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AERONAUTICAL ENGINEERING

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Supplement 49

OCTOBER 1974

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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NASA SP-7037(49)

AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 49

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 September 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 368 reports, journal articles, and other documents originally announced in September 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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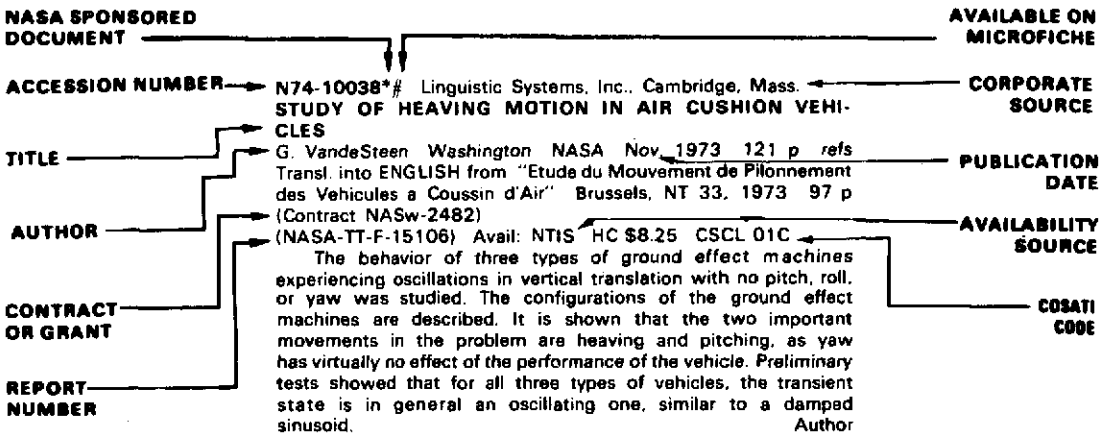

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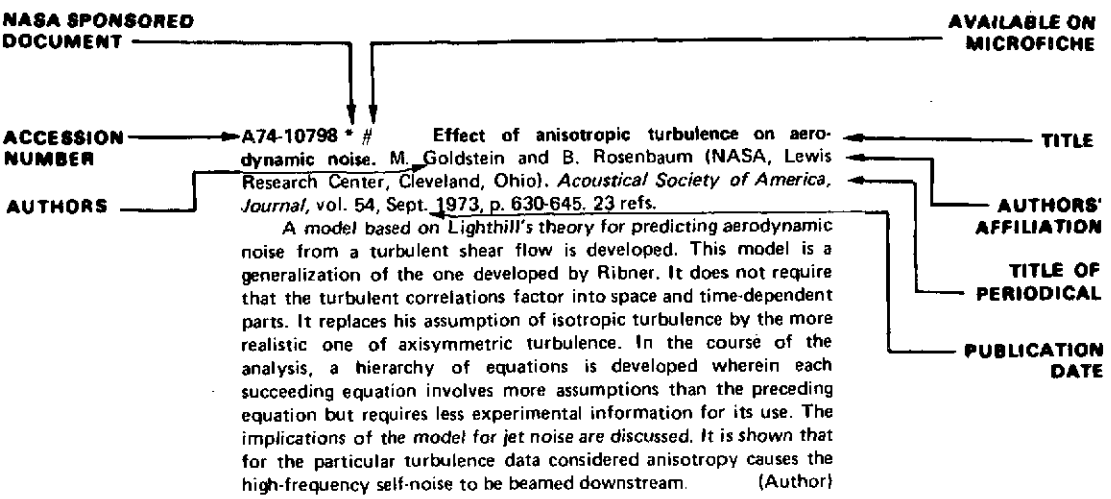

AERONAUTICAL ENGINEERING

A Special Bibliography (Suppl. 49) OCTOBER 1974

IAA ENTRIES

A74-35098 **A contribution to the nonlinear lift and pitching moment properties of slender wing-body combinations (Ein Beitrag zu den nichtlinearen Auftriebs- und Nickmomenteneigenschaften von schlanken Flügel-Rumpf-Kombinationen).** H. Otto (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Zentralabteilung Niedergeschwindigkeits-Windkanäle, Braunschweig, West Germany). *Zeitschrift für Flugwissenschaften*, vol. 22, June 1974, p. 187-200. 11 refs. In German.

The nonlinear aerodynamic properties of slender wing-body combinations in incompressible flow were studied by means of three-component measurements and flow investigations. In these tests the wings were located at the center line of the fuselages and their rear position was altered in a wide range. Considering the most important nonlinear influences determined from these experiments, the linear theory for wing-body combinations due to Hafer was extended to the calculation of the nonlinear contributions to lift and pitching moment. In this approach the wing is represented by the vortex model of Gersten's nonlinear lifting-surface theory. The results of sample calculations, carried out for slender wing-body combinations at different rear positions of the wings with respect to the fuselages, are compared with experimental results. In all cases an excellent agreement between theory and experiment was obtained. (Author)

A74-35121 * **NO and O3 measurements in the lower stratosphere from a U-2 aircraft.** M. Loewenstein, J. P. Paddock, I. G. Poppoff, and H. F. Savage (NASA, Ames Research Center, Moffett Field, Calif.). *Nature*, vol. 249, June 28, 1974, p. 817, 818. Research supported by the U.S. Department of Transportation.

In situ measurements of nitric oxide and ozone were carried out at altitudes up to 21 km during two flights of a U-2 aircraft on Dec. 6 and 18, 1973, over the west coast of the United States. A chemiluminescent detector based on the luminescent reaction of nitric acid with excess ozone was used in nitric acid measurements. Ozone concentration measurements were based on the absorption of the Hg line at 2,537 A in the Hartley continuum. The results are compared with available data. V.Z.

A74-35127 **GCA radars - Their history and state of development.** H. R. Ward, C. A. Fowler, and H. I. Lipson (Raytheon Equipment Development Laboratories, Sudbury, Mass.). *IEEE, Proceedings*, vol. 62, June 1974, p. 705-716. 12 refs.

The evolution and state of development of the radars used in the Ground-Controlled Approach (GCA) systems of the U.S. Air Force are described. Emphasis is placed on the radar requirements of this application and the evolution made possible by the advances in component technology. We first review the concept of GCA operation and show how this leads to the requirements of the two radars in the system. Next we discuss the early history of GCA and the AN/MPN-1, the first operational system. The evolution of the GCA radars since the AN/MPN-1 is then summarized. Finally, we describe in more detail the AN/TPN-19. (Author)

A74-35132 **The effects of relative source strength and signal-to-noise ratio on angular resolution of antennas.** B. D. Steinberg (Pennsylvania, University, Philadelphia, Pa.; U.S. Navy, Radar Div., Washington, D.C.). *IEEE, Proceedings*, vol. 62, June 1974, p. 758-762. 11 refs.

High angular resolution is a desirable property of mapping and reconnaissance radar systems. The synthetic-aperture principle reduced the beamwidth of airborne radar by as much as two orders of magnitude. Notwithstanding the long interest in the subject, a quantitative relationship is lacking between beamwidth and resolution. This paper is an attempt to overcome this deficiency. Among its several results, it is shown that the angular resolution of synthetic-aperture radar can be considerably poorer than expected. It is also shown that a modest tapering of the synthetic aperture in those cases offers significant improvement. (Author)

A74-35204 **Nonlinear and adaptive control techniques; Proceedings of the First Annual Advanced Control Conference, Purdue University, Lafayette, Ind., April 29-May 1, 1974.** Conference sponsored by Purdue University. Chicago, Dun-Donnelley Publishing Corp., 1974. 135 p. $15.

The current status of control and instrumentation systems engineering is reflected in basic tutorial papers and in descriptions of specific applications of advanced nonlinear and adaptive control techniques. Particular uses of adaptive and nonlinear control concepts include compensation for nonlinearities degrading high-speed performance of hydraulic drives, nonlinear control of aircraft cabin pressure, adaptive control of suspension processes in PVC production, automatic landing control for carrier-based aircraft, predictive control of hot strip steel mill runout table cooling sprays, control of interconnected power systems, multizone temperature control, and control of chemical processes. T.M.

A74-35206 **Adaptive and nonlinear control systems in aerospace applications.** S. M. Shinners (Sperry Rand Corp., Sperry Systems Management Div., Great Neck, N.Y.). In: Nonlinear and adaptive control techniques; Proceedings of the First Annual Advanced Control Conference, Lafayette, Ind., April 29-May 1, 1974. Chicago, Dun-Donnelley Publishing Corp., 1974, p. 27-52. 51 refs.

Description of the theoretical principles of operation and practical applications of adaptive and nonlinear automatic control systems used in aerospace vehicles. Systems described include model-reference adaptive control, nonlinear adaptive control, test-pulse-type and correlation-type impulsive response adaptive digital-computer augmented adaptive control. The MIT rule for design of model reference adaptive control systems is explained along with Liapunov, Dressler, Price, and Monopoli synthesis procedures. Applications in spacecraft attitude control are outlined together with the adaptive characteristics of human controllers in aerospace control tasks. T.M.

A74-35208 **Cabin pressure control - An exercise in nonlinear design.** W. R. Kolk (Rensselaer Polytechnic Institute, Troy, N.Y.). In: Nonlinear and adaptive control techniques; Proceedings of the First Annual Advanced Control Conference, Lafayette, Ind., April 29-May 1, 1974. Chicago, Dun-Donnelley Publishing Corp., 1974, p. 81-87.

The nonlinear nature of the cabin dynamics of a commercial

A74-35236 **Application of modern control theory to the analysis of aircraft autoland performance using a scanning beam guidance system.** R. R. Huber (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). In: Joint Automatic Control Conference, 15th, Austin, Tex., June 18-21, 1974, Proceedings. New York, American Institute of Chemical Engineers, 1974, p. 23-32. 8 refs.

A flexible digital computer analysis technique was developed to predict aircraft longitudinal landing performance from the FAA Category II window to touchdown. A microwave landing system provided sampled data elevation angle guidance and continuous DME (distance measuring equipment) information. Atmospheric disturbances including deterministic winds and random gusts as well as the airliner represent a control problem which is all the more interesting because of the analytical simplicity of the plant. Linearized about an operating point, it is simply a dc gain and first order lag. However, its range of operating points from a wide open outflow valve to a choked valve cause the gain and lag to vary by orders of magnitude. A rather simple correlation is shown to permit the use of a ratio changer as the nonlinear control element which provides both stability and responsiveness at all operating points. (Author)

A74-35209 **AN/SPN-42 automatic carrier landing system.** W. D. T. Davies and R. Noury (Bell Aerospace Co., Buffalo, N.Y.). In: Nonlinear and adaptive control techniques; Proceedings of the First Annual Advanced Control Conference, Lafayette, Ind., April 29-May 1, 1974. Chicago, Dun-Donnelley Publishing Corp., 1974, p. 99-110.

This paper discusses the design of the digital, ship based automatic carrier landing system AN/SPN-42 developed by Bell Aerospace Co. for the U.S. Navy. The system enables 'hands off', all automatic, all weather landing of carrier based aircraft to be performed as a matter of course. The basic problems encountered are discussed together with the solution developed to overcome them. The control hardware and software arrangement as well as the basic design procedure are presented in the text. (Author)

A74-35211 **The historical development of shell research and design.** E. E. Sechler (California Institute of Technology, Pasadena, Calif.). In: Thin-shell structures: Theory, experiment, and design; Proceedings of the Symposium, Pasadena, Calif., June 29, 30, 1972. Englewood Cliffs, N.J., Prentice-Hall, Inc., 1974, p. 3-25.

The historical background of the major problems of the elements of thin shell structures is reviewed, and the chronological development of both theory and experiment is surveyed. The motivation for each major new development is discussed. The current state of the art is assessed, and the needs of future research are pointed out. Special attention is given to the search for the basic parameters underlying the phenomenon of thin-shell instability. M.V.E.

A74-35234 **Optimal trajectories of high thrust aircraft.** G. M. Anderson (USAF, Institute of Technology, Wright-Patterson AFB, Ohio) and W. L. Othling, Jr. (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). In: Joint Automatic Control Conference, 15th, Austin, Tex., June 18-21, 1974, Proceedings. New York, American Institute of Chemical Engineers, 1974, p. 11-16.

The usual necessary conditions for an optimal trajectory break down on arcs with sustained maximum turn rate at the corner velocity. The purpose of this paper is to present a method for handling this type of optimal trajectory arc. First necessary conditions are developed for a general class of optimal control problems with two state dependent inequality constraints on one control variable. Then it is shown that optimal trajectory problems with high-thrust aircraft are members of this general class of problems and the necessary conditions are presented for these high thrust aircraft problems. The problem of minimum time-to-turn is used to illustrate the characteristics of optimal trajectories containing maximum turn rate arcs at the corner velocity. (Author)

microwave landing system noise were modeled. The automatic flight control system was modeled as a linear optimal servo. A covariance propagation technique was used to predict the system statistical performance along the landing trajectory and at touchdown. Results are presented for a DC-8 aircraft for variations in atmospheric turbulence intensity levels and variations in landing guidance system data rate. (Author)

A74-35237 **A comparative study of two model reference, adaptive aircraft control systems.** V. E. Edwards (Honeywell, Inc., Minneapolis, Minn.) and W. L. Garrard (Minnesota, University, Minneapolis, Minn.). In: Joint Automatic Control Conference, 15th, Austin, Tex., June 18-21, 1974, Proceedings. New York, American Institute of Chemical Engineers, 1974, p. 33-42. 18 refs.

Two types of model reference adaptive control systems for aircraft - one based on the well-known MIT design procedure and one based on Liapunov's stability theory - are compared in terms of adaptivity to changes in parameters affecting aircraft performance. A study of the simulated dynamic response of an adaptively controlled aircraft under various flight conditions leads to the conclusion that the Liapunov-based technique provides a more desirable response than does the MIT system. V.Z.

A74-35249 **A generalized comparison sensitivity concept for sensitivity reduction in control system design.** G. Grübel (Ruhr-Universität, Bochum, West Germany) and G. Kreisselmeier (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Dynamik der Flugsysteme, Oberpfaffenhofen, West Germany). In: Joint Automatic Control Conference, 15th, Austin, Tex., June 18-21, 1974, Proceedings. New York, American Institute of Chemical Engineers, 1974, p. 328-332.

The paper discusses a method for dealing with sensitivity considerations in control system design by using a generalized comparison sensitivity concept. The degree of freedom necessary for a sensitivity reduction is achieved by suitably relaxing the equivalence constraint which is required for a meaningful sensitivity comparison. This removes the necessity of a specific controller structure and thereby allows a more systematic design of parameter-insensitive regulator systems, than it was possible so far. The iterative design procedure is illustrated by a control problem for an aerodynamically unstable aircraft. (Author)

A74-35252 **Input design for parameter identification. I - A new formulation and a practical solution.** R. T. N. Chen (Calspan Corp., Buffalo, N.Y.). In: Joint Automatic Control Conference, 15th, Austin, Tex., June 18-21, 1974, Proceedings. New York, American Institute of Chemical Engineers, 1974, p. 398-408. 19 refs.

This paper presents a new formulation and a practical and useful solution to the input design for identification of system parameters. The new formulation is directly relevant to the following question: for a given measurement system and with prescribed physical constraints on the input and output magnitudes, what should the input functions be and for how long should the data record be taken to enable identification of system parameters to a specified accuracy. Time optimal control theory is used in the formulation of this important problem. Necessary conditions for the optimal control input are discussed. By converting the calculation of the Cramer-Rao lower bounds into a sequential operation, a practical and useful solution is then presented. Application of this new input design approach is then made to the identification of aircraft stability and control parameters. (Author)

A74-35269 # **Stall flutter of a thin aerofoil with leading edge separation.** K. Shinohara, H. Tanaka, and Y. Hanamura (Tokyo, University, Tokyo, Japan). *JSME, Bulletin*, vol. 17, May 1974, p. 578-586. 13 refs.

Consideration of the unsteady aerodynamic forces acting on a thin vibrating airfoil with leading edge separation. It is assumed that the unsteady component of the velocity is small compared with the velocity of the uniform flow and that the flow separates from the

leading edge smoothly. It is shown that, in general, this kind of problem can be solved by assuming that the vorticity of the flow separated at the sharp edge of the thin blade is finite at the point of separation. In the region of small reduced frequencies of the thin blade, comparatively good agreement is obtained between the computational and experimental results. In the region of large reduced frequencies, however, the effects of steady circulation shed into the wake from the boundary layer of the thin blade must be considered, and the flow does not seem to satisfy fully the assumption that it separates smoothly from the leading and trailing edges without going around them. A.B.K.

A74-35279 **Recent Air Force electronic systems corrosion problems.** F. H. Meyer, Jr. (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio). *National Association of Corrosion Engineers, International Corrosion Forum Devoted Exclusively to the Protection and Performance of Materials, Chicago, Ill., Mar. 4-8, 1974, Paper 24.* 6 p. $1.50.

Review of some of the corrosion problems encountered in Air Force electronic systems, and discussion of the corrosion prevention requirements these problems suggest. The most common cause of corrosion in electronic equipment is shown to be water condensation on components not specifically selected or protected. Dissimilar metals in contact and inadequate removal of solder flux are among the other corrosion causes discussed. M.V.E.

A74-35357 # **VFW 614 airframe.** *Aircraft Engineering,* vol. 46, June 1974, p. 6-8, 10, 11.

The present work gives a complete general description of the structural design of the airframe of the VFW 614 short-haul aircraft. Particular emphasis was laid on the requirement for a long service life and good fail-safe characteristics. In many areas, the bonding technique was applied. Partial results of structural tests are reported, and the brake chute system is described. P.T.H.

A74-35358 # **VFW 614 cockpit.** *Aircraft Engineering,* vol. 46, June 1974, p. 12, 13.

