Author

N74-32443*# Virginia Univ., Charlottesville. Dept. of Engineering Science and Systems.
EFFECTS OF AIRCRAFT DESIGN ON STOL RIDE QUALITY: A SIMULATOR STUDY Annual Report, 1 Jul. 1973 - 30 Jun. 1974
Ira D. Jacobson and Craig R. Jones Jul. 1974 23 p refs
(Grant NGR-47-005-208)
(NASA-CR-140059; ESS-4035-102-74; Memo-403502) Avail: NTIS HC $4.25 CSCL 01C

To improve the ride quality in short takeoff aircraft, several means have been investigated. In general, these methods consist of placing sensors in the aircraft which sense aircraft motion, usually linear accelerations and angular rates. These signals are then used to deflect control surfaces which generate aerodynamic forces and moments which tend to minimize the motion which the passenger feels. One of the disadvantages of some of these systems is that they may tend to degrade the handling qualities or controllability of the airplane, making it more difficult or annoying for the pilot to fly. Rather than using active control systems to control ride quality, one might possibly design aircraft so that they are inherently pleasant to ride. The purpose of this study is to determine the relationship between characteristic aircraft motions and aircraft ride quality. Author

N74-32451# Northrop Corp., Hawthorne, Calif. Aircraft Div.
ADVANCED METALLIC STRUCTURES: AIR SUPERIORITY FIGHTER WING DESIGN FOR IMPROVED COST WEIGHT AND INTEGRITY. VOLUME 2: CRITERIA SENSITIVITY STUDY Final Report, Oct. 1972 - Mar. 1973
Fred A. Figge Jun. 1973 154 p refs
(Contract F33615-72-C-1891; AF Proj. 486U)
(AD-781811; NOR-73-82-Vol-2; AFFDL-TR-52-Vol-2) Avail: NTIS CSCL 01/3

Recent catastrophic airframe failures and near failures has led to a strong impetus to design new airframe primary structure to damage tolerant criteria requirements. Generally, this reflects a recognition that inadvertent or inherent flaws can be introduced in manufacturing of primary aircraft components that cannot be detected by existing NDI techniques. The current version of this criteria is the proposed revision to MIL-A-008866A, dated 18 August 1972, Revision D. This version of the damage tolerant criteria was considered a design requirement by Northrop in this Advanced Metallic Structures/Advanced Development Program. Information regarding the impact this criteria could have on a thin, high load factor, aircraft wing is very limited. Of particular concern are the effects deviations in nominal analysis variables can have on crack growth service life and damage tolerant design stress predictions. This damage tolerant criteria sensitivity study investigates these effects on an aircraft designed prior to the existence of these requirements. (Modified author abstract) GRA

N74-32453# West Virginia Univ., Morgantown. College of Engineering.
NONLINEAR HELICOPTER ROTOR LIFTING SURFACE THEORY, PART 1
Thomas A. Csencsitz, Jerome B. Fanucci, and Hsi F. Chou Sep. 1973 208 p refs
(Contract N00014-68-A-0512; NR Proj. 215-163)
(AD-781885; TR-35-Pt-1) Avail: NTIS CSCL 01/3

A numerical method is developed based on potential flow nonlinear lifting surface theory for predicting the surface velocities and pressures on a rotor blade of an arbitrary helicopter rotor system which is executing a constant rotational and constant axial translational motion including, specifically, the hover flight mode. The formulation of the problem is exact in the sense that the normal surface boundary condition is satisfied on the surface of the rotor blade. The problem is governed by a Fredholm integral equation of the first kind which relates a singular velocity doublet potential surface distribution applied on the rotor blades and wakes to the normal relative velocity on the rotor blade surface. The wake model is assumed to be of a prescribed shape. (Modified author abstract) GRA