The present work gives a general description of the cockpit of the VFW 614. The flight deck is designed for a crew of two members and ICAO Category I operation with adequate space for extension to Category II. All controls are arranged in such a way that they can be operated by either crew member. All instruments and instructions can be read by both crew members. Seat design, instrumentation, equipment and system control locations, illumination, center console design, and avionics display are briefly described. P.T.H.

A74-35359 # **VFW 614 hydraulics.** *Aircraft Engineering,* vol. 46, June 1974, p. 15-17.

Hydraulically operated systems of the VFW 614 are supplied by two mutually independent main systems (I and II). Each main system is supplied by an axial-piston pump driven by one engine. In the event of a pump failure in one system, the pump of the other system supplies power by means of a transfer unit connected between systems I and II. Shock absorber characteristics, main and nose landing gear, and the steering system are also described in general terms. P.T.H.

A74-35360 # **VFW 614 de-icing.** *Aircraft Engineering,* vol. 46, June 1974, p. 20, 21.

The ice protection system for the airframe of the VFW 614 is a T.K.S. fluid system, which works on the principle of forming a film of Glycol-based freezing point depressant fluid over the protected surfaces. The system can be operated in a de-icing or anti-icing mode. The fluid film is established by exuding de-icing fluid through porous panels which form the leading edges of the air-foils. These porous panels form a part of the load-carrying structure of the leading edge. Use of a longitudinal dam to separate the panels into two compartments enables the quantity of fluid used to be reduced. P.T.H.

A74-35361 # **VFW 614 oxygen system.** *Aircraft Engineering,* vol. 46, June 1974, p. 21, 22.

The VFW 614 oxygen system consists of two independent plug-in fix-installed systems for crew and for passengers, both systems combined by a tube and a check valve to enable the crew preferably to breathe also oxygen from the passenger oxygen cylinder. A schematic of the whole oxygen system is shown, describing the following newly developed components: filler connection, pressure reducer, automatic flow valve, altitude-controlled pressure regulator, pressure switch, plug-in valve, and portable oxygen equipment. P.T.H.

A74-35362 # **VFW 614 surface control system.** *Aircraft Engineering,* vol. 46, June 1974, p. 23, 24.

The VFW 614 has been designed around a manual primary flight control system for rudder elevator and aileron. A cable tension regulator is introduced into the cable loop system in order to maintain correct rig tension. The control systems for the throttle and fuel cock, rudder and aileron trim circuits utilize wire rope as signal carrier. Rig tension in these circuits is maintained by means of a compensator device built into the control loop. P.T.H.

A74-35363 # **VFW 614 electrical system.** *Aircraft Engineering,* vol. 46, June 1974, p. 24-26.

The ac electric power generation system of the VFW 614 consists of two main engine/constant speed drive driven channels and one auxiliary power unit (gas turbine) driven channel. Each channel consists of a generator, a generator control unit, a differential protection current transformer assembly, and a control CT assembly. A schematic of the whole system is given along with the basic system parameters. P.T.H.

A74-35364 # **VFW 614 avionics.** *Aircraft Engineering,* vol. 46, June 1974, p. 26, 28-32.

Description of VFW 614's flight guidance system (including flight evaluation procedures and results), augmentation control laws, autopilot/flight director integration, system self-test equipment, weather radar system and antenna system, and the communications control and intercom system. P.T.H.

A74-35365 # **VFW 614 powerplant.** *Aircraft Engineering,* vol. 46, June 1974, p. 32-34.

The M 45H-01 powerplant of the VFW 614 is a twin spool turbofan engine constructed in nine separate modules. The low pressure system comprises the fan, the fan casing, intermediate compressor, LP turbine and associated shafting, and the high pressure system comprises the intermediate casing with number 2 and 3 bearing supports, the HP compressor, combustion chamber, HP turbine with shafting and exhaust diffuser. Modular construction provides for fast turn round times at the repair base with the possibility of changing modules without subsequent engine test. P.T.H.

A74-35386 # Wind tunnel and flight development of the F-14 subsonic/transonic maneuvering configuration. S. B. Honig and J. DeLuca (Grumman Aerospace Corp., Bethpage, N.Y.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 8th, Bethesda, Md., July 8-10, 1974, Paper 74-618.* 11 p. 7 refs. Members, $1.50; nonmembers, $2.00.

The maneuvering configuration of the Grumman F-14 air superiority fighter has evolved through an extensive wind tunnel and flight test development program. Some of the factors associated with the subsonic and transonic maneuvering configuration are cited, beginning with the design philosphy for a Navy air superiority fighter and discussing the initial empirical estimates of buffet-free and maximum usable lift coefficients; early wind tunnel indications of high-angle-of-attack capability; and the introduction of the spin-avoidance philosophy, including development of a maneuvering slat. The discussion carries through with flight demonstrations of initial goals and a comparison of recent flight test data with final predictions of the aircraft's maneuvering capability. (Author)

A74-35387 # Transonic Aircraft Technology /TACT/ program. C. J. Cosenza and L. J. Kummeth (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 8th, Bethesda, Md., July 8-10, 1974, Paper 74-620.* 8 p. Members, $1.50; nonmembers, $2.00.

The purpose of the Transonic Aircraft Technology (TACT) program is to demonstrate in flight the performance advantage of the supercritical wing (SCW) to high performance aircraft, provide the necessary data to verify the SCW aerodynamic benefits, and investigate and improve wind tunnel testing techniques through extensive correlation of wind tunnel and flight test data. The TACT SCW wind tunnel models have been and are continuing to be extensively tested in Air Force and NASA facilities. Test results have shown large improvements in Mach divergence and at lift coefficient at buffet onset. (Author)

A74-35388 * # Wind tunnel and flight performance of the YF-12 inlet system. D. B. Smeltzer (NASA, Ames Research Center, Moffett Field, Calif.), R. H. Smith (NASA, Flight Research Center, Edwards, Calif.), and R. W. Cubbison (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 8th, Bethesda, Md., July 8-10, 1974, Paper 74-621.* 9 p. 6 refs. Members, $1.50; nonmembers, $2.00.

The steady-state internal performance from 1/3-scale and full-scale wind tunnel models of the YF-12 inlet system is compared with results from flight tests. All systems were thoroughly instrumented for static and total pressure measurements. Results obtained included the inlet mass flows, surface pressure distribution, boundary layer profiles, and detailed total pressure measurements at the engine face. Inlet performance is compared at Mach numbers 2.1 and 2.8 and at several Reynolds numbers over a wide range of inlet operating conditions. Analysis generally shows good agreement in the results between the three systems when inlet conditions are closely matched. (Author)

A74-35389 # A unique supersonic inlet unsteady aerodynamic cascade experiment. S. Fleeter, R. B. McClure, G. T. Sinnet, and R. L. Holtman (General Motors Corp., Detroit Diesel Allison Div., Indianapolis, Ind.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 8th, Bethesda, Md., July 8-10, 1974, Paper 74-622.* 9 p. 5 refs. Members, $1.50; nonmembers, $2.00. Contract No. N00014-72-C-0351.

Description of a unique supersonic inlet with a subsonic axial component time-dependent cascade experiment. In this experiment two laboratory-size digital computers are used to: (1) determine the steady-state cascade flow conditions; (2) initiate and precisely control the torsional time-dependent cascade operation including the interblade phasing angle; (3) digitalize the time-dependent strain gauge signals from each airfoil in the cascade at rates to 100,000 points per second; (4) permanently store the time-variant data on a magnetic disk, plot the digitalized signals and analyze them on-line to determine aerodynamic damping, interblade phase angle and oscillatory frequency; and (5) control a high-speed movie camera enabling color schlieren movies to be obtained of the time-dependent cascade phenomena. (Author)

A74-35393 # Wind tunnel instrumentation considerations for buffet predictions. M. A. Bell (LTV Aerospace Corp., Vought Systems Div., Dallas, Tex.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 8th, Bethesda, Md., July 8-10, 1974, Paper 74-629.* 12 p. 5 refs. Members, $1.50; nonmembers, $2.00.

Experimental efforts to evaluate the onset of airframe buffet indicates that certain instrumentation refinements are needed for valid results. An A-7 model was tested in two transonic wind tunnels for buffet data. Results of an analysis of these data are presented to establish the necessary changes. First, an improved data reduction process should be employed for root bending moment excitation data to eliminate the noise associated with background wind tunnel turbulence levels which are not representative of flight conditions. Secondly, additional instrumentation is needed to measure local pressure disturbances which accompany flow separation. This can be accomplished using frequency-sensitive pressure transducers strategically located on the wing upper surface. (Author)

A74-35394 # The need for a large transonic wind tunnel in Europe - A summary of the report of an A.G.A.R.D. working group /LaWs/. R. Hills (Aircraft Research Association, Ltd., Bedford, England). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 8th, Bethesda, Md., July 8-10, 1974, Paper 74-630.* 11 p. Members, $1.50; nonmembers, $2.00.

In 1972, an AGARD working group was set up to study the future needs for large wind tunnel facilities in Europe. Their investigations covered the whole speed range, but this paper deals mainly with the transonic speed range. The requirements for such transonic testing are described, and a specification for a suitable tunnel is drawn up. Four different types of tunnel, a Ludwieg tube, an injector driven tunnel, a piston type (Evans Clean Tunnel), and a hydraulically driven tunnel are suggested as possible designs to meet this specification. (Author)

A74-35395 * # Test results from the Langley high Reynolds number cryogenic transonic tunnel. E. J. Ray, R. A. Kilgore, J. B. Adcock, and E. E. Davenport (NASA, Langley Research Center, High-Speed Aircraft Div., Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 8th, Bethesda, Md., July 8-10, 1974, Paper 74-631.* 9 p. Members, $1.50; nonmembers, $2.00.

NASA has recently developed and proof tested a pilot cryogenic transonic pressure tunnel. In addition to providing an attractive method for obtaining high Reynolds number results at moderate aerodynamic loadings and tunnel power, this unique facility enables the independent determination of the effects of Reynolds number, Mach number, and aeroelasticity. The proof-of-concept experimental and theoretical studies are briefly reviewed. Experimental results are included which indicate pressure distributions for a two-dimensional airfoil and strain-gage balance characteristics for a three-dimensional delta wing model. (Author)

A74-35405 # High lift testing in closed wind tunnels. J. E. Hackett and R. A. Boles (Lockheed-Georgia Co., Marietta, Ga.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 8th, Bethesda, Md., July 8-10, 1974, Paper*

74-641. 12 p. 7 refs. Members, $1.50; nonmembers, $2.00.

A new method for estimating blockage corrections is described which involves wall static pressure measurements at the test section entry and exit. Model, rig and power effects are included. Using this method, tests on a 20-inch jet flap model in a 42-inch wide tunnel correlated well with 'free air' results in a large tunnel. The highest test lift coefficient was 15 and a moving ground was used. Theoretical and experimental studies are described concerning the use of a tangentially-blown wind tunnel floor to replace a moving ground. Tests on the above model, at one chord altitude, confirm the feasibility of this approach. Applications of the new procedures are described and discussed. (Author)

A74-35494 General theory of stratified media - Application to research concerning the correction of aircraft radome aberration (Théorie générale des milieux stratifiés - Application à la recherche de la correction de l'aberration d'un radome aéroporté). C. Favier de Coulomb (Thomson-CSF, Laboratoire Antennes, Corneilles-en-Parisis, Val-d'Oise, France). *Nouvelle Revue d'Optique*, vol. 5, May-June 1974, p. 185-196. In French.

A rigorous general theory of electromagnetic wave propagation in stratified media is outlined. The theory is used to solve the problem of correcting the aberration of a slender radome that forms the nose tip of a supersonic aircraft. V.P.

A74-35496 Fuel state - Expensive. P. Masefield. *Flight International*, vol. 105, June 27, 1974, p. 835-838.

There are real possibilities in the use of liquid hydrogen, although many problems remain, not least those of ground handling. Moreover, production of liquid hydrogen at present requires fossil fuels as the energy source. The whole purpose of using liquid hydrogen can be served only by the development of manufacturing cycles based on the use of nuclear, geothermal, tidal, solar, or hydroelectric power. To convert a petroleum-operated air-transport economy to a liquid-hydrogen operated air-transport economy would be vastly expensive. One other attractive nonfossil fuel would appear to be ethanol, which can be produced by solar energy from fermented cereal grain. It is not anticipated that oil supplies will run short in this century, and coal is even more plentiful. F.R.L.

A74-35559 Society for Information Display, International Symposium and Exhibition, San Diego, Calif., May 21-23, 1974, Digest of Technical Papers. Edited by L. Winner. New York, Lewis Winner, 1974. 178 p. Members, $15.; nonmembers, $20.

Papers dealing with various aspects of advanced display technology are included. Gas discharge display systems, video disk techniques, matrix-addressed panels, display duality and human perception, visual flight simulation, computer displays in an interactive system, and large area displays are covered. The subjects also include laser displays, holographic displays, 3-D displays, software and system tradeoffs, on-board vehicle route instructions, and collision avoidance systems. V.Z.

A74-35560 Advanced integrated modular instrumentation system. W. G. Mulley (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa.). In: Society for Information Display, International Symposium and Exhibition, San Diego, Calif., May 21-23, 1974, Digest of Technical Papers. New York, Lewis Winner, 1974, p. 54, 55.

Discussion of AIMIS, a totally new concept in modular cockpit instrumentation developed for naval air missions under all operational conditions. The concept meets the requirements imposed by advanced aircraft, and combines an integrated control set, head-up, vertical situation, horizontal situation, master monitor, and engine management displays into an integrated modular system. A dynamic simulation of AIMIS is carried out at the Naval Air Development Center to demonstrate the potential of this system. V.Z.

A74-35563 Holographic multicolor moving map display. K. D. Quiring (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa.). In: Society for Information Display, International Symposium and Exhibition, San Diego, Calif., May 21-23, 1974, Digest of Technical Papers. New York, Lewis Winner, 1974, p. 60, 61.

Discussion of the performance characteristics of a holographic multicolor moving map display system which is considered to be superior to full-color moving maps currently used in military aircraft cockpits. Details are given on the preparation of a quasi-focused image hologram which was found to be most suitable for the multicolor moving map display. The process of hologram reconstruction in the display is discussed in detail. V.Z.

A74-35567 Integrated, universal pilot warning/collision avoidance display. W. E. Buchanan and E. F. Kiley (Johns Hopkins University, Silver Spring, Md.). In: Society for Information Display, International Symposium and Exhibition, San Diego, Calif., May 21-23, 1974, Digest of Technical Papers. New York, Lewis Winner, 1974, p. 148, 149. 14 refs.

The state of the art in the development and implementation of an integrated ground-based and air-to-air pilot warning indicator/collision avoidance system is discussed. The display technology already available includes multicolored alphanumeric components and off-the-shelf drivers. The four means used for 3-D position sensing and the hardware of the system are reviewed briefly. V.Z.

A74-35629 # Digital fly-by-wire - Computers lead the way. D. C. Fraser and P. G. Felleman (Charles Stark Draper Laboratory, Inc., Cambridge, Mass.). *Astronautics and Aeronautics*, vol. 12, July-Aug. 1974, p. 24-32.

The possibilities of a replacement of electromechanical control systems in aircraft design by a digital fly-by-wire system are considered. According to the new approach aircraft will be controlled by digital computers connected only by wires to the control surfaces. The characteristics of a fly-by-wire system are described. In fly-by-wire the command from the pilot travels only electrically to the actuator. Three systems which exemplify the use of digital fly-by-wire systems in a spacecraft, an aircraft, and a hybrid vehicle are described. The reasons for selecting a digital flight control system for Apollo are considered. G.R.

A74-35632 # Concorde - Testing the market. R. D. Fitzsimmons (Douglas Aircraft Co., Long Beach, Calif.). *Astronautics and Aeronautics*, vol. 12, July-Aug. 1974, p. 46-52.

It is pointed out that the future of the supersonic transport will be determined by the response of the passenger in 1976 when the Concorde will begin its service as a commercial airliner. A survey of North Atlantic traffic shows that 90% of today's first-class and 40% of today's full-fare-paying economy passengers would take the Concorde service if it were offered at present first-class fares. The situation which will occur in 1976 is compared with conditions in the early 1950s when jet airliner service was first provided by the British airliner Comet. Because of a very favorable response of the passenger to the new jet transport, the manufacturers of the Comet would have captured a great part of the world's airliner markets had it not been for a number of unfortunate accidents ending in the grounding of the Comet fleet in 1954. G.R.

A74-35664 # Processing of operational data recorded on flight report cards (Zpracovani provoznich dat hodnocenych kartou 'hlaseni o letu'). V. Kahanek and F. Otrusinik. *Zpravodaj VZLU*, no. 1, 1974, p. 7-16. In Czech.

Description of the procedure used in processing flight data recorded on special cards for the purpose of detecting structural defects in the aircraft and determining the reliability and profitabili-

ty of the aircraft. Following a brief description of the format of the card, which includes entries regarding takeoff, flight, landing, and irregularities occurring during any of these stages, a detailed account is given of the factors entering into analyses of lifetime and fatigue, reliability, and technical and economic characteristics. The transfer of flight data from these cards to magnetic tape is discussed, as well as the procedure used for correcting cards containing errors. A.B.K.

A74-35666 # Experience gained from statistical testing of fatigue lives of model samples (Zkusenosti ze statistickeho testovani unavovych zivotu modelovych vzorku). Z. Vituv. *Zpravodaj VZLU,* no. 1, 1974, p. 27-31. In Czech.

Review of the practical information obtained from the use of graph-analytic statistical tests in analyzing the results of fatigue experiments on model samples of aircraft structures. A specific example of the estimation of the lifetimes of tested samples by using Weibull probability paper in conjunction with a nomogram for determining the shape parameter and the position parameter is presented. A.B.K.

A74-35668 Those Concorde economics again. A. Hofton. *Flight International,* vol. 106, July 4, 1974, p. 5-7.