N74-32456# Boeing Commercial Airplane Co., Seattle, Wash.
ADVANCED METALLIC STRUCTURE: CARGO FUSELAGE DESIGN FOR IMPROVED COST, WEIGHT, AND INTEGRITY Final Report, 1 Jun. 1972 - 1 Apr. 1973
John E. McCarty Jun. 1973 461 p refs
(Contract F33615-72-C-1893; AF Proj. 486U)
(AD-781814) Avail: NTIS CSCL 01/3

The preliminary design study was conducted to identify, evaluate, and select advanced concepts for cargo aircraft fuselage structure. The goals were to reduce the structural weight, maintain the baseline fatigue life (60,000 flight-hours and 20,000 flights), and reduce the acquistion cost. All three selected fuselage shell concepts provide a reduction in both total unit (2% to 7%) and participating weight (17% to 19%). Three adhesive-bonded fuselage shell concepts are recommended for further study, development, and test evaluation. Adhesive-bonded construction was chosen as the primary assembly method to reduce structural weight because it allows a significant improvement in fatigue quality of the structure. The improved fatigue quality allowed effective utilization of the new aluminum alloys, which provide a combination of improved fracture toughness and strength. Fracture mechanics and fatigue life characteristics of new aluminum alloys were investigated in an exploratory testing program. Sensitivity studies were conducted to evaluate the impact of the application of the USAF Damage Tolerance Criteria. (Modified author abstract) GRA

N74-32467# Army Aviation Systems Command, St. Louis, Mo.
MAJOR ITEM SPECIAL STUDY (MISS), OH-6A MAIN ROTOR HUB Interim Report, 1 Jan. 1964 - 1 Jul. 1973
Jun. 1974 23 p
(AD-781507; USAAVSCOM-TR-74-29) Avail: NTIS CSCL 01/3

Major Item Special Study (MISS) reports are performed on DA Form 2410 reportable components. These are time change items and certain condition change items selected because of high cost or need for intensive management. Basically, the MISS reports are concerned with analyzing reported removal data presented in the Major Item Removal Frequency (MIRF) report. The failure modes reported for each removal are examined and grouped into categories which are intended to clarify the intent of the data reporting. From this data, removal distribution can be plotted and an MTR (mean time to removal) can be calculated. The MISS reports then investigate possible cost savings based on total elimination of selected failure modes. These modes are chosen because of the percentage of failures they represent and/or because they appear to be feasible Product Improvement Program (PIP) areas. Author (GRA)

N74-32481 Lucas Aerospace Ltd., Bradford (England).
INTERRUPT TIMES ON CONSTANT FREQUENCY ac SYSTEMS
C. J. Yarrow *In* RAE Current Develop. Status of Variable Speed Constant Freq. (VSCF) Cycloconvertor Elec. Supply Systems for Aircraft, Dec. 1973 p 43-57

The interrupt times to which constant frequency loads may be subjected are reviewed, and various CF systems for aircraft power supply are compared in respect to interrupt times. The cause of interrupts may be classified as follows: generation faults, bus-bar faults, downstream faults, and load switches. It was demonstrated that especially downstream fault interrupt times are very long and necessitate current limiting circuit breakers to prevent the occurrence of under voltages. ESRO

N74-32482 Ministry of Defence, London (England).
COMPARISON OF ELECTRICAL GENERATING SYSTEMS BASED ON IDG AND VSCF TECHNIQUES IN TWO TYPES OF AIRCRAFT
D. E. Marshall *In* RAE Current Develop. Status of Variable Speed Constant Freq. (VSCF) Cycloconvertor Elec. Supply Systems for Aircraft, Dec. 1973 p 59-73

Electrical generating systems of the IDG and VSCF technology were compared for an airbus type aircraft, and a small twin-engined military aircraft capable of operating at speeds up to Mach 2.