British Airways state that Concorde will break even (excluding capital charges) at a seat factor of 56%, based on an average of 93 seats for sale; this corresponds to a break-even load of 52 passengers. British Airways proposes to fit 100 seats at 38-in. pitch to its Concordes and this configuration will give a break-even load factor, under the British Airways definition, of 52%. Perhaps more than anything else, the success of Concorde is dependent on market penetration. A measure of Concorde's sensitivity to marketing is that one additional passenger per aircraft per flight provides an extra 1,000,000 pounds in annual revenue on a fleet of five Concordes. F.R.L.

A74-35669 Quantitative evaluation of the effect of mechanical processing on the effectiveness of penetrant inspection. J. F. Cook, R. J. Lord, and R. J. Roehrs (McDonnell Aircraft Co., St. Louis, Mo.). *(American Society for Nondestructive Testing, National Spring Conference, Los Angeles, Calif., Mar. 11-14, 1974.) Materials Evaluation,* vol. 32, July 1974, p. 133-141.

Certain mechanical processes may cause surface metal to flow and cover over defects originally open to the surface, thereby reducing the effectiveness of subsequent penetrant inspection. The effects of several mechanical processes on penetrant inspection of aluminum, titanium, and steel are presented in terms of the amount of etching required to restore penetrant indications lost due to mechanical processing. Also, methods of producing the cracked standards used to evaluate the mechanical processing effects are described. (Author)

A74-35718 Civil aviation research and development (La ricerca e lo sviluppo dell'aviazione civile). L. Lazzarino (Pisa, Università, Pisa, Italy). *(Associazione Italiana di Aeronautica e Astronautica, Congresso Nazionale, 2nd, Pisa, Italy, Sept. 24-28, 1973.) L'Aerotecnica - Missili e Spazio,* vol. 53, Feb. 1974, p. 5-12. 23 refs. In Italian.

Analysis of the most significant elements of recent trends in civil aviation for the purpose of revealing certain research topics of primary interest for the harmonious development of complex aeronautical systems. Following a brief review of the general trends of development noted in civil aviation, recommendations are made concerning the proper direction to be taken by research on problems regarding flight operation and systems design, as well as research dealing with aircraft power plants and structural design. A.B.K.

A74-35719 An experimental study of box beam wing structures subjected to torsion (Un'indagine sperimentale su strutture alari a cassone, soggette a torsione). E. Antona and G. Gabrielli (Torino, Politecnico, Turin, Italy). *(Associazione Italiana di Aeronautica e Astronautica, Congresso Nazionale, 2nd, Pisa, Italy, Sept. 24-28, 1973.) L'Aerotecnica - Missili e Spazio,* vol. 53, Feb. 1974, p. 13-24. 12 refs. In Italian. Consiglio Nazionale delle Ricerche Contract No. 115,980,0,3721.

Description of an experimental study of the effect of torsion on box beam structures consisting of two spars, two skin panels, an intermediate frame, and two outboard frames. Four types of panels are considered - namely, flat panels, panels reinforced by riveted extruded L-stiffeners, integral panels with longitudinal stiffeners, and honeycomb sandwich panels. The tests were carried out within the framework of an experimental program designed to examine the behavior of these panels when stressed under typical restraint conditions, such as those offered by actual frames and spars. These tests make it possible to evaluate the effect of both initial imperfections and box twist on panel deformations as the applied load is increased up to specimen failure. A.B.K.

A74-35720 Aircraft cabin pressure and temperature control through reliable fluidic circuits. D. Dini and G. Nardi (Pisa, Università, Pisa, Italy). *L'Aerotecnica - Missili e Spazio,* vol. 53, Feb. 1974, p. 25-38. 6 refs.

Examination of the requirements governing pressurization and air conditioning systems used in commercial aircraft, and description of compact systems of fluidic control of cabin pressure and temperature. Following a review of the pressurization and air conditioning systems usually found in modern transport aircraft, in which bleed air is extracted from the propulsion engine compressors with the aid of high-pressure ducts and air shutoff valves, the basic control characteristics for a typical military combat aircraft cabin pressurization control and for civil aircraft are outlined. A detailed study is then made of fluidic systems designed to control cabin pressure automatically by choking the discharge flow of the cabin conditioning air. Also discussed are the temperature sensors required to keep the air in the air conditioning system at a set temperature. In addition, the block diagram of an air conditioning control system which distributes air throughout the cabin and maintains a safe operating temperature is analyzed. Finally, the reliability of a proposed cabin pressure and temperature controller which uses an all-fluidic circuit is evaluated. A.B.K.

A74-35743 Fly-by-wire controls are on the way. J. Morisset. *Telonde,* Dec. 1973, p. 7-9. Translation.

It is pointed out that the mechanical control system for aircraft prevents the development of a new concept, the 'control configured vehicle' (CCV). Application of the CCV concept will make it possible to achieve a significant weight reduction in any given aircraft for a given mission. Other advantages include the increase of flight speeds, a reduction of the sensitivity to gusts, a decrease in aircraft vulnerability, and enhanced maneuverability of the aircraft. In order to make the introduction of the CCV possible, the mechanical control system will be replaced by fly-by-wire controls. G.R.

A74-35744 Evolution and new functions of airborne radars. P. Condom. *Telonde,* Dec. 1973, p. 20-25. Translation.

It is pointed out that technology improvements have affected all hardware components. Solid-state technology has made it possible to reduce the length of the radar and to increase the diameter of the antenna by relocating it further aft in the nose of the aircraft. In the case of microwave circuitry a tenfold reduction in bulk has been achieved in the space of a few years. New functions have been developed that contribute to enhance reliability. G.R.

A74-35807 **Nonflammable fibrous materials for aeronautical systems.** J. H. Ross (USAF, Materials Laboratory, Wright-Patterson AFB, Ohio). In: New industries and applications for advanced materials technology; Proceedings of the Nineteenth National Symposium and Exhibition, Buena Park, Calif., April 23-25, 1974. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1974, p. 166-177. 7 refs.

The fibrous materials used in many subsystems composing aircraft interiors and aircrew clothing are chosen primarily for their aesthetics, cost, and durability, with little or no emphasis placed on *resistance to burning and decomposition by-products caused by* heating and/or burning. Aircraft accidents in recent years have been highlighted by specific cases where toxic gases and fire have been the primary cause of many fatalities. Current research directed on the development of nonflammable polymeric fibers has yielded a number of potential polymeric systems which would greatly increase the chances of survival in aircraft accident fires. (Author)

A74-35823 ***Metal matrix composite blade fabrication methods.*** I. J. Toth (TRW, Inc., Materials Technology Div., Cleveland, Ohio). In: New industries and applications for advanced materials technology; Proceedings of the Nineteenth National Symposium and Exhibition, Buena Park, Calif., April 23-25, 1974. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1974, p. 406-416. 10 refs.

This paper discusses the characteristics of three processing methods studied at TRW for the fabrication of high-strength, high-modulus, low-density filamentary reinforced aluminum and titanium matrix composite gas-turbine fan blades. The preconsolidated monotape method when combined with the use of preformed (to airfoil twist and camber) ply elements was found to give the highest quality blade. The economics and other considerations that will affect the fabrication and usage (in production quantities) of metal composite blades are also discussed. (Author)

A74-35824 **Structural fabrication of metal-matrix composites.** M. F. Miller (General Dynamics Corp., Convair Aerospace Div., San Diego, Calif.). In: New industries and applications for advanced materials technology; Proceedings of the Nineteenth National Symposium and Exhibition, Buena Park, Calif., April 23-25, 1974. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1974, p. 417-423. 6 refs.

Several significant metal-matrix airframe structures, measuring up to seven feet long, have been built using a combination of tape layup and modified sheet metal fabrication techniques. These structures (four of which are discussed in this paper) include a missile adapter, aircraft engine bulkhead, shear beam, several compression panels, a tubular truss, and landing gear drag struts. On the basis of the success of these structures, boron/aluminum is being considered for applications to the Space Shuttle. (Author)

A74-35826 **Properties of beryllium reinforced titanium matrix composites.** V. L. Goodwin. In: New industries and applications for advanced materials technology; Proceedings of the Nineteenth National Symposium and Exhibition, Buena Park, Calif., April 23-25, 1974. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1974, p. 440-442.

Beryllium reinforced titanium matrix composites (Be/Ti) are newcomers in the field of composite materials and offer features not found in the longer established composite systems. Be/Ti is similar to alternate systems in offering high specific strengths and moduli; yet differs markedly in being a ductile composite further characterized by limited anisotropy and *excellent fracture resistance. Shear* properties are outstanding as is the retention of composite properties at temperature to 900 F. Additionally, these composites have metal-like fabricability and have an economical price projected at $20 to $30/lb in volume. (Author)

A74-35837 **New application potential for lower cost, heavy denier Kevlar-49 yarns.** R. H. Stone (Lockheed-California Co., Burbank, Calif.). In: New industries and applications for advanced materials technology; Proceedings of the Nineteenth National Symposium and Exhibition, Buena Park, Calif., April 23-25, 1974. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1974, p. 609-627.

The recent development of heavy-denier Kevlar-49 (PRD-49) yarns provides a significant reduction in the costs of Kevlar-49 fabrics and prepregs. This now increases the applications where *Kevlar-49 becomes a cost-effective replacement for fiberglass.* An evaluation of heavy-denier Kevlar-49 pre-pregs and laminates indicates an improvement in compressive strength and impact resistance over the standard Kevlar-49. Some improvement is needed in the drapability of the plain-weave heavy-denier fabrics. (Author)

A74-35838 **An automated tape layup system /ATLAS/.** R. V. Evers (U.S. Army, Directorate for Research, Development and Engineering, St. Louis, Mo.). In: New industries and applications for advanced materials technology; Proceedings of the Nineteenth National Symposium and Exhibition, Buena Park, Calif., April 23-35, 1974. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1974, p. 628-640. Army-sponsored research.

The ATLAS is capable of tape placement in three flat axes and three curvilinear axes. Any one or combination of these can be utilized, including all six at one time. A hand control on the gantry is used for manual tape placement to start layup or change layup path of tape when digitizing the structure. The ATLAS has a head and tail stock for suspension of structural and tooling lengths up to 50 ft, which can be extended by increments of 12 ft. There are intermediate supports called steady rests which help support the long length between the stocks and the tape head, making it possible to layup long structures of many configurations without significant blade deflection and tape misalignment. The most noteworthy feature of the ATLAS is the method of digitizing. F.R.L.

A74-35841 **Recent advances in the processing of polyimide resins for high temperature radome applications.** M. C. Cray (British Aircraft Corp., Ltd., Stevenage, Herts., England). In: New industries and applications for advanced materials technology; Proceedings of the Nineteenth National Symposium and Exhibition, Buena Park, Calif., April 23-25, 1974. Azusa, Calif., Society for the Advancement of Material and Process Engineering, 1974, p. 663-670. 8 refs.

Advances in various aspects of the technology and monitoring of the manufacture of polyimide resin composites are described. It is shown that wider experience has led to considerable gains in mechanical performance and thus greater confidence in the use of these resins for structural as well as dielectric applications. A novel technique for processing polyimide resins directly from the powdered form, developed during work based on a British resin, provides extra versatility, since the need for the conventional but costly solvent-based preimpregnation of the fibrous reinforcement is obviated. This process can be operated at low to medium pressures with a range of reinforcements and has been employed successfully in the production of prototype missile radomes of consistent quality. (Author)

A74-35981 **Noise attenuation in the case of the microturbine engine TRS 18 (Geräuschdämpfung am Kleinturbotriebwerk TRW 18).** J. F. Speth. *Flug Revue/Flugwelt International,* July 1974, p. 33-36. 7 refs. In German.

It is pointed out that the noise produced by the engine TRS 18 exceeds the maximum noise levels of the currently valid international regulations in the area of general aviation. The engine noise would, therefore, have to be reduced before the TRS 18 can be used in aircraft. An investigation was conducted to study approaches for

reducing the noise produced by the engine to admissible levels without great losses in thrust or changes in design. The origin of compressor and jet noise is considered and methods for reducing the noise are discussed. G.R.

A74-35994 # Application of acrylic based room temperature curing adhesives to structural helicopter bondments. C. H. Jacobi (Boeing Vertol Co., Philadelphia, Pa.). *Society for the Advancement of Material and Process Engineering, National Symposium and Exhibition, 19th, Buena Park, Calif., Apr. 23-25, 1974, Paper.* 31 p.

Acrylic based room temperature curing adhesives have exhibited strength and stressed environmental endurance properties equivalent to the new, improved, 250 F heat curing type film adhesives. The elimination of heat curing reduces residual thermal stresses in bondments and allows lower cost fabrication. This paper presents data generated during application development for bonding boron composite stiffeners to aluminum structural parts. It also deals with the handling of these adhesives and discusses some of the characteristics inherent in their use. The program verified vendor data and provided processing techniques to produce void-free bonds. (Author)

A74-36000 # Inspection of advance composite structures by nondestructive testing. R. G. Buckley (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). *Society for the Advancement of Material and Process Engineering, National Symposium and Exhibition, 19th, Buena Park, Calif., Apr. 23-25, 1974, Paper.* 18 p.

Advance composite structures using boron-epoxy and graphite epoxy materials are rapidly replacing metal components in modern day high performance aircraft. Because these materials are used in areas of high stress, the need for stringent nondestructive inspection requirements is compulsory. This paper discusses acceptance classes and zoning of blueprints with emphasis placed on selecting the proper inspection method for solving specific problems. The preparation of reference standards used with various methods of inspection is described. The basic methods of inspection (including radiographic and ultrasonic and sonic applications) are employed, although many of the parameters are unique and are not normally associated with general applications. Detailed requirements for the nondestructive inspection methods now required by most military contracts are given. (Author)

A74-36037 # Reduction of environmental testing and analysis costs through simulation. J. C. Haley and R. D. Mower (USAF, Avionics Laboratory, Wright-Patterson AFB, Ohio). In: Cost effectiveness in the environmental sciences; Proceedings of the Twentieth Annual Meeting, Washington, D.C., April 28-May 1, 1974. Mount Prospect, Ill., Institute of Environmental Sciences, 1974, p. 393-396.

Discussion of the use of dynamic analysis techniques for reducing costs of designing, developing, testing, and acquiring new and better reconnaissance systems. It is shown how significant cost savings can be realized when simulation and environmental testing techniques are employed at critical times during the research and development phases. M.V.E.

A74-36044 * # Measurement of dynamic cross-derivatives due to pitching and yawing. K. J. Orlik-Rückemann, J. G. LaBerge, and E. S. Hanff (National Aeronautical Establishment, Ottawa, Canada). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 8th, Bethesda, Md., July 8-10, 1974, Paper 74-611.* 11 p. 5 refs. Members, $1.50; nonmembers, $2.00. Contracts No. NASw-2369; No. NASw-2646.

A novel wind-tunnel apparatus is described with which all the 12 static and dynamic moment derivatives due to pitching and yawing can be obtained at angles of attack up to 40 deg and in the presence of some sideslip. The experimental technique and the data reduction procedure are discussed, and preliminary data on dynamic derivatives for an aircraft-like configuration at M = 0.70 are presented. It is shown that in the range of angle of attack investigated, some rather large variations occur in both the two direct damping derivatives and some of the dynamic cross-derivatives; the latter, however, remain small as compared to the corresponding direct damping derivatives (in general less than 10%). (Author)

A74-36046 # Selected results from the YF-16 wind tunnel test program. J. K. Buckner and J. B. Webb (General Dynamics Corp., Convair Aerospace Div., Fort Worth, Tex.). *American Institute of Aeronautics and Astronautics, Aerodynamic Testing Conference, 8th, Bethesda, Md., July 8-10, 1974, Paper 74-619.* 13 p. Members, $1.50; nonmembers, $2.00.

YF-16 force-model results from several facilities are compared, with emphasis on the drag data. Rather large initial subsonic differences between the NASA-Ames 11-ft and Calspan 8-ft tunnels are reconciled by the 'relative buoyancy' discoveries of S. L. Treon et al. (1971). Data from two model scales in these tunnels also demonstrate scale effects on profile and induced drag. The higher turbulence level of the Calspan tunnel is evident from the Reynolds number effects observed in both tunnels. It is further shown that simple force-model techniques can be used successfully to derive inlet spillage effects. It appears that nozzle-exit-diameter effects on airplane drag can also be derived by force-model testing on a single-engine fighter aircraft, but the size of the model support sting restricts the ability to simulate the small dry-power nozzle exit. (Author)

A74-36115 * Steady state decoupling and design of linear multivariable systems. J. Y. Huang (Santa Clara, University, Santa Clara, Calif.) and G. J. Thaler (U.S. Naval Postgraduate School, Monterey, Calif.). In: Milwaukee Symposium on Automatic Control, Milwaukee, Wis., March 28-30, 1974, Proceedings. Milwaukee, University of Wisconsin, 1974, p. 248-258. 10 refs. Grant No. NGR-05-017-010.

A constructive criterion for decoupling the steady states of linear multivariable systems is developed. The criterion consists of n(n-1) inequalities with the type numbers of the compensator transfer functions as the unknowns. These unknowns can be chosen to satisfy the inequalities and hence achieve a steady state decoupling scheme. It turns out that pure integrators in the loops play an important role. An extended root locus design method is then developed to take care of the stability and transient response. The overall procedure is applied to the compensation design for STOL C-8A aircraft in the approach mode. (Author)

A74-36154 # Controllability and stability of systems with restricted resources (Upravliaemost' i ustoichivost' sistem s ogranichennymi resursami). A. M. Formal'skii. Moscow, Izdatel'stvo Nauka, 1974. 367 p. 90 refs. In Russian.

In real systems of automatic control, the controlling devices are usually subject to various physical constraints, so that it is not always possible to bring the system from a given initial state to the desired working regime. The present work is concerned with that area of control theory which defines the region of initial states from which it is possible to bring a system to a given regime. Three kinds of constraint are considered: force, energy, and moment limitations on the controlling action. These constraints can act separately or jointly. Theory is applied to both closed-loop and open-loop systems. A section is included on the stability of systems with dry friction, analyzing the controllability of a gyrostabilizer. P.T.H.

A74-36188 * # Some comparisons of the flow characteristics of a turbofan compressor system with and without inlet pressure distortion. D. G. Evans, C. E. DeBogdan, R. H. Soeder, and E. J. Pleban (NASA, Lewis Research Center, Cleveland, Ohio). *U.S. Air Force and United Aircraft Corp., Workshop on Unsteady Flows in*

Jet Engines, East Hartford, Conn., July 11, 12, 1974, Paper. 19 p. 5 refs.

The measured effects of a circumferential distortion in inlet total pressure on the fan, low, and high compressor of an afterburning turbofan engine are presented and discussed. Extensive inner-stage instrumentation, combined with a unique test technique offered an accurate means of measuring the shifts in flow, performance, and stall mechanisms within the compressor. These effects are compared at one speed to the corresponding effects measured with undistorted inlet flow. The results show the rate at which the distorted flow areas were attenuated and rotated, as well as the change in flow velocities that occurred at various points in the compressor. High response pressure traces indicated the location of stalls including the sequence of dynamic events from the onset and propagation of various stall-recovery events, to compressor surge, to the resulting hammershock. (Author)

A74-36227 # **Recent developments in shipboard V/STOL testing.** J. M. Rebel, J. G. Hoeg, and G. E. Clarke (U.S. Navy, Naval Air Test Center, Patuxent River, Md.). In: Flight testing today - 1973; Proceedings of the Fourth National Symposium, Las Vegas, Nev., August 21-23, 1973. Symposium sponsored by the Society of Flight Test Engineers. California, Md., Society of Flight Test Engineers, 1973. 9 p.

The first U.S. evaluation of the shipboard operating capability of the AV-8A Harrier, the world's first operational jet V/STOL aircraft, was conducted by the Naval Air Test Center in the spring of 1971. The tests showed that the AV-8A could successfully operate from various types of shipboard platforms. However, some problems were encountered with the particular version of the AV-8A used in the evaluation. Changes in aircraft design made as a result of the initial test work are discussed along with details concerning test methods and test results, giving attention to STO performance and handling qualities. G.R.

A74-36240 **Heat transfer effects on a delta wing in subsonic flow.** R. W. Blohm, III (USAF, Robins AFB, Ga.) and J. F. Marchman, III (Virginia Polytechnic Institute and State University, Blacksburg, Va.). In: Heat Transfer and Fluid Mechanics Institute, 24th, Corvallis, Ore., June 12-14, 1974, Proceedings. Stanford, Calif., Stanford University Press, 1974, p. 220-235. 5 refs.

During reentry of the space shuttle the surface temperature of the underside of the wings will reach about 2000 F with peak temperatures on the leading edges of about 3500 F. The effects of this heating on the wing's aerodynamics and boundary layer are of critical importance in the latter stages of the flight. In order to investigate the aerodynamic effects of heat transfer for a heated delta wing, a cast aluminum model was constructed and tested over a wide range of angles and yaw in a wind tunnel. G.R.

A74-36304 **Design of uniformly long-lived structures of minimum weight.** Iu. D. Safronov (Kazanskii Aviatsionnyi Institut, Kazan, USSR). *(Problemy Prochnosti,* vol. 5, June 1973, p. 26-30.) *Strength of Materials,* vol. 5, no. 6, Mar. 1974, p. 671-676. 6 refs. Translation.

A74-36316 **A review of precious resources and their effect on air transport; Proceedings of the Spring Convention, London, England, May 15, 16, 1974.** Convention sponsored by the Royal Aeronautical Society. London, Royal Aeronautical Society, 1974. 282 p. $14.35.

Papers on air transport resources are given, covering nuclear contribution to future energy supplies, alternative energy sources, metallic and other material resources, noise reduction goals, effects of fuel and materials shortages on aircraft development and operation, future propulsion technology for ground transport, and economic resources utilization in aviation. The pricing policies of oil producing nations, hydrogen energy systems, man as a precious resource, and the quality of life vs aeronautics are also dealt with. V.Z.

A74-36317 # **Metallic and other material resources.** D. C. Moore (Imperial Chemical Industries, Ltd., Kidderminster, Worcs., England). In: A review of precious resources and their effect on air transport; Proceedings of the Spring Convention, London, England, May 15, 16, 1974. London, Royal Aeronautical Society, 1974. 11 p. 7 refs.

An attempt is made to evaluate the effect of current and future changes in the availability of aircraft materials and also of their prices, population growth, and supply competition on the future well-being of the aircraft industry and air transport. Huge waste of material at most stages of aircraft manufacturing and the increasing uses of new advanced types of materials in the future are also considered as factors of influence in this industry. Economical and technical considerations are given in support of the conclusion that the air transport industry will be able to afford higher materials prices with a competing edge over many other industries. V.Z.

A74-36318 # **Noise - Future targets.** G. M. Lilley (Southampton, University, Southampton, England). In: A review of precious resources and their effect on air transport; Proceedings of the Spring Convention, London, England, May 15, 16, 1974. London, Royal Aeronautical Society, 1974. 12 p. 5 refs.

Requirements for achieving minimum levels of aircraft noise are summarized in the context of the numerous factors involved, notably the quality of life. Noise scales and indices, community reaction to noise, noise certification and its future amendments, aircraft noise sources, and optimized aircraft operation are considered. Some noise regulations of current legislation in the United Kingdom are quoted. Suggestions are made for achieving a quieter environment by taking full advantage of current progress in aircraft and engine designs and noise reduction techniques for subsonic aircraft. V.Z.

A74-36319 # **The development of aircraft as influenced by the shortage of materials and fuel.** H. A. Goldsmith (British Aircraft Corp., Ltd., Filton, Bristol, England). In: A review of precious resources and their effect on air transport; Proceedings of the Spring Convention, London, England, May 15, 16, 1974. London, Royal Aeronautical Society, 1974. 17 p.

The broad implications of possible shortages and high prices of basic materials in the aviation industry are discussed, covering aluminum, titanium, iron, nickel, composites, and fuel. High prices of any of these materials are viewed as possible but the real near term shortage of any significance is believed to be only that of fuel. Some alternative fuels are considered, with hydrogen produced from water using energy derived from non-fossil power sources as an obvious candidate. V.Z.

A74-36321 # **The economic utilisation of resources through aviation.** I. Chichester-Miles (Hawker Siddeley Aviation, Ltd., Hatfield, Herts., England). In: A review of precious resources and their effect on air transport; Proceedings of the Spring Convention, London, England, May 15, 16, 1974. London, Royal Aeronautical Society, 1974. 74 p.

Civil aviation is assessed as a social utility producing a desirable and useful service with a minimum demand on resources such as manpower, time, land and fuel. It is indicated that a progressive improvement of aircraft technology, with the present level of airline administration and operations efficiency and present constraints on airport access and locations, can only partially benefit the pro-

ductivity of the air transport system as a whole. Even so, technical improvements in conventional subsonic aircraft should consolidate the position of aviation as the most efficient user of manpower over distances down to 600 km or even less. It is also anticipated that the attraction of aviation in terms of efficient land utilization will steadily increase with the growing volume of air traffic. V.Z.

A74-36322 # **Precious resources and air transport - An airline view.** R. H. Whitby (British Airways Board, London, England). In: A review of precious resources and their effect on air transport; Proceedings of the Spring Convention, London, England, May 15, 16, 1974. London, Royal Aeronautical Society, 1974. 11 p.

Recent fuel price increases and possible further increases are discussed in the context of their effects on airline operation planning at present and in immediate and more remote future. The fuel position of air transport vs other transport competitors is analyzed with the conclusion that aviation is not a major user of existing oil fuels and that there will be hardly a short supply of kerosene type products at practical prices for aviation within the next 60 years. V.Z.

A74-36326 **Symposium on Air Transport in Europe, London, England, January 16, 1974, Proceedings.** Symposium sponsored by the Royal Aeronautical Society. London, Royal Aeronautical Society, 1974. 73 p. $6.65.

Some of the nontechnical aspects of the current European air transport scene are discussed, and the structure and operation of some regulatory bodies are described. Some of the topics covered include an airline's view of the opportunities and implications of the European Economic Community, commercial trends and prospects for air transport in Europe, the development of third level air services, and traffic control in Europe. P.T.H.

A74-36327 # **Air transport in Europe - Commercial trends and prospects.** J. J. Scarlett (British Airways, European Div., Ruislip, Middx., England). In: Symposium on Air Transport in Europe, London, England, January 16, 1974, Proceedings. London, Royal Aeronautical Society, 1974, 12 p.

The present work indicates in general terms some of the main factors which would have to be taken into consideration in order to obtain a picture of the air travel industry in Europe over the next decade or so. It is pointed out that because of the increase in fuel prices, the fuel content of the operating costs of a charter airline might rise from 20/25% to one-third or more of the total cost of operation, which could dramatically change the trend over the past decade towards very low-fare travel within Europe. Other topics discussed include traffic growth and financial prospects. P.T.H.

A74-36328 # **The development of third level air services in France.** M. Ziegler (Air Alpes, Viviers-du-Lac, Savoie, France). In: Symposium on Air Transport in Europe, London, England, January 16, 1974, Proceedings. London, Royal Aeronautical Society, 1974. 11 p.

The present work discusses the organization, operation, and development of the French third level air services. Most third level routes were opened up under a high degree of uncertainty about their potential traffic. Part of the financial risks involved was supported by subsidies from the French Chamber of Commerce. Although the third level carriers face the same administrative, technical, and financial problems as the major airlines, they also have some specific problems. For example, most third level pilots hold a professional pilot license, which means that the maximum take-off weight of the aircraft which the pilot can fly is 5.7 tons. As the need arises, third-level carriers will have to operate bigger, faster, and more profitable aircraft, with the result that these carriers would have to employ First Class professional pilots at greater financial cost. P.T.H.

A74-36329 # **Technical regulation and direction.** G. H. Capsey (Civil Aviation Authority, London, England). In: Symposium on Air Transport in Europe, London, England, January 16, 1974, Proceedings. London, Royal Aeronautical Society, 1974. 9 p.

The origin, organization, operation and achievements of the European Civil Aviation Conference (ECAC) are discussed. The ECAC had its first meeting in 1955, and one of its main objectives was to review 'the development of intra-European air transport with the object of promoting the co-ordination, the better utilization and the orderly development of such air transport'. The technical regulatory power of ECAC consists in making recommendations to its member governments. For example, the Multilateral Agreement Relating to Certificates of Airworthiness for Imported Aircraft (1960), for which at last count 12 member states have deposited instruments of approval or ratification, replaced a number of existing bilateral agreements and has simplified the procedure of validating certificates of airworthiness for aircraft, components, parts, and engines manufactured in another state. P.T.H.

A74-36353 # **Pyrotechnic pulse generators for in-flight structural tests (Impulseurs pyrotechniques pour essais de structures en vol).** P. Larue, M. Millet, and G. Piazzoli. *La Recherche Aérospatiale,* May-June 1974, p. 137-146. 5 refs. In French.

Description of a number of models of pyrotechnic pulse generators by applying a percussion to an aircraft structure undergoing vibration tests. Following a brief review of the principle of the aeroelastic test method employed, the geometrical and mass characteristics of three recently developed types of pyrotechnic pulse generators are cited, together with their performances. The three devices are, respectively, a flat pulse generator with a thrust of 50 daN lasting 22 msec, a pulse generator consisting of laminated elements with a thrust of 175 daN lasting 26 msec, and a cylindrical shaped pulse generator with a thrust of 20 daN lasting 18 msec. A program of acceptance tests for these pulse generators is described, as well as some modifications of the generator design to produce generator types suitable for low-frequency vibration tests. A.B.K.

A74-36427 **Evaluation of lateral displacement of SLS antennas.** N. Marchand (Marchand Electronic Laboratories, Inc., Greenwich, Conn.). *IEEE Transactions on Antennas and Propagation,* vol. AP-22, July 1974, p. 546-550. Contract No. AF 19(628)-6080.

A detailed analysis is made of a laterally displaced interrogator sidelobe suppression (SLS) radar beacon antenna system. This method is recommended as a very economical solution to the FAA requirement for installing interrogator SLS capability at operating beacon systems where no provision had been made for interrogator SLS. The analysis was verified by an actual field test at a Department of Defense/Federal Aviation Agency radar site. Sidelobe suppression was practically complete, and neither time displacement nor blockage was discernible, as predicted by the analysis. (Author)

A74-36451 # **Experimental investigation of optimal fuselage nose parts for supersonic passenger aircraft (Eksperimental'noe issledovanie optimal'nykh nosovykh chastei fiuzeliazhei sverkhzvukovykh passazhirskikh samoletov).** G. L. Grodzovskii, R. A. Zhukova, Iu. A. Lashkov, A. A. Rafaeliants, A. A. Tupolev, G. A. Cheremukhin, and E. A. Shumilkina. *TsAGI, Uchenye Zapiski,* vol. 3, no. 1, 1972, p. 19-22. 8 refs. In Russian.

A74-36452 # **The three-dimensional boundary layer in the vicinity of the stagnation line of a swept wing in the case of nonuniform suction (Trekhmernyi pogranichnyi sloi v okrestnosti kriticheskoi linii skol'ziashchego kryla pri neravnomernom otsasyvanii).** V. A. Barinov. *TsAGI, Uchenye Zapiski,* vol. 3, no. 1, 1972, p. 23-29. 8 refs. In Russian.

A numerical method of calculating the equations of an incompressible boundary layer is obtained by extending a method of

integral relations developed by Dorodnitsyn to the three dimensional case. The characteristics of the boundary layer are calculated for various distributions of the suction intensity along the front edge of the wing. Sample calculations are performed for the case of a parabolic suction intensity over a certain interval and zero suction outside. The results show that the change in boundary layer characteristics depends on the total airflow in that suction region. J.K.K.

A74-36454 # **Calculation of the static stability of aircraft at large angles of attack (K raschetu staticheskoi ustoichivosti letatel'nykh apparatov na bol'shikh uglakh ataki).** G. V. Aleksandrov and G. E. Kuzmak. *TsAGI, Uchenye Zapiski,* vol. 3, no. 1, 1972, p. 38-44. In Russian.

The static stability of an aircraft is calculated for different positions of its center of gravity, and a formula relating the aerodynamic moment increment to the aerodynamic force increment and the position of the metacenter is derived. Special note is given the case where the range of attack angles in question contains angles of attack beyond stalling. The range of positions of the center of gravity at which stability is maintained for all angles is either limited or nonexistent in such a case, and any attempt to increase stability by shifting the center of gravity forward may have the opposite effect. J.K.K.

A74-36455 # **Application of the method of extreme values to the determination of maximum operating loads (Primenenie metoda ekstremal'nykh znachenii k opredeleniiu maksimal'nykh ekspluatatsionnykh nagruzok).** V. M. Chizhov. *TsAGI, Uchenye Zapiski,* vol. 3, no. 1, 1972, p. 45-50. In Russian.

Probability methods are used to determine the maximum operating loads for aircraft structures when the loading is represented in the form of random processes or random sequences. These methods are used to establish and derive the dependence of the maximum operating loads on the time of operation of the aircraft. J.K.K.

A74-36458 # **Application of fusible temperature indicators for measuring heat flows to models in wind tunnels (Primenenie plaviashchikhsia termoindikatorov dlia izmereniia teplovykh potokov k modeliam v aerodinamicheskikh trubakh).** M. M. Ardasheva, S. A. Il'ina, N. A. Lodygin, G. I. Maikapar, G. E. Pervushin, and K. F. Tolmacheva. *TsAGI, Uchenye Zapiski,* vol. 3, no. 1, 1972, p. 77-82. In Russian.

A74-36463 # **Effect of the differentiability of random stationary processes on the magnitude of the mean square approximation error (O vliianii differentsiruemosti sluchainykh statsionarnykh protsessov na velichinu srednekvadratichnoi pogreshnosti approksimatsii).** Iu. P. Borodin. *TsAGI, Uchenye Zapiski,* vol. 3, no. 1, 1972, p. 107-110. In Russian.

The mean square error in digital measuring devices used to record the instantaneous values of aerodynamic forces and moments acting on helicopter rotors depends on the length of the sampling interval and the form of the approximating function. Formulas are obtained for calculating the mean square error in discrete measurements of aerodynamic variables whose temporal behavior is described by standard correlation functions. The degree of the Lagrange polynomial serving as the approximating polynomial is related to the differentiability of the signals. It is shown that choosing polynomials of higher degree increases the accuracy of measurement only when the random process is differentiable. J.K.K.

A74-36499 # **A variation of the aerodynamic shape of a body which leads to a decrease in its drag (Variatsiia aerodinamicheskoi formy tela, privodiashchaia k umen'sheniiu ego soprotivleniia).** N. N. Glushkov, D. P. Krotkov, and L. M. Shkadov. *TsAGI, Uchenye Zapiski,* vol. 3, no. 2, 1972, p. 11-20. In Russian.

Development of a direct gradient method of improving the aerodynamic characteristics of a flight vehicle by a small variation of its surface. Within the framework of linear theory, using a flow reversibility theorem, an expression is obtained for the local angle of attack variation leading to a decrease in the pressure drag of a flight vehicle without changing the volume, lifting force, longitudinal momentum, etc. It is proposed that the pressure distribution on the surface of a body chosen in a particular way, which must be known in order to construct an improving variation, be determined experimentally. In various examples of plane flow an analysis is made of the effect of viscosity forces and of the nonlinear dependence of pressure on the local angle of attack. It is shown that in all the cases considered the expression for the improving variation obtained within the framework of linear theory ensures a surface deformation in a direction corresponding to a decrease in drag. A.B.K.