The comparison was based mainly on mass. For the airbus, a VSCF supply does not have significant superior characteristics and it would therefore be expected that only a small equipment mass saving would be possible. For military aircraft it would appear that, on the basis of mass, the VSCF electrical generating system should be considered together with IDG for installation in small military aircraft of the future. ESRO

N74-32483 Hawker Siddeley Aviation, Ltd., Kingston upon Thames (England).
AIRCRAFT AUXILIARY POWER SYSTEMS STUDY. A MAIN GENERATION CHANNEL FOR A V/STOL STRIKE AIRCRAFT
E. F. Pincombe *In* RAE Current Develop. Status of Variable Speed Constant Freq. (VSCF) Cycloconvertor Elec. Supply Systems for Aircraft, Dec. 1973 p 75-93 refs

The type of power generation system suitable for a V/STOL strike aircraft, notably the generation channel, was examined. Constant frequency ac, variable frequency ac, and low frequency dc supply were considered. The study of the type of power for main generation led to two possible arrangements: constant speed drive and constant frequency generator (from variable frequency generation and frequency conversion), which were discussed in detail. Performance, reliability, installation, weight, and costs of the two arrangements were compared. ESRO

N74-32485 Lucas Aerospace Ltd., Hemel Hempstead (England).
VSCF GENERATORS
E. Wharton *In* RAE Current Develop. Status of Variable Speed Constant Freq. (VSCF) Cycloconvertor Elec. Supply Systems for Aircraft, Dec. 1973 p 121-151

Design and construction aspects of variable speed constant frequency generators, notably solid rotor machines, are discussed. Results of performance tests are detailed. ESRO

N74-32486 Royal Aircraft Establishment, Farnborough (England). Engineering Physics Dept.
CONTROL ASPECTS OF AIRCRAFT TYPE CYCLOCONVERTORS
R. L. Piper and G. W. Wilcock *In its* Current Develop. Status of Variable Speed Constant Freq. (VSCF) Cycloconvertor Elec. Supply Systems for Aircraft. Dec. 1973 p 153-181

Control aspects of a cycloconverter for a variable speed constant frequency system are discussed. Topics dealt with include performance of generator control loop, cycloconverter power circuit, performance of cycloconverter without automatic control, reduction of the distortion in the cycloconverter output, regulation of the cycloconverter output, and system performance. ESRO

N74-32903# Los Alamos Scientific Lab., N.Mex.
DEVELOPMENT OF A LASL WHOLE-AIR SAMPLER FOR WB-57F AIRCRAFT
R. D. Glenn Jan. 1974 8 p refs
(Contract W-7405-eng-36)
(LA-5491-MS) Avail: NTIS HC $4.00

A whole-air sampler was developed for collecting samples of stratospheric air at ambient pressures for laboratory analysis. The principle of operation is to evacuate the sample containers, fly them to sampling altitude, open the remotely operated vacuum valves, and take in ambient air through a suitable air delivery system until the internal sample pressure equilibrates with ambient. This system was designed for use aboard the WB-57F aircraft. The first test series was flown and certain mechanical problems uncovered. Conclusions and recommendations for system improvement and future investigations are presented. Author (NSA)

N74-33114*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
A FLIGHT INVESTIGATION OF A TERMINAL AREA NAVIGATION AND GUIDANCE CONCEPT FOR STOL AIRCRAFT
D. W. Smith, F. Neuman, D. M. Watson, and G. H. Hardy Jul. 1974 17 p refs
(NASA-TM-X-62375) Avail: NTIS HC $3.00

A digital avionics system referred to as STOLAND has been test-flown in the NASA CV-340 to obtain performance data for time-controlled guidance in the manual flight director mode. The addvanced system components installed in the cockpit included an electronic attitude director indicator and an electronic multifunction display. Navigation guidance and control computations were all performed in the digital computer. Approach paths were flown which included a narrow 180-deg turn and a 1-min, 5-deg straight-in approach to the 30-m altitude go-around point. Results are presented for 20 approaches: (1) blended radio/inertial navigation using TACAN and a microwave scanning beam landing guidance system (MODILS) permitted a smooth transition from area navigation (TACAN) to precision terminal navigation (MODILS), (2) guidance system (flight director) performance measured at an altitude of 30.5 m was within that prescribed for category II CTOL operations on a standard runway, and (3) time of arrival at a point about 2 mi from touchdown was about 4 sec plus or minus sec later than the computed nominal arrival time. Author