A74-36505 # **A gradient method of control correction for the solution of a boundary value problem (Gradientnyi metod korrektsii upravleniia dlia resheniia kraevoi zadachi).** I. O. Mel'ts and G. V. Uskov. *TsAGI, Uchenye Zapiski,* vol. 3, no. 2, 1972, p. 77-85. 9 refs. In Russian.

Consideration of a gradient method of constructing a correction for control functions and parameters which in a linear approximation ensures a given variation of the boundary-condition vector at the right-hand end of the trajectory. A comparison is made of the results of a number of works on direct methods of optimization in which such a problem is considered. The construction of a correction for control functions in a class of piecewise-constant functions is investigated. The results of calculations for the problem of an angle-of-attack control which ensures gliding of a flight vehicle to a given point are presented as an illustration. It is shown that the desired control correction formulas can be obtained by minimizing the generalized norm of this correction for a given small variation of the boundary-condition vector and simultaneously compensating for violations of the control constraints. A.B.K.

A74-36509 # **The problem of optimum design of a wing under strength and aeroelastic constraints (O zadache optimal'nogo proektirovaniia konstruktsii kryla iz uslovii prochnosti i aeroupругosti).** V. I. Biriuk. *TsAGI, Uchenye Zapiski,* vol. 3, no. 2, 1972, p. 114-119. In Russian.

Consideration of design optimization for a sweptback wing of an aircraft for which some flight regime characteristics are given (velocity, altitude, overload). The problem consists in the search for the minimum beam structure weight and optimum distribution of strength material. Wing design must include a safety factor taking into account the effect of static loading in the case of maneuvering with maximum overload and the case of normalized wind gusts. Aeroelastic requirements must also be met, such as reversal and flutter stability. The search for optimum distribution of strength material is carried out by means of a method of steepest descent using penalty functions first introduced by Courant (1945-1946). P.T.H.

A74-36510 # **Effect of prior creep on durability of AK4-1-T1 alloy (Vliianie predvaritel'noi polzuchesti na vynoslivost' splava AK4-1-T1).** A. Z. Vorob'ev, S. I. Ol'kin, and V. N. Stebenev. *TsAGI, Uchenye Zapiski,* vol. 3, no. 2, 1972, p. 120-126. In Russian.

The fatigue characteristics of aluminum alloy test specimens were studied in a series of mechanical tests. The specimens were either cylindrical with a circumferential notch or flat with a central hole. Prior to testing they were exposed to prolonged elevated

temperatures under some kind of load in order to induce the effects of creep in them. It was shown that the effect of prior creep depends on a large number of factors, such as structural changes and the relaxation of process residual stresses caused by prolonged heat exposure, residual stresses which were formed in the stress concentration zone as a result of nonuniform creep deformation, cold hardening, or destruction of compactness. These factors, depending on their combined action, can either diminish or increase the fatigue strength of the material. P.T.H.

A74-36513 # Separation of a shock wave from the edge of a V-shaped backswept wing (Ob otsoedinenii skachka uplotneniia ot kromki strelovidnogo v-obraznogo kryla). Iu. I. Zaitsev and V. V. Keldysh. *TsAGI, Uchenye Zapiski*, vol. 3, no. ?, 1972, p. 135-139. In Russian.

It is shown that the boundary conditions on the wing downstream from its pointed leading edge determine both the intensity of an edge-attached shock wave and the time of its separation from a V-shaped backswept wing in a supersonic flow. It is also found that the separation of a shock wave from the leading edge occurs at larger angles of attack in backswept wings with a concave lower surface than in comparable flat swept wings. V.Z.

A74-36559 # A time-saving method for calculating subsonic flows at airfoils (O bystrom metode rascheta dozvukovogo techeniia okolo profilia). Iu. B. Lifshits and A. A. Shagaev. *TsAGI, Uchenye Zapiski*, vol. 3, no. 3, 1972, p. 12-17. 10 refs. In Russian.

Chaplygin used Karman's (1941) relation between pressure and density, and a certain form of the Bernoulli equation to describe a gas. A method is proposed for calculating the subsonic flow of a 'Chaplygin gas' past a symmetric airfoil. Some data obtained by the method are analyzed. V.P.

A74-36560 # Flow past a triangular wing with blunted edges in the case of strong compression in the shock layer (Obtekanie treugol'nogo kryla s zatuplennymi kromkami pri sil'nom szhatii v udarnom sloe). V. V. Mikhailov. *TsAGI, Uchenye Zapiski*, vol. 3, no. 3, 1972, p. 18-24. In Russian.

A74-36571 # The heat flux to a waverider of simple configuration and its L/D ratio (Aerodinamicheskoe kachestvo i teplovoi potok k volnoletu prosteishei formy). N. A. Davydova. *TsAGI, Uchenye Zapiski*, vol. 3, no. 3, 1972, p. 111-115. In Russian.

A lifting body with sharp leading edges, whose shape is derived from known flow fields (the stream surface behind a plane shock wave and the stream surface of unperturbed flow) is examined. The influence of the waverider's principal geometric parameters and of the freestream Mach and Reynolds numbers on the total heat flow to the craft and on the craft's L/D ratio is analyzed. The total heat flow is treated as the waverider's generalized heating characteristic that defines the weight of the heat shield or thermal insulation system. The graphs obtained can be used for determining the optimal geometric parameters when both the volume and the lifting area are given. V.P.

A74-36576 # Determination of the efficiency of the longitudinal control systems of an elastic flight vehicle (Ob opredelenii effektivnosti organov prodol'nogo upravleniia uprugogo letatel'nogo apparata). Iu. F. Laremchuk. *TsAGI, Uchenye Zapiski*, vol. 3, no. 3, 1972, p. 134-138. In Russian.

The quality of longitudinal control system performance is analyzed for an elastic flight vehicle which is performing a stabilized longitudinal maneuver. Expressions are obtained for the aerodynamic characteristics and control parameters of this vehicle as functions of the matrix elements of a system of equations describing its motion. V.Z.

A74-36584 Controls and displays for helicopter IFR operation - Pilot factor considerations. F. J. Winter, Jr. (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 825*. 7 p. Members, $1.50; nonmembers, $2.00.

A flight research effort has been established to investigate all aspects of helicopter instrument flight rule (IFR) operations ranging from lift-off, transition to cruise, approach, hover, and landing. The basic purpose is to evaluate recent developments in rotary wing instrument flight capability. These developments center around vehicle controllability through both control/display and stability augmentation systems. The configuration to be first evaluated was designed from the results documented by actual pilot performance during typical rotary wing IFR maneuvers. The maneuver profiles were designed and flown to record pilot activity and aircraft attitude. Several subject pilots flew the designed profiles to establish in what areas improvements were required. Each pilot's performance was then computerized to create a 'mean' value of pilot ability to perform prescribed tasks. The analysis of the data gathered determined in what areas pilot performance could most likely be improved through refined helicopter controls and displays. This configuration is currently being flown in two US Air Force TH-1F helicopters to interface the various avionic systems and establish pilot acceptability prior to operational suitability testing. (Author)

A74-36585 Helicopter vibration reduction with pendulum absorbers. R. B. Taylor and P. A. Teare (Boeing Vertol Co., Philadelphia, Pa.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 830*. 9 p. Members, $1.50; nonmembers, $2.00.

Review of the analytical and experimental results obtained in helicopter vibration control by means of rotor-blade-mounted pendulum absorbers. A significant vibration reduction is shown to have been achieved in this manner on a four-bladed tandem-rotor helicopter. The importance of pendulum tuning as well as the use of generalized coordinates to obtain reduction of vibratory loads are discussed. M.V.E.

A74-36586 * On the use of first order rotor dynamics in multiblade coordinates. K. H. Hohenemser and S. K. Yin (Washington University, St. Louis, Mo.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 831*. 15 p. 16 refs. Members, $1.50; nonmembers, $2.00. Contract No. NAS2-7613.

This paper is directed to the question of how to represent most efficiently rotor/body coupling in a linear flight dynamics analysis. Rigid body pitch, roll and vertical motions are considered for the rotor/body coupling studies. Flapping stability limits, eigenvalues, transient responses to control step inputs, to step gusts and to random gusts are determined for a hypothetical hingeless compound helicopter operating up to .8 advance ratio. Data are obtained for the basic helicopter and for the craft with two simple control feedback systems. While complete periodic system modeling is necessary for determining flapping stability limits and vibrations, constant system modeling using first order dynamics in each of the multiblade rotor coordinates was found to be adequate for rotor-craft stability and response computations. (Author)

A74-36588 Effect of blade design parameters on helicopter stall boundaries. R. H. Blackwell (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.) and P. H. Mirick (U.S. Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va.). *American Helicopter Society, Annual National V/STOL*

Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 833. 13 p. 10 refs. Members, $1.50; nonmembers, $2.00. Grant No. DAAJ02-72-C-0105.

An experimental and analytical study has determined the effects of blade structural design parameters on stall-related operating boundaries of helicopter main rotors. Emphasis was placed on the effects of blade properties on the buildup of vibratory control loads in stall. Two-dimensional oscillating airfoil tests and a series of blade aeroelastic response calculations were completed for a typical low-twist rotor blade with symmetric airfoil section. It was found that vibratory torsional moments were reduced by reducing torsional stiffness or torsional inertia and moving the blade aerodynamic center axis aft of the coincident elastic and center-of-gravity axis. In addition, increasing blade twist was found to reduce the control load stall speed at high rotor thrust coefficient to solidity ratios, but increase the rate of buildup of control loads with airspeed. (Author)

A74-36589 AH-56A /AMCS/ compound helicopter vibration reduction. W. D. Anderson and E. R. Wood (Lockheed-California Co., Burbank, Calif.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 834.* 10 p. 6 refs. Members, $1.50; nonmembers, $2.00. Grant No. DAAJ01-73-C-0286.

Problems encountered during initial flight tests of the Lockheed AH-56A helicopter led to design and development of an advanced mechanical control system. Flight tests of this new control system required reballasting of the helicopter to a configuration different from the basic AH-56A design due to installation of extensive instrumentation in the aircraft, and to the removal of major components of the armament, avionics, and weapon system. In initial flights of this configuration, vibration levels measured at high speeds were found to be totally unacceptable. Analytical and experimental efforts were systematically undertaken to reduce these levels to acceptable values. The methods incorporated to reduce the levels and the effects of various parameters on vibrations of a high-speed compound helicopter are described. Flight variables such as rotor speed, collective blade angle, roll rate, and maneuvering load factor are discussed. (Author)

A74-36590.* Aeroelastic-stability characteristics of a V/STOL tilt-rotor aircraft with hingeless blades - Correlation of analysis and test. H. R. Alexander, L. M. Hengen (Boeing Vertol Co., Philadelphia, Pa.), and J. A. Weiberg (NASA, Ames Research Center, Moffett Field, Calif.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 835.* 12 p. 7 refs. Members, $1.50; nonmembers, $2.00. Contracts No. NAS2-6505; No. NAS2-6598.

The potential aeroelastic problems of a tilt rotor aircraft are described. The type of mathematical model required to predict such behavior is discussed and results of a design study on a specific configuration are presented. The sensitivity of the results to variation of the structural parameters is evaluated. The methodology used for analytical studies is shown to predict accurately the behavior of a full-scale rotor-pylon-wing system tested in the NASA-Ames 40- by 80-foot wind tunnel. It is concluded that there is no impediment from an aeroelastic viewpoint in designing and flying a tilt-rotor aircraft using a soft-in-plane hingeless rotor. (Author)

A74-36591 Handling qualities evaluation of the XV-15 tilt rotor aircraft. R. L. Marr (Bell Helicopter Co., Fort Worth, Tex.) and W. E. B. Roderick (National Research Council, Flight Research Laboratory, Ottawa, Canada). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 840.* 14 p. 13 refs. Members, $1.50; nonmembers, $2.00.

Handling-quality evaluations of the XV-15 tilt rotor aircraft have used model testing, digital flight simulation, piloted moving-base simulation, and a variable-stability helicopter. Powered and unpowered wind tunnel model testing has delineated aircraft aerodynamics and rotor-airframe interference effects for use in a mathematical model. Proper simulation of visual cues and control system dynamics were found to be very important for correct interpretation of the aircraft characteristics. The Canadian NRC in-flight simulator in a Bell Model 205A-1 helicopter was used to compare the collective stick with an airplane throttle lever for controlling the height of the tilt rotor aircraft in helicopter mode. (Author)

A74-36592 An experimental investigation of STOL lateral-directional flying qualities and roll control power requirements using the variable stability X-22A aircraft. J. V. Lebacqz, R. C. Radford (Calspan Corp., Buffalo, N.Y.), and R. E. Smith (National Research Council, Ottawa, Canada). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 841.* 14 p. 16 refs. Members, $1.50; nonmembers, $2.00. Contract No. N00019-72-C-0417.

A74-36593 Rotor moment control with flap-moment feedback. A. J. Potthast and A. W. Kerr (Lockheed-California Co., Burbank, Calif.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 842.* 11 p. 11 refs. Members, $1.50; nonmembers, $2.00.

A simple single-degree-of-freedom model of a helicopter including the rotor, controls and body is defined and the basic response of the helicopter to cyclic inputs is examined. The problems associated with helicopter control are highlighted. A control system using integrated rotor flap-moment and body angular rate feedback which allows the utilization of the full capabilities of any type of rotor is described. The concept effectively isolates the undesirable variable aerodynamic characteristics of the rotor and makes the control of a helicopter independent of these rotor characteristics. This feature permits the handling qualities to be tailored completely independent of rotor characteristics. Rate feedback is used to replace normal rotor damping which has also been isolated from the body. The system provides the pilot with an aircraft with direct rate control and closely controls rotor transient loads and blade deflections. It also provides low gust response and low trim rotor moments. Examples of research and flight test experience using this concept are included. (Author)

A74-36594 Analysis, simulation, and piloted performance of advanced tandem-rotor helicopters in hover. R. P. Smith (U.S. Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va.), R. T. Lytwyn, and F. White (Boeing Vertol Co., Philadelphia, Pa.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 843.* 12 p. Members, $1.50; nonmembers, $2.00. Grant No. DAAJ02-72-C-0095.

In order to explore the potential parameters of possible future tandem-rotor helicopters, which are likely to affect aircraft performance during precise hover missions, four tandem-rotor helicopters, with the gross weight capabilities of 50,000, 80,000, 120,000, and 200,000 lb, were defined parametrically in sufficient detail to permit stability and control evaluation and piloted simulations. Automatic stabilization and hover hold functions were then synthesized for each configuration. Several command systems were established specifically for the piloted hover hold missions. The hover performance was established analytically, including hover hold capability in turbulence with automatic control functions alone and the piloted hover capability without automatic hold functions. The 50,000-lb configuration was utilized to generate similar performance results with the Northrop Corporation Large Amplitude Simulator/Wide Angle Visual System (LAS/WAVS). The simulator results were then directly compared with the analysis in order to establish the degree of validity of the selected analytical approaches. F.R.L.

A74-36595 Helicopter icing handling qualities. W. E. Griffith, II and L. K. Brewer (U.S. Army, Aviation Systems Test Activity, Edwards AFB, Calif.). *American Helicopter Society, An-*

nual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 844. 10 p. 13 refs. Members, $1.50; nonmembers, $2.00.

Reviewed helicopter icing test results show that deliberate flight into light icing conditions requires an adequate windshield anti-ice system for both pilot and copilot, an improved sensitive outside air temperature gage, and an ice-accumulation rate resulting in no loss of autorotational capability. In no event should flight be attempted at temperatures of -10 C and below when visible moisture is present, nor should flight be conducted in freezing rain pending further testing. M.V.E.

A74-36596 Fabrication of boron-hybrid swashplates. J. Jakubowski and A. Yankovoy (Boeing Vertol Co., Philadelphia, Pa.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 850.* 10 p. Members, $1.50; nonmembers, $2.00.

Description of the prototype production and subsequent fabrication method development for the high-modulus advanced composite rings to be used to reinforce the stationary and rotating swashplate assemblies of a heavy-lift helicopter. Special attention is given to the material selection, fabrication step sequence, and adhesive bonding development. M.V.E.

A74-36597 0-0-1% - Q. A. by objectives. J. M. Gooch (Bell Helicopter Co., Fort Worth, Tex.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 851.* 5 p. Members, $1.50; nonmembers, $2.00.

A special audit concept is presented that provides the objectives and feedback methods for independent quality assurance. This 0-0-1% audit scheme is shown to have proven to be a good management tool, one which makes possible an accurate judgment of the product performance of primary part producers. M.V.E.

A74-36598 Heat transfer modeling for curing process of composite rotor blade. T. L. Huang and A. A. Peterson (Boeing Vertol Co., Philadelphia, Pa.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 852.* 7 p. 6 refs. Members, $1.50; nonmembers, $2.00.

Heat transfer modeling offers a scientific methodology for thermal analysis of composite structure bonding assemblies. The heat transfer model can be used to predict temperature distribution during the curing process. This, in turn, permits selection of the optimum power density, distribution of the heaters, location of the sensors, and determination of the zoning control sequence for tooling design. (Author)

A74-36599 Processing of titanium tubes - An approach to helicopter blade spar manufacturing. S. M. Silverstein (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 853.* 18 p. Members, $1.50; nonmembers, $2.00.

Description of the fabrication of a high-performance rotor blade for CH-53 helicopters. The blade consists essentially of a one-piece 32-foot long titanium spar structure, a fiberglass skin, and a reinforced plastic honeycomb core. The spar is made of annealed titanium 6Al-4V tapered thickness sheet, which is fabricated into a cylindrical shape by cold brake forming. The cylindrical preform is joined to a tube shape by longitudinal butt plasma arc welding. A forged titanium 6Al-4V flange is friction-welded to the root end of the welded tube to complete the one-piece spar construction. The tube assembly is simultaneously hot-formed and annealed to its desired airfoil shape in a ceramic die. Shot peening and a surface pretreatment for subsequent bonding of fiberglass components complete the titanium spar fabrication cycle. (Author)

A74-36600 Helicopter reliability testing. T. L. House (U.S. Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 860.* 14 p. Members, $1.50; nonmembers, $2.00.

Review of the technical and management issues related to helicopter reliability development testing. Special attention is given to the impact of reliability on life cycle cost, and how issues such as fleet size, program schedule, and test technique effectiveness contribute to decisions regarding development test requirements. The risk of errors in judgments is also discussed. M.V.E.

A74-36604 UTTAS flight test - Real-time data analysis. D. L. Marshall and H. H. Steinmann (Boeing Vertol Co., Philadelphia, Pa.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 864.* 9 p. Members, $1.50; nonmembers, $2.00.

The Boeing Vertol Company's helicopter for the U.S. Army Utility Tactical Transport Aircraft System (UTTAS) competition will be flight-tested at Grumman Aerospace Corporation's facility at Calverton, Long Island. The Grumman Automated Telemetry System (ATS) will be used to expedite UTTAS qualification testing with minimum risk by providing on-line analysis of measured data. This paper discusses the special application software developed for helicopter testing with the ATS, which has heretofore been used only for flight test of fixed-wing aircraft. The software is designed to provide timely engineering analysis of test measurements in order to minimize flight-safety risks, aircraft turn-around time, repeat testing, and developmental problem delays. The analyses include structural, dynamic, aerodynamic, and aircraft-system considerations. Selected samples of real-time analytical displays generated on the ATS are included. (Author)

A74-36605 Heavy-lift helicopter engine control system. J. R. Alwang (Boeing Vertol Co., Philadelphia, Pa.) and R. D. McLain (General Motors Corp.; Detroit Diesel Allison Div., Indianapolis, Ind.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 870.* 12 p. Members, $1.50; nonmembers, $2.00.

The Heavy-Lift Helicopter is planned as a component of a U.S. Army logistics system with the primary mission of picking up and delivering a 22.5-ton external payload. The control aspects of the XT701-AD-700 engines for the Heavy-Lift Helicopter are described. Control system requirements as related to the air/vehicle interface are discussed with emphasis on the engine control fly-by-wire concept, mission objectives, and system response. A description of the major engine control components is given, and particular airframe integration efforts are discussed. A brief review of the dynamic analysis and representative results are presented. (Author)

A74-36606 The impact of advanced turboshaft engine technology on T700-powered helicopter systems. L. B. Veno (General Electric Co., Aircraft Engine Group, Lynn, Mass.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 871.* 8 p. 5 refs. Members, $1.50; nonmembers, $2.00.

The General Electric T700-GE-700 turboshaft engine currently under development by the U.S. Army for UTTAS (Utility Tactical Transport Aircraft System) and AAH (Advanced Attack Helicopter) represents a new generation of advanced technology engines in the 1500 horsepower class. How such an engine will provide notable improvements in performance, operation, and economy for this new generation of VTOL vehicles is described. A combination of the UTTAS and AAH helicopters illustrates these improvements. The T700 is a simple engine when compared to preceding turboshaft engines which manufacturers have produced in this horsepower class. Only five axial compressor stages and one centrifugal stage are necessary to achieve a pressure ratio higher than today's generation of engines. F.R.L.

A74-36607 **Small Turbine Advanced Gas Generators for future engine requirements.** E. T. Johnson and G. A. Elliott (U.S. Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 872.* 12 p. 7 refs. Members, $1.50; nonmembers, $2.00.

The purpose of the Small Turbine Advanced Gas Generator (STAGG) program is to provide the core gas generator technology base for future small gas turbine engine programs for the Department of Defense as well as the Army. STAGG is a core gas generator (gas producer) with the compressor, combustor, turbine, and bearings and seals as prime interest areas. Four contracts have been awarded, two in the 1-2 lb/sec airflow size and two in the 3-5 lb/sec airflow size. The general characteristics of these four generators are summarized, including schematic diagrams and photographs of some of the components and configurations. P.T.H.

A74-36609 **Digital computer techniques for engine/airframe simulation.** D. V. Lewis (Boeing Vertol Co., Philadelphia, Pa.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 874.* 10 p. 6 refs. Members, $1.50; nonmembers, $2.00.

Techniques for development of mathematical models of helicopter rotor and drive systems from representations similar to those proposed by ARP704 are explained from application of F = ma equations to model presentation in the form of functional block diagrams. Mechanization of mathematical models into digital computer simulations with the Z-transform theory is described; a discussion of the analysis and development of Z-transform theory for digital simulations is also presented. Methods for performing frequency-response analysis and evaluation of engine/airframe torsional stability by both classical and simulation techniques are provided. Stability evaluations of nonlinear systems using simulation techniques are included, from the modeling of nonlinearities through the analysis of simulation data. (Author)

A74-36610 * **Application of advanced composites to helicopter airframe structures.** M. J. Rich, G. F. Ridgley, and D. W. Lowry (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 880.* 9 p. Members, $1.50; nonmembers, $2.00. Contract No. NAS1-11688.

The present work outlines a study whose objective was to assess the possible use of advanced composite materials to helicopter fuselage structure. The study used the CH-53D as a baseline design for comparison of composite with current conventional construction. Boron/epoxy and graphite/epoxy appeared to be the prime candidate materials for the major portion of the primary structure, while Kevlar-49/epoxy was the prime candidate material for secondary structure. A single-laminate shear-carrying skin combined with stringers and frames in an all-molded construction was considered the most promising concept for the airframe shell construction; foam-stabilized graphite/epoxy stringer was considered the prime concept for stringer construction. Shell construction and assembly concepts are discussed, and comparison of weight and material between current CH-53D airframe and the composite airframe shows that the latter may represent an 18% weight saving. Based on a fleet requirement of 600 vehicles, the operating cost for a fleet of helicopters constructed with the composite material airframe flying 500 hours a year per aircraft over a ten-year service life was calculated, indicating a $337,000 saving per helicopter. P.T.H.

A74-36611 **The application of fracture mechanics to the design of damage-tolerant components for the UTTAS helicopter.** W. L. Weiss and J. C. Zola (Boeing Vertol Co., Philadelphia, Pa.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 882.* 11 p. 5 refs. Members, $1.50; nonmembers, $2.00.

Implementation of the damage-tolerance criterion relied heavily on the technology of fracture mechanics. This technology was used in conducting material tradeoff studies, providing estimates of crack-growth characteristics for sizing components, and establishing procedures for bench tests to check compliance of components with damage-tolerance criteria. Two fracture-mechanics-based techniques, in particular, were widely used to achieve damage tolerance. One technique used the approach of designing a component to prevent damage of a given size from growing under operational loads. This led to the concept of a fatigue-crack-growth threshold, which is a function of stress level and crack size. The other technique consisted of designing a component so that damage growth is limited to noncatastrophic proportions. These techniques entered directly in the design of more than 10 critical dynamic-system components for the YUH-61A helicopter. It is concluded that fracture mechanics provides a valuable tool for the design of damage-tolerant structure. F.R.L.

A74-36613 **Composite material geodesic structures - A structural-concept for increased helicopter rotor blade survivability.** S. Pociluyko, I. E. Figge (U.S. Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va.), C. F. Griffin, and L. Blad (Lockheed-California Co., Burbank, Calif.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 884.* 9 p. 7 refs. Members, $1.50; nonmembers, $2.00.

Research conducted to determine the feasibility of using composite material geodesic structures to increase the survivability of helicopter main rotor blades is described. An analytical structural characterization was conducted to determine the effects of geometry and materials on the strength and stiffness of geodesic panels. The results of this study indicate that a grid pattern with intermediate modulus graphite/epoxy elements oriented at 0 deg, plus or minus 30 deg, and 90 deg offers the best combination of shear stiffness, longitudinal tensile strength, and longitudinal tensile stiffness for use on a rotor blade. The results of static tensile tests on panels and elements were lower than predicted. It appears that fiber wrinkles in the nodal regions had a detrimental effect on the mechanical behavior of the structure. (Author)

A74-36614 * **Laser velocimeter measurements of the helicopter rotor-induced flow field.** J. C. Biggers and K. L. Orloff (NASA, Ames Research Center, Moffett Field, Calif.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 800.* 8 p. 21 refs. Members, $1.50; nonmembers, $2.00.

The use of a two-color laser velocimeter to measure the flow velocities in the wake of a helicopter rotor is discussed, including methods for obtaining two components of both instantaneous and time-averaged velocities. Results are presented from an experiment using a 2.13 m diameter model helicopter rotor operating at a tip speed ratio of 0.18 in a wind tunnel. The location of the tip vortex from the preceding blade was determined on the advancing side, and the diameter of the vortex core was found to be 15 percent of the blade chord (1.5 percent of the radius). The effects of the airfoil's bound vorticity were observed in the velocity distributions very near the blade. These effects suggest that the laser velocimeter may be used to determine the aerodynamic loading (circulation) at a spanwise station on the blade. Also, the structure and boundary of the time-averaged wake were investigated. (Author)

A74-36615 * **The prediction of rotor rotational noise using measured fluctuating blade loads.** R. N. Hosier (U.S. Army, Air Mobility Research and Development Laboratory, Hampton, Va.), R. J. Pegg (NASA, Langley Research Center, Hampton, Va.), and R. Ramakrishnan. *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 801.* 14 p. 8 refs.

In tests conducted at the NASA Langley Research Center

Helicopter Rotor Test Facility, simultaneous measurements of the high-frequency fluctuating aerodynamic blade loads and far-field radiated noise were made on a full-scale, nontranslating rotor system. After their characteristics were determined, the measured blade loads were used in an existing theory to predict the far-field rotational noise. A comparison of the calculated and measured rotational noise is presented with specific attention given to the effect of blade loading coefficients, chordwise loading distributions, blade loading phases, and observer azimuthal position on the predictions. (Author)

A74-36616 Tail-rotor thrust on a 5.5-foot helicopter model in ground effect. R. W. Empey and R. A. Ormiston (U.S. Army, Air Mobility Research and Development Laboratory, Moffett Field, Calif.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 802.* 14 p. 8 refs. Members, $1.50; nonmembers, $2.00.

Wind-tunnel experiments were conducted to investigate tail-rotor performance for flight conditions in ground effect where helicopter directional control deficiencies have been experienced. Tail-rotor thrust was measured on a small-scale helicopter model for various wind speeds and azimuths. For a main-rotor height/diameter ratio of 0.265, the largest thrust reductions occur when (1) the tail rotor rotates in the direction where the top blade moves forward, (2) wind speeds are above 15 knots, and (3) wind azimuths are between 50 and 180 deg. Opposite rotation of the tail rotor eliminates most of the adverse interference effects of the main rotor. Flow visualization with neutrally buoyant helium bubbles revealed a small, well-defined ground vortex core at moderate and high wind velocities. Interpretation of the measured data showed that the ground vortex and trailing vortex systems of the main-rotor flowfield produced tail-rotor thrust perturbations that are due to rotational and axial interference with the tail rotor. (Author)

A74-36617 Can helicopter rotors be designed for low noise and high performance. D. R. Clark (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 803.* 12 p. 10 refs. Members, $1.50; nonmembers, $2.00.

The development of the use of wake modeling methods for the prediction hovering rotor airloads is followed from the rigorous but time consuming Free Wake approach to the more practical Prescribed Wake methods. The generalization of available wake flow visualization data taken at model scale and its application to the full scale problem is traced in detail. The correlation of the method as used to calculate the performance of a wide range of rotors is established and its use in the design of a family of rotors with improved performance is described. The role of the tip vortex from the preceding blade in the performance and noise generation processes is explored and several possible noise producing mechanisms are suggested. The fact that low noise and good performance are not necessarily mutually exclusive goals is demonstrated. The answer to the title question, it is concluded, is 'yes'. Rotors can be designed for high performance and low noise. (Author)

A74-36618 A systematic study of helicopter rotor stall using model rotors. A. J. Landgrebe and E. D. Bellinger (United Aircraft Research Laboratories, East Hartford, Conn.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 804.* 15 p. 7 refs. Members, $1.50; nonmembers, $2.00. Grant No. DAAJ02-72-C-0030.

A wind tunnel test was conducted to systematically determine the effects of twist, camber, taper ratio, number of blades, and torsional frequency on model helicopter rotor stall characteristics. Model rotor performance, blade response, and boundary layer separation data were acquired at low Reynolds and Mach numbers to determine the occurrence and extent of blade stall. Boundary layer information was obtained by means of hot-film gages installed over the outer 25% span on the suction surface of two blade designs. The data obtained indicated consistently the azimuthal, chordwise, and radial location of stall onset and recovery and the laminar/turbulent transition of the boundary layer. Based on the average of these stall indicators, the effects of the various design parameters on stall were determined for advance ratios of 0.15, 0.30, and 0.45. (Author)

A74-36619 Design to cost at work for helicopter systems. L. J. Marchinski (Boeing Vertol Co., Philadelphia, Pa.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 810.* 11 p. Members, $1.50; nonmembers, $2.00.

Description of an ongoing design-to-cost program currently applied to the design of helicopter systems. The program involves limiting requirements to mission essentials, controlling sophistication, identifying high-cost designs, increasing standardization, incorporating design to cost as a discipline consistent with dynamics and stress, and providing the designer with guideline bogeys and the tools by which he can attain the bogeys. Examples of simplified designs with parts-count reduction are presented. M.V.E.

A74-36620 Improved cost effectiveness of helicopters through a two-point design criterion. A. Plaks, R. F. Metzger, R. C. Meier (Kaman Aerospace Corp., Bloomfield, Conn.), and H. I. MacDonald (U.S. Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 811.* 11 p. 5 refs. Members, $1.50; nonmembers, $2.00. Grant No. DAAJ02-72-C-0064.

A method was developed for determining the most cost effective second-design point. The method uses a series of mathematical models which include performance relationships, mission analysis, statistical and analytical weight predictions, mission effectiveness (including payload utilization data and environmental statistics), and fixed and operating cost estimation. First a helicopter is sized to meet primary mission requirements. Then by the use of an analytical weight model the helicopter is grown to meet the selected second-design point requirements, and the cost effectiveness of the resulting design is determined. The repetition of these calculations for several second-design points leads to the determination of the most cost effective second-design point. The method is applied to a utility type helicopter, with substantial improvement in cost effectiveness. F.R.L.

A74-36621 The scissors rotor. W. G. O. Sonneborn and J. M. Drees (Bell Helicopter Co., Fort Worth, Tex.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 812.* 14 p. 15 refs. Members, $1.50; nonmembers, $2.00.

The results of an evaluation of a four-bladed scissors rotor performed in model and full-scale tests are reported. Flight speeds over 150 knots were reached and high maneuvers over two g's. The results include the finding that the scissors rotor offers considerable weight savings over symmetrical in-plane stiff multibladers, but will be heavier than soft-in-plane and two-bladed rotors. M.V.E.

A74-36622 Hingeless circulation control rotor blade design. P. H. Kesling and J. Schmidt (Lockheed-California Co., Burbank, Calif.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 813.* 7 p. 12 refs. Members, $1.50; nonmembers, $2.00. Navy-supported research.

The investigation reported was conducted in connection with studies concerning the modifications in helicopter design required for the development of a circulation control rotor (CCR) helicopter. Questions regarding the CCR blade design process are considered along with aerodynamic criteria and structural design criteria. The major conclusions reached in the investigation are listed. The CCR

blade loading can and should be higher than that used for conventional airfoil blades. The CCR rotor blade must be made very stiff to realize the potential advantages of increased performance. G.R.

A74-36623 **Hybrid aircraft for heavy lift.** J. B. Nichols and D. B. Doolittle (All American Engineering Co., Wilmington, Del.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 814.* 11 p. Members, $1.50; nonmembers, $2.00.

Although airplane payloads have been attained suitable for most requirements, the same cannot be said about helicopters, whose payload capabilities lag far behind the needs represented by many useful purposes. By combining lighter-than-air (LTA) elements with helicopter elements in a hybrid configuration, it is possible to provide a highly maneuverable, heavy lift crane of almost unlimited payload capacity. The availability of such a tool to the construction, logging, mining, and transport industries would result in the development of entirely new techniques and introduce economies impossible to attain with present methods. F.R.L.

A74-36626 **Helicopter command instrument systems.** J. F. Hatcher (U.S. Army, Flight Standards and Qualification Div., St. Louis, Mo.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 822.* 7 p. 5 refs. Members, $1.50; nonmembers, $2.00.

The direct application of fixed wing systems to helicopters has proven inadequate, resulting in a command system designed uniquely for helicopters. The importance of a command instrument system is twofold: (1) the increased emphasis on helicopter IFR flight, and (2) the expanded flight envelope of helicopters in the steep angle approach regime. In both applications, the command instrument system improves flight path accuracy while reducing pilot workload. This enables the maximum utilization of the helicopter in the vertical plane for which it is best suited. F.R.L.

A74-36627 **U.S. Navy VTOL automatic landing system development program.** R. S. Buffum, R. W. Huff, and G. L. Keyser (U.S. Navy, Flight Test Div., Patuxent River, Md.). *American Helicopter Society, Annual National V/STOL Forum, 30th, Washington, D.C., May 7-9, 1974, Preprint 823.* 9 p. Members, $1.50; nonmembers, $2.00.

Description of HOVVAC (Hovering Vehicle Versatile Automatic Control), a research and development automatic flight control system which is being utilized to develop the requirements for VTOL automatic approach, hover, and landing. The test program to date includes system definition of the vehicle dynamics via a sine wave forcing function method. Curved and straight path approaches have been controlled by an airborne digital computer in a simulated microwave landing system environment. M.V.E.

A74-36630 # **Contribution to the theory of the sonic flow past a profile (K teorii obtekaniia profilia zvukovym potokom).** S. G. Ignat'ev and Iu. B. Lifshits. *TsAGI, Uchenye Zapiski,* vol. 3, no. 4, 1972, p. 9-13. 6 refs. In Russian.