N74-33116# Boeing Commercial Airplane Co., Seattle, Wash.
DEVELOPMENT OF AN INDEPENDENT ALTITUDE MONITOR CONCEPT Final Report, Feb. 1973 - Sep. 1973
Donald L. Parks, Maxie M. Hayashi, and James R. Fries Sep. 1973 160 p refs
(Contract DOT-FA73WA-3233)
(AD-775454; D6-41293; FAA-RD-73-168) Avail: NTIS HC $5.00

Methods by which safe altitude is monitored and conveyed to the crew, and possible systems to provide an independent altitude monitor (IAM) function were investigated. Study effort was in three phases: (1) initial analysis and survey involved terminal area operations analysis, to define the overall circumstances under which IAM requirement exist: (2) accident data analysis, for accident types and circumstances to which an IAM might apply; and (3) operations/research/manufacturer/vendor survey, to identify associated problem areas and to determine the nature of ongoing research and systems development. Data collation/requirements analysis, included integration of information in a detailed analysis of approach/land functions, including specific actions and associated information requirements. Results provided the basis for identifying IAM system functional requirements. Concepts covered a variety of possibilities related to (1) basic IAM trade study requirements, (2) visual aids, (3) present and future landing systems, (4) airborne IAM systems (5) cooperative/ground IAM systems, and (6) procedures and training considerations. Author

N74-33218* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
ABATING EXHAUST NOISES IN JET ENGINES Patent
Ira R. Schwartz, inventor (to NASA) Issued 20 Aug. 1974 25 p Filed 23 Mar. 1973 Supersedes N73-20826 (11 - 11, p 1334)
(NASA-Case-ARC-10712-1; US-Patent-3,830,431; US-Patent-Appl-SN-344410; US-Patent-Class-239-265.11; US-Patent-Class-181-33HC) Avail: US Patent Office CSCL 21E

A noise abating improvement for jet engines including turbojets, turbofans, turboprops, ramjets, scramjets, and hybrid jets is introduced. A provision is made for an apparatus in the primary and/or secondary flow streams of the engines; the apparatus imparts to the exhaust gases a componet rotation or swirl about the engine's longitudinal axis. The rotary component in the exhaust gases causes a substantial suppression of sound energy build up normally produced by an axial flow exhaust system. Official Gazette of the U.S. Patent Office

N74-33225# National Aviation Facilities Experimental Center, Atlantic City, N.J.
THE FEASIBILITY OF DETECTING A BURNER-CAN BURN-THROUGH BY MEANS OF CO, CO2, PRESSURE, AND AIR TEMPERATURE LEVELS IN A JET ENGINE NACELLE *Final Report, Jan. 1972 - Jul. 1973*
Richard Hill Mar. 1974 27 p
(FAA Proj. 181-522-010)
(AD-775304; FAA-RD-74-18; FAA-NA-73-110) Avail: NTIS HC $3.25

Full-scale tests simulating engine combustion section thermal failure (burn-through) were conducted using a cowled J-57 engine to determine the feasibility of detecting a burn-through by monitoring the carbon monoxide (CO), carbon dioxide (CO2), a pressure level, or air temperature in the nacelle before, during, and after engine case rupture. Results of the tests indicated that CO, CO2, pressure, and air temperature in the nacelle cannot be relied upon for early detection of a burn-through. Test results also indicated that containment of a burn-through flame in the nacelle creates extremely high temperatures in the nacelle and can cause extensive structural damage. Author