An empirical formula is derived which relates the pressure to the local angle of slope of the velocity vector at the trailing edge of an airfoil situated in a sonic stream. The formula is used to determine the optimum trailing-edge configuration of the airfoil. V.P.

A74-36631 # **Effect of the body of a helicopter of single-prop or coaxial design on the optimal configuration of the main-rotor blades for hover-flight conditions (Vliianie korpusa vertoleta odnovintovoi ili soosnoi skhemy na optimal'nuiu dlia rezhima visseniia formu lopastei nesushchego vinta).** L. S. Vil'dgrube. *TsAGI, Uchenye Zapiski,* vol. 3, no. 4, 1972, p. 14-21. In Russian.

A74-36632 # **Investigation of the influence of vortex generators on turbulent boundary layer separation (Issledovanie vliianiia generatorov vikhrei na otryv turbulentnogo pogranichnogo sloia).** V. M. Gadetskii, Ia. M. Serebriiskii, and V. M. Fomin. *TsAGI, Uchenye Zapiski, vol.* 3, no. 4, 1972, p. 22-28. In Russian.

The influence of a parallel system and a diffusor-type system of vortex generators on the position of the shock wave on the airfoil profile is studied experimentally. Data showing the superiority of a parallel system of vortex generators mounted at an angle of 20 deg to the oncoming flow over a system of diffusers mounted pairwise on the airfoil are presented. V.P.

A74-36634 # **Optimally fast-acting control of aircraft roll in the presence of constraints on the angle of aileron deflection and the deflection rate (Optimal'noe po bystrodeistviiu upravlenie samoletom po krenu pri nalichii ogranichenii na velichinu ugla i skorost' otkloneniia eleronov).** V. A. Bobtsov and G. E. Kuzmak. *TsAGI, Uchenye Zapiski,* vol. 3, no. 4, 1972, p. 37-48. In Russian.

Optimally fast-acting roll control is studied on the basis of an equation describing the isolated rolling motion. It is shown that for the constraints under consideration, the design of optimally fast-acting control is equivalent to that of a control which ensures at any moment of time the maximum possible angular rate of roll. This result makes it possible to identify all optimum control modes and to determine their regions of existence. A solution of the corresponding variational problem is obtained by introducing dimensionless parameters. V.P.

A74-36635 # **Dynamic model of a parachute and determination of its characteristics (O dinamicheskoi modeli parashiuta i opredelenii ego kharakteristik).** A. G. Blushgens and A. A. Shilov. *TsAGI, Uchenye Zapiski,* vol. 3, no. 4, 1972, p. 49-58. 7 refs. In Russian.

Equations describing the plane motions of a parachute of specified geometry are derived with allowance for the influence of the virtual air masses. An analysis of the equations leads to formulas for converting parachute parameters and characteristics to correspond with the behavior of the system's center of mass. A frequency analysis method is proposed for determining the aerodynamic and dynamic parameters required in the linear analysis of parachute stability. V.P.

A74-36645 # **Approximate optimal control of the banking angle in the problem of hypersonic vehicle return (Priblizhennoe optimal'noe upravlenie uglom krena v zadache vozvrashcheniia giperzvukovykh apparatov).** V. T. Pashintsev. *TsAGI, Uchenye Zapiski,* vol. 3, no. 4, 1972, p. 136-144. 5 refs. In Russian.

The path of a controlled hypersonic vehicle to an assigned landing site during a passive travel through the atmosphere is analyzed. A convenient recording system is proposed for the selection of an optimal banking angle during maneuvering in the atmosphere, with some optimal control characteristics given in explicit form. A simplified banking angle control program is developed by an approximate qualitative analysis of optimal banking angle control. The program is described by a function of time-variable phase coordinates and a certain variable parameter. V.Z.

A74-36646 # **Estimation of the effect of unsteadiness in calculating flutter in aircraft with small aspect ratio wings in an incompressible flow (Otsenka vliianiia nestatsionarnosti v raschete na flatter samoletov s krylom malogo udlineniia v neszhimaemom potoke).** E. N. Nabiullin. *TsAGI, Uchenye Zapiski,* vol. 3, no. 4, 1972, p. 145-148. In Russian.

A74-36649 # **Reproduction of interactions between aerodynamic loads and deformation in the strength analysis of structures (Vosproizvedenie vzaimodeistviia aerodinamicheskikh nagruzok i deformatsii konstruktsii pri ispytaniiakh na prochnost').** L. G. Ziabrev and P. V. Miodushevskii. *TsAGI, Uchenye Zapiski,* vol. 3, no. 4, 1972, p. 158-163. In Russian.

Description of an assembly for automatically controlled strength tests on aircraft structural components under combined action of aerodynamic loads and associated strains. An analog computer is used in the assembly for programmed testing with various combinations of interdependent aerodynamic loads and deformations. Good agreement was obtained between test results and calculations. V.Z.

A74-36657 Aircraft accident data recording systems: System evaluation and data recovery. R. G. Feltham. Research sponsored by the Department of Trade and Industry. London, Her Majesty's Stationery Office, 1973. 104 p. 53 refs. $4.20.

An introduction is provided to the current practice of in-flight data acquisition for the purpose of aircraft accident investigation, and the historical background and the present and probable future requirements in this field are surveyed. An attempt is made to develop, as a main objective, an overall systems engineering approach to the problems of accident data recording and data recovery, and the many areas in which proper evaluation of the system is necessary if the high accuracy standards and high confidence levels essential to this type of data acquisition are to be achieved are examined. Past shortcomings in regulatory standards and in system installation, operation, and maintenance are highlighted and the possible limitations of data recovered from present systems are emphasized. F.R.L.

A74-36791 # **Index of the relative technical perfection level of long-range aircraft jet engines (Pokazatel' otnositel'nogo urovnia tekhnicheskogo sovershenstva vozdushno-reaktivnogo dvigatelia dlia dal'nikh samoletov).** L. M. Shkadov. *TsAGI, Uchenye Zapiski,* vol. 3, no. 5, 1972, p. 47-53. In Russian.

The analysis is performed for a class of engines defined by the following set of characteristics: the engine diameter and weight, the take-off thrust, the cruising thrust reduced to 11,000 m, and the specific fuel consumption under these conditions. The best engine for a given airframe is the one that provides maximum range at equal take-off distance. The rational engine dimensions for a given airframe and the engine's perfection level are evaluated under the assumption that the engine's cruising mode (turbine inlet and outlet gas temperatures, the rpm's, the compression ratio of the compressor, etc.) is fixed, and only the engine diameter, weight, and thrust may be varied. V.P.

A74-36799 # **Consideration of the effect of the fuselage of a two-rotor helicopter of the transverse or longitudinal type when determining the optimal rotor blade configuration for hovering (Uchet vliianiia korpusa dvukhvintovogo vertoleta poperechnoi ili prodol'noi skhemy pri opredelenii optimal'noi dlia rezhima viseniia komponovki lopastei nesushchikh vintov).** L. S. Vil'dgrube. *TsAGI, Uchenye Zapiski,* vol. 3, no. 5, 1972, p. 88-95. In Russian.

A74-36803 # **Some problems of the multi-point excitation technique in the experimental study of the vibrations of elastic structures (Nekotorye voprosy metodiki mnogotochechnogo vozbuzhdeniia pri eksperimental'nom issledovanii kolebanii uprugikh konstruktsii).** V. I. Smyslov. *TsAGI, Uchenye Zapiski,* vol. 3, no. 5, 1972, p. 110-118. 7 refs. In Russian.

A74-36804 # **Calculation of the loads and strains on a swept wing with mechanical analog devices (O raschete nagruzok i deformatsii strelovidnogo kryla s pomoshch'iu mekhanicheskikh analogovykh priborov).** B. L. Merkulov. *TsAGI, Uchenye Zapiski,* vol. 3, no. 5, 1972, p. 119-123. In Russian.

A74-36805 # **Determining the scale of rigidity and estimating the degree of nonsimilarity of elastic models of wings with a low aspect ratio (Opredelenie masshtaba zhestkosti i otsenka stepeni nepodobiia uprugikh modelei kryl'ev malogo udlineniia).** V. V. Egorov. *TsAGI, Uchenye Zapiski,* vol. 3, no. 5, 1972, p. 124-126. In Russian.

A74-36814 # **An index of the relative level of technical perfection of an airframe (Pokazatel' otnositel'nogo urovnia tekhnicheskogo sovershenstva planera samoleta).** L. M. Shkadov. *TsAGI, Uchenye Zapiski,* vol. 3, no. 6, 1972, p. 88-93. In Russian.

Consideration of the possibility of using the flight range attainable for a predetermined takeoff run as an index for comparing the level of perfection of the airframes of transport aircraft. The problem of determining the optimal throttled regime of operation of an engine of fixed size and given throttle characteristic during a change in the airframe parameters is considered, as well as the effect of the airframe characteristics on the maneuvering characteristics of the aircraft. Indices of relative perfection are presented for aircraft whose main flight regime is range flight and for maneuvering aircraft. A.B.K.

A74-36815 # **Method of calculating the nonstationary aerodynamic loads on a thin wing of finite aspect ratio undergoing elastic harmonic vibrations in subsonic flow (Metod rascheta nestatsionarnykh aerodinamicheskikh nagruzok na tonkoe krylo konechnogo udlineniia, sovershaiushchee uprugie garmonicheskie kolebaniia v dozvukovom potoke).** E. N. Nabiullin. *TsAGI, Uchenye Zapiski,* vol. 3, no. 6, 1972, p. 94-100. 7 refs. In Russian.

A74-36816 # **The stress concentration in a stretched plate reinforced by a central belt and having an aperture (O kontsentratsii napriazhenii v rastianutoi plastine s otverstiem, podkreplennoi tsentral'nym poiasom).** V. I. Grishin. *TsAGI, Uchenye Zapiski,* vol. 3, no. 6, 1972, p. 101-106. In Russian.

A74-36818 # **Calculation of the surface of a minimum-drag wing with a shock-free leading edge (Raschet poverkhnosti kryla minimal'nogo soprotivleniia s bezudarnoi perednei kromkoi).** T. D. Proshina. *TsAGI, Uchenye Zapiski,* vol. 3, no. 6, 1972, p. 112-118. In Russian.

Consideration of the problem of calculating the surface configuration on an infinitely thin lifting wing with shock-free leading edges in a supersonic flow from a given potential distribution. The potential is taken in the form of a certain polynomial which ensures shock-free flow past the leading edge, while the coefficients of the polynomial are determined from the conditions of minimum wing drag for a given lifting force. Calculations can be performed for wings with a swept-back leading edge with discontinuities and a supersonic trailing edge. By way of example, calculations are presented for a delta wing with a subsonic leading edge for polynomials with various numbers of terms. A.B.K.

A74-36826 # **Calculation of transonic gas flows past axisymmetric bodies and lifting wing profiles (Raschet obtekaniia osesimmetrichnykh tel i nesushchikh krylovykh profilei transzvukovym potokom gaza).** A. S. Fonarev. *TsAGI, Uchenye Zapiski,* vol. 4, no. 3, 1973, p. 1-10. 17 refs. In Russian.

Godunov's finite difference method (1959) is applied to calculate the parameters of transonic gas flows about axisymmetric bodies and lifting wing surfaces of various types. The results of calculations are given for a cylindrical body with a spherically blunted nose, a cylinder with a flat end surface, and two different types of wing profiles at different angles of attack with Mach numbers from 0.7 to 1.3. V.Z.

A74-36827 # **Numerical method of calculating the aerodynamic characteristics of cambered and uncambered wings in supersonic flow (Chislennyi metod rascheta aerodinamicheskikh kharakteristik ploskikh i neploskikh kryl'ev v sverkhzvukovom potoke).** A. G. Zakharov. *TsAGI, Uchenye Zapiski,* vol. 4, no. 3, 1973, p.11-15. In Russian.

A74-36834 # **Buckling of rods under creep conditions (Vypuchivanie sterzhnei v usloviiakh polzuchesti).** V. F. Galkin. *TsAGI, Uchenye Zapiski,* vol. 4, no. 3, 1973, p. 66-72. 5 refs. In Russian.

Consideration of the problem of determining the time-variable stress and strain state of a compressed rod of rectangular cross section with an initial deflection under creep conditions. A method of solution is proposed which is based on a nonlinear formulation of a variational theorem due to Sanders et al. (1965) for the rates of change in the stresses and strains. A procedure for creep-testing homogeneous rods of rectangular cross section which are hinged at both ends and are compressed by an axial force is outlined. The results of calculations by this procedure are compared with experimental results. A.B.K.

A74-36839 # **Interference of a sweptback wing and the fuselage at transonic speeds (Interferentsiia strelovidnogo kryla i korpusa pri okolozvukovykh skorostiakh).** L. A. Potapova. *TsAGI, Uchenye Zapiski,* vol. 4, no. 3, 1973, p. 101-104. In Russian.

Calculation results are presented for the interference of a flat sweptback wing and a cylindrical fuselage at transonic speeds and small angles of attack. A random law of spanwise load distribution is used. Results are graphically presented and compared with experimental data. P.T.H.

A74-36864 # **Optimal configuration of the rotor blades of a single-rotor helicopter during horizontal flight (Optimal'naia komponovka lopastei nesushchego vinta odnovintovogo vertoleta dlia rezhimov poleta s gorizontal'noi skorost'iu).** L. S. Vil'dgrube. *TsAGI, Uchenye Zapiski,* vol. 4, no. 4, 1973, p. 92-98. In Russian.

A74-36906 **Implementation of grease lubrication into U.S. Army helicopter tail rotor gearboxes - Preliminary results.** F. Ho (U.S. Army, Aviation Systems Command, St. Louis, Mo.). *(American Society of Lubrication Engineers, Annual Meeting, 28th, Chicago, Ill., Apr. 30-May 3, 1973.) Lubrication Engineering,* vol. 30, July 1974, p. 351-353.

A discussion is given for an Army program aimed at implementing Military Specification MIL-G-83363 Grease into OH-6 and OH-58 helicopter tail rotor gearboxes. Results are given for the first phase of the testing. The results of the first phase indicate that the entire program will ultimately be a success. The success of this program may lead to the implementation of the grease into all U.S. Army helicopter transmissions and gearboxes. (Author)

A74-36941 **The good and bad usages of air transport (Des bons et des mauvais usages du transport aérien).** M. Wolkowitsch (Aix-Marseille, Université, Marseille, France). *Revue Générale de l'Air et de l'Espace,* vol. 37, no. 1, 1974, p. 7-17. In French.

The present work advocates that, especially in view of the fuel crisis and rising prices in air transport, plans for expanding air services to remoter regions and for short-haul purposes be reconsidered. Rather, it would be best to continue improving the quality of air service for those routes where its advantages over other means of transport are undeniable, and to restrain the proliferation of air service where its existence is not absolutely necessary and where the development or improvement of rail transportation, for example, would be more sane and economical. P.T.H.

A74-37049 **Dynamic behaviour of cylinder with spring and concentrated mass collided with rigid body.** S. Suzuki (Nagoya University, Nagoya, Japan). *Ingenieur-Archiv,* vol. 43, no. 4, 1974, p. 215-221.

The dynamic behavior of a cylinder is investigated for the case where it collides with a rigid body with constant velocity. Spring and concentrated mass are attached to both ends of the cylinder. The relationships between the dimensions of cylinder and spring and the maximum values of dynamic stresses are obtained. Dynamic behavior of the spring is also taken into consideration. The fundamental equations of oscillation are solved by the Laplace transformation method. From the results of theoretical analysis, it became evident that impulsive stresses are damped considerably by the spring. (Author)

A74-37053 **Discrete tones of isolated airfoils.** C. K. W. Tam (Florida State University, Tallahassee, Fla.). *Acoustical Society of America, Journal,* vol. 55, June 1974, p. 1173-1177. 11 refs. NSF Grant No. GK-35790.

Recent experimental measurements reveal that discrete tones are emitted by isolated airfoils under certain operating conditions. Arguments are presented that these tones are unrelated to vortex shedding processes as has been suggested. It is proposed that the tones are generated by a self-excited feedback loop of aerodynamic origin. The loop consists of large-scale unstable disturbances in the boundary layer and wake flow and the feedback acoustic waves. Quantitative deductions based on the feedback loop model compare favorably with experimental measurements. It is also found that the proposed model is consistent with the observed characteristic features associated with the discrete tone phenomena. (Author)

A74-37061 **Reply to criticisms by V. E. Callaway of papers MM1 and MM11 at the 86th Meeting of the ASA.** S. R. Lane (California, University, Los Angeles, Calif.). *Acoustical Society of America, Journal,* vol. 55, June 1974, p. 1346-1348. 20 refs.

A74-37138 # **Interaction between an overexpanded gas jet and a flat obstacle (Vzaimodeistvie pererasshirennoi strui gaza s ploskoi pregradoi).** A. V. Antsupov, V. I. Blagosklonov, and V. G. Pimshtein. *TsAGI, Uchenye Zapiski,* vol. 4, no. 1, 1973, p. 84-87. 6 refs. In Russian.

A74-37143 # **Flow patterns of fuselage-wing models at supercritical angles of attack (Spektry obtekaniia modeli kombinatsii fiuzeliazh-krylo na zakriticheskikh uglakh ataki).** G. I. Golovatiuk and Ia. I. Teteriukov. *TsAGI, Uchenye Zapiski,* vol. 4, no. 1, 1973, p. 109-114. In Russian.

The vortex system of a cylindrical fuselage/straight trapezoidal wing model was studied in a vertical water tunnel of square cross section, using a dye visualization technique. The vortex system is found to consist of two free vortex streets trailing off the nose of the fuselage, and deviating strongly from the direction of the oncoming flow toward the tail section of the model, up to the boundary of the aerodynamic signature of the wing. Within the signature, the fuselage vortices mix with the wing vortices. At large supercritical angles of attack, no separate wing-tip vortices were observed in the presence of a fuselage. V.P.