N74-33226*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Group.
QUIET ENGINE PROGRAM FLIGHT ENGINE DESIGN STUDY
J. F. Klapproth, R. E. Neitzel, and C. T. Seeley Jul. 1974 123 p refs
(Contract NAS3-12430)
(NASA-CR-134660; R74AEG327) Avail: NTIS HC $9.25 CSCL 21E

The results are presented of a preliminary flight engine design study based on the Quiet Engine Program high-bypass, low-noise turbofan engines. Engine configurations, weight, noise characteristics, and performance over a range of flight conditions typical of a subsonic transport aircraft were considered. High and low tip speed engines in various acoustically treated nacelle configurations were included. Author

N74-33228*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FRETTING IN AIRCRAFT TURBINE ENGINES
Robert L. Johnson and Robert C. Bill [1974] 17 p refs Presented at the Specialists Meeting on Friction and Wear in Aircraft Systems, Munich, 11-12 Oct. 1974; sponsored by AGARD
(NASA-TM-X-71606; E-8090) Avail: NTIS HC $3.00 CSCL 21E

The problem of fretting in aircraft turbine engines is discussed. Critical fretting can occur on fan, compressor, and turbine blade mountings, as well as on splines, rolling element bearing races, and secondary sealing elements of face type seals. Structural fatigue failures have been shown to occur at fretted areas on component parts. Methods used by designers to reduce the effects of fretting are given. Author

N74-33229*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
SEALING TECHNOLOGY FOR AIRCRAFT GAS TURBINE ENGINES
L. P. Ludwig and R. L. Johnson 1974 15 p refs Presented at the 10th Propulsion Conf., San Diego, Calif., 21-24 Oct. 1974; sponsored by AIAA and SAE
(NASA-TM-X-71607; E-8096) Avail: NTIS HC $3.00 CSCL 21E

Experimental evaluation under simulated engine conditions revealed that conventional mainshaft seals have disadvantages of high gas leakage rates and wear. An advanced seal concept, the self-acting face seal, has a much lower gas leakage rate and greater pressure and speed capability. In endurance tests (150 hr) to 43 200 rpm the self-acting seal wear was not measurable, indicating noncontact sealing operation was maintained even at this high rotative speed. A review of published data revealed that the leakage through gas path seals has a significant effect on TSFC, stall margin and engine maintenance. Reducing leakages by reducing seal clearances results in rubbing contact, and then the seal thermal response and wear determines the final seal clearances. The control of clearances requires a material with the proper combination of rub tolerance (abradability) and erosion resistance. Increased rub tolerance is usually gained at the expense of reduced erosion resistance and vice versa. Author

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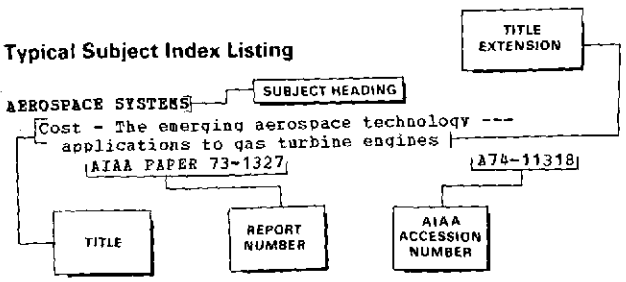

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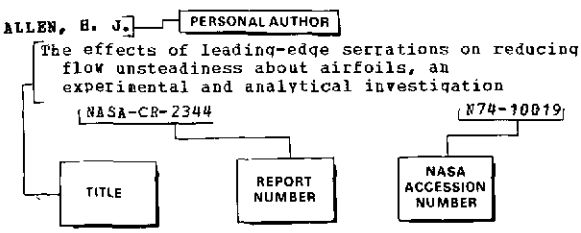

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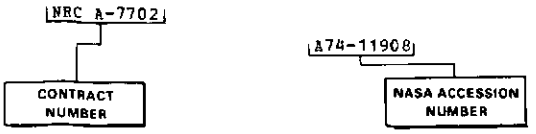

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