A74-37149 # **Piecewise smooth approximation method for sensor data (Metod kusochno-gladkoi approksimatsii pokazanii datchikov).** A. G. Kharchenko. *TsAGI, Uchenye Zapiski,* vol. 4, no. 1, 1973, p. 144-148. In Russian.

An algorithm is developed for the approximation of strain gauge sensor readings by a piecewise smooth function containing a rectilinear segment and a curvilinear segment having the form of a second-order parabola. A quadratic equation is derived whose coefficients are used to determine the coordinates of the junction between the rectilinear and curvilinear segments. Examples of sensor reading approximation by this method are given for static tests of aircraft structures. V.Z.

A74-37234 # **Turbulence studies on a high-altitude sounding aircraft (Issledovanie turbulentnosti s pomoshch'iu vysotnogo samoleta-zondirovshchika).** V. D. Litvinova. In: Turbulence and convection. Moscow, Gidrometeoizdat, 1973, p. 86-90. In Russian.

A74-37257 * **Experimental studies of turbulent aircraft wake.** N. A. Chigier (Sheffield, University, Sheffield, England). *(Israel Society of Aeronautics and Astronautics and Technion - Israel Institute of Technology, Israel Annual Conference on Avionics and Astronautics, 14th, Haifa, Israel, Mar. 1, 2, 1972.) Israel Journal of Technology,* vol. 11, no. 6, 1973, p. 367-372. 8 refs. NASA-supported research.

Review of wind tunnel test data obtained for tip vortex studies on a square-tipped rectangular wing. The results include wing surface pressure distributions, three-dimensional velocity components in the wake, and principal vortex characteristics such as peak tangential velocity and core size distributions. The wind tunnel measurements are compared with flight test data. These comparisons show that the magnitudes of circumferential velocities, normalized by flight speed and lift coefficient, as well as the vortex core radius, normalized by wing span, are in close agreement. The data obtained make possible the calculation of turbulence stress distributions and the formulation of models for the prediction of downstream flow fields. M.V.E.

A74-37268 Uniform asymptotic solutions for the two-dimensional potential field about a slender body. J. F. Geer (New York, State University, Binghamton, N.Y.). *SIAM Journal on Applied Mathematics,* vol. 26, May 1974, p. 539-553. Research supported by the State University of New York.

An investigation is conducted concerning the potential field about a slender cylindrical body, taking into account the case in which either a Dirichlet or a Neumann boundary condition is prescribed. Attention is given to the determination of the two-dimensional irrotational flow of an incompressible inviscid fluid past a cylindrical airfoil and the electrostatic field in the exterior of a perfectly conducting cylinder. Complete uniform asymptotic expansions of the solutions are obtained with respect to a parameter providing a measure of the thinness of the cylinder. G.R.

A74-37283 # **Calculation of initial vortex roll-up in aircraft wakes.** J. E. Yates. *Journal of Aircraft,* vol. 11, July 1974, p. 397-400. 8 refs. Contracts No. F44620-69-C-0089; No. F33615-72-C-2116.

The initial in-plane acceleration of a vortex sheet in two-dimensional incompressible flow is calculated. The theory is used to estimate the strength and location of the discrete vortices that roll-up behind an aircraft wing. Numerical results are presented for a C-141 takeoff and a DC-9 landing configuration. The results verify a hypothesis of Donaldson et al. (1973) for estimating the strength and location of the discrete vortices that is required in a Betz-type roll-up calculation. The present theory also provides an estimate of the relative rates of vortex roll up. (Author)

A74-37284 # **Minimum noise climbout trajectories of a VTOL aircraft.** F. Henschel, E. Plaetschke, and H.-K. Schulze (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Flugmechanik, Braunschweig, West Germany). *Journal of Aircraft,* vol. 11, July 1974, p. 429-432. 6 refs.

Review of the results of calculations of minimum-noise climbout trajectories for a VTOL aircraft. In determining these minimum-noise trajectories, only those noise-sensitive areas were considered that lay along the ground track of the climbout path. The results indicate that the optimum trajectory is essentially influenced by the noise directivity characteristics of the engines. M.V.E.

A74-37341 # **Recommended design procedure for VASI-2 systems.** N. D. Witteveen and M. L. Borta (Michigan Aeronautics Commission, Lansing, Mich.). *(Michigan Aeronautics Commission, Engineering Conference, 7th, East Lansing, Mich., Dec. 13, 14, 1972.) ASCE, Transportation Engineering Journal,* vol. 100, Aug. 1974, p. 553-565. 13 refs.

The term 'Visual Approach Slope Indicator' (VASI) is the name of a visual landing aid system which was installed on civil airports since the mid-1960's. Initial guidance and expertise on VASI design was very limited because of the lack of consolidation of information particularly associated with VASI systems to meet the requirements of the Airport Development Aid Program (ADAP) connected with the passage of the Airport and Airway Development Act of 1970. Recommendations are made concerning a design procedure for VASI-2 systems on ADAP projects in Michigan. VASI-2 is commonly referred to as the 'economy system' and consists of two light units, one in each bar, both located on the left side of the runway. Its use is intended for propeller driven aircraft. Attention is given to equipment and electrical data, location and aiming criteria, a layout design procedure, and a sample problem. G.R.

A74-37342 # **Fatigue concepts for concrete airport pavement design.** R. G. Packard (Portland Cement Assoc., Skokie, Ill.). *ASCE, Transportation Engineering Journal,* vol. 100, Aug. 1974, p. 567-582. 18 refs.

A74-37343 # **Structural analysis of flexible airfield pavements.** R. G. Ahlvin, Y. T. Chou, and R. L. Hutchinson (U.S. Army, Soils and Pavements Laboratory, Vicksburg, Miss.). *ASCE, Transportation Engineering Journal,* vol. 100, Aug. 1974, p. 625-641. 10 refs.

The methods commonly used in the design of airfield pavements can be divided into two groups, related to the theoretical analysis approach and the experimental field approach. It is pointed out that there is generally a poor correlation between the two approaches. An investigation is conducted to bridge the gap between theory and performance. Good correlations are established between the observed performance of numerous full-scale accelerated traffic test pavements, under both single-wheel and multiple-wheel heavy gearloads, and the maximum shearing strains computed for these pavements. G.R.

A74-37376 # **Sonic boom from an aircraft flying in a quiet atmosphere (Zvukovoi udar ot samoleta pri polete v spokoinoi atmosfere).** Iu. L. Zhilin. *TsAGI, Uchenye Zapiski,* vol. 4, no. 2, 1973, p. 1-10. 5 refs. In Russian.

An arbitrary flight path in still air under conditions of variable temperature and pressure is examined. It is shown that the damping factor of the aircraft disturbances depends solely on four similarity parameters characterizing the flight conditions and the position, with respect to the flight path, of the observer experiencing the sonic boom. Systematic calculations for a standard atmosphere show that for a wide range of similarity parameter variation, the influence of two of these parameters can be identified explicitly with a high degree of accuracy. V.P.

A74-37383 # **Synthesis of an optimal system for stabilizing aircraft center of gravity paths (O sinteze optimal'noi sistemy stabilizatsii traektorii dvizheniia tsentra mass samoleta).** V. A. Bobtsov. *TsAGI, Uchenye Zapiski,* vol. 4, no. 2, 1973, p. 64-71. In Russian.

The optimal control of a center of gravity path is synthesized for the case of three control parameters. These are angle of attack, the angle of roll, and the amount of thrust. The problem is solved by a version of the method of penalty functions, using approximations for the constraints placed on the deflection of the control elements. It is assumed that the instantaneous values of the aircraft weight, velocity, and altitude, and of the course angle and flight path angle are available onboard the aircraft. The limiting potentials of the control parameters are established. V.P.

A74-37385 # **Determination of the fatigue life of structural elements for a biharmonic loading process (Opredelenie ustalostnoi dolgovechnosti konstruktivnykh elementov pri bigarmonicheskom protsesse nagruzheniia).** G. G. Zaveriukha. *TsAGI, Uchenye Zapiski,* vol. 4, no. 2, 1973, p. 85-96. 5 refs. In Russian.

Samples in the form of perforated strips prepared from the two aluminum alloys (AK4-1T1 and VAD-33) were tested, using a biharmonic loading process consisting of a low- and a high-frequency component. The fatigue data obtained for frequency ratios of 660/66 and 2000/6 to 16 are tabulated. An analytical method for calculating fatigue life for this type of loading is proposed. Existing methods of calculating fatigue life for biharmonic loading are reviewed. V.P.

A74-37393 # **Statistical estimate of the characteristics of a proposed aircraft by Monte Carlo method (Statisticheskaia otsenka kharakteristik proektiruemogo samoleta s pomoshch'iu metoda Monte-Karlo).** V. E. Denisov, V. K. Isaev, A. M. Riabov, and L. M. Shkadov. *TsAGI, Uchenye Zapiski,* vol. 4, no. 2, 1973, p. 137-142. 5 refs. In Russian.

A74-37394 # **Reciprocal-action computational systems for complex calculations in aeromechanics (O vychislitel'nykh sistemakh vzaimodeistviia dlia kompleksnykh raschetov v aeromekhanike).** N. G. Bun'kov and V. D. Il'ichev. *TsAGI, Uchenye Zapiski,* vol. 4, no. 2, 1973, p. 143-146. In Russian.

Some experiences with a collective computational system designed to assist several workers who are attempting to solve a single general problem are described. The system was first used in the testing of propeller blades for durability, and in related design problems. It consists of a high-speed computer, three teletypes which allow direct access to each of the three subscribing specialists, a set of programs for each of the three aspects of the calculation, and a special set of operational programs which provides ready information exchange and integration of programs throughout. A program for modifying the geometry of the aggregate and maximizing design features is also supplied. The system showed great potential for collective solving of complex problems requiring the coordinated effort of several specialists. J.K.K.

A74-37481 * **Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings.** Meeting sponsored by the American Helicopter Society and NASA. Moffett Field, Calif., NASA Ames Research Center, 1974. 386 p.

Analysis of specific problems in rotorcraft dynamics. Topics include hingeless rotor theory, dynamic stall modelling, periodic systems identification, analysis of complex systems with phasing matrices, flapping stability, flap-lag dynamics at high advance ratios, finite element analysis and fuselage free-vibration characteristics, coupled rotor/frame vibration methods, gust response characteristics with unsteady stall effects, antiresonance theory, cyclic feathering motions and dynamic loads, control load envelope shaping, rotor aeroelasticity, use of Floquet theory, theory of proprotors and tilt-rotors, two-bladed teetering rotors, stability of air and ground resonance, vertical-plane pendulum absorbers, multicyclic jet-flap control, engine/frame interface dynamics, and others. The minutes of the question and answer periods following the presentations are presented in the supplement. J.K.K.

A74-37482 # **Hingeless rotor frequency response with unsteady inflow.** D. A. Peters (U.S. Army, Air Mobility R & D Laboratory, Moffett Field, Calif.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings. Moffett Field, Calif., NASA Ames Research Center, 1974. 12 p. 11 refs.

Hingeless rotor frequency response calculations are obtained by applying a generalized harmonic balance to the elastic blade flapping equations. Nonuniform, unsteady induced flow effects are included by assuming a simple three-degree-of-freedom description of the rotor wake. Results obtained by using various models of elastic blade bending and induced flow are compared with experimental data obtained from a 7.5-ft diameter wind tunnel model at advance ratios from 0.0 to 0.6. It is shown that the blade elasticity and nonuniform, unsteady induced flow can have a significant effect on the transient response characteristics of rotor systems. Good correlation between theory and experiment is obtained by using: (1) a single rotating mode shape description of the elastic blade bending, (2) an empirical formula for the quasi-steady induced flow behavior, and (3) the apparent mass terms from potential flow for the unsteady induced flow characteristics. (Author)

A74-37483 # **Dynamic stall modeling and correlation with experimental data on airfoils and rotors.** R. G. Carlson, R. H. Blackwell (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.), G. L. Commerford (United Aircraft Fluid Dynamics Laboratory, East Hartford, Conn.), and P. H. Mirick (U.S. Army Air Mobility R & D Laboratory, Fort Eustis, Va.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings. Moffett Field, Calif., NASA Ames Research Center, 1974. 11 p. 10 refs.

Two methods for modeling dynamic stall have been developed at United Aircraft. The alpha, A, B method generates lift and pitching moments as functions of angle of attack and its first two time derivatives. The coefficients are derived from experimental data for oscillating airfoils. The time delay method generates the coefficients from steady-state airfoil characteristics and an associated time delay in stall beyond the steady-state stall angle. Correlation with three types of test data shows that the alpha, A, B method is somewhat better for use in predicting helicopter rotor response in forward flight. Correlation with lift and moment hysteresis loop generated for oscillating airfoils was good for both models. (Author)

A74-37486 * # **Some approximations to the flapping stability of helicopter rotors.** J. C. Biggers (NASA, Ames Research Center, Moffett Field, Calif.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings. Moffett Field, Calif., NASA Ames Research Center, 1974. 9 p.

The flapping equation for a helicopter in forward flight has coefficients which are periodic in time, and this effect complicates the calculation of stability. This paper presents a constant coefficient approximation which will allow the use of all the well known methods for analyzing constant coefficient equations. The flapping equation is first transformed into the nonrotating coordinate frame, where some of the periodic coefficients are transformed into constant terms. The constant coefficient approximation is then made by using time averaged coefficients in the nonrotating frame. Stability calculations based on the approximation are compared to results from a theory which correctly includes all of the periodicity. The comparison indicates that the approximation is reasonably accurate at advance ratios up to 0.5. (Author)

A74-37487 # **Flap-lag dynamics of hingeless helicopter blades at moderate and high advance ratios.** P. Friedmann and L. J. Silverthorn (California, University, Los Angeles, Calif.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings. Moffett Field, Calif., NASA Ames Research Center, 1974. 12 p. 17 refs.

Equations for large amplitude coupled flap-lag motion of a hingeless elastic helicopter blade in forward flight are derived. Only a torsionally rigid blade excited by quasi-steady aerodynamic loads is considered. The effects of reversed flow together with some new terms due to forward flight are included. Using Galerkin's method the spatial dependence is eliminated and the equations are linearized about a suitable equilibrium position. The resulting system of equations is solved using multivariable Floquet-Liapunov theory, and the transition matrix at the end of the period is evaluated by two separate methods. Results illustrating the effects of forward flight and various important blade parameters on the stability boundaries are presented. (Author)

A74-37488 # **Correlation of finite-element structural dynamic analysis with measured free vibration characteristics for a full-scale helicopter fuselage.** I. J. Kenigsberg, M. W. Dean (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.), and R. Malatino (U.S. Navy, Naval Air Systems Command, Washington, D.C.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings.
Moffett Field, Calif., NASA Ames Research Center, 1974. 14 p. 5 refs.

Finite element analyses can predict accurately the frequencies and mode shapes of complex helicopter structures, provided the structural data base is defined accurately. Complete stripping of a vehicle for correlation purposes may make the analysis overly sensitive to normally minor modeling assumptions. Significant changes can be predicted accurately in the character and frequency of fuselage and transmission modes due to changes in mass distributions and structural characteristics. The modeling techniques established by this study can be used during aircraft design regardless of the finite-element analytical system being used. A full-scale shake test correlation should be performed on a fully assembled flight vehicle to establish and validate modeling techniques for those appendages removed during the study. F.R.L.

A74-37489 # **Coupled rotor/airframe vibration prediction methods.** J. A. Staley and J. J. Sciarra (Boeing Vertol Co., Philadelphia, Pa.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings.
Moffett Field, Calif., NASA Ames Research Center, 1974. 10 p. 10 refs. Grant No. DAHC04-71-C-0048.

The problems of airframe structural dynamic representation and effects of coupled rotor/airframe vibration are discussed. Several finite element computer programs (including NASTRAN) and methods for idealization and computation of airframe natural modes and frequencies and forced response are reviewed. Methods for obtaining a simultaneous rotor and fuselage vibratory response, determining effectiveness of vibration control devices, and energy methods for structural optimization are also discussed. Application of these methods is shown for the vibration prediction of the Model 347 helicopter. (Author)

A74-37490 # **Helicopter gust response characteristics including unsteady aerodynamic stall effects.** P. J. Arcidiacono, R. R. Bergquist (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.), and W. T. Alexander, Jr. (U.S. Army, Air Mobility R & D Laboratory, Fort Eustis, Va.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings.
Moffett Field, Calif., NASA Ames Research Center, 1974. 10 p. 15 refs.

The results of an analytical study to evaluate the general response characteristics of a helicopter subjected to various types of discrete gust encounters are presented. The analysis employed was a nonlinear coupled, multiblade rotor-fuselage analysis including the effects of blade flexibility and unsteady aerodynamic stall. Only the controls-fixed response of the basic aircraft without any aircraft stability augmentation was considered. A discussion of the basic differences between gust sensitivity of fixed- and rotary-wing aircraft is presented. The effects of several rotor-configuration and aircraft-operating parameters on initial gust-induced load factor and blade vibratory stress and pushrod loads are discussed. The results are used to assess the accuracy of the gust alleviation factor given by MIL-S-8698. (Author)

A74-37491 # **Application of antiresonance theory to helicopters.** F. D. Bartlett, Jr. and W. G. Flannelly (Kaman Aerospace Corp., Bloomfield, Conn.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings.
Moffett Field, Calif., NASA Ames Research Center, 1974. 6 p. 7 refs.

A technique is presented for the numerical calculation of antiresonant frequencies. It is shown that antiresonances are eigenvalues and that they can be determined by matrix iteration. Applications of antiresonance theory to helicopter engineering problems, using the antiresonant eigenvalue equation introduced in the description of the proposed technique, are suggested. M.V.E.

A74-37492 # **The effect of cyclic feathering motions on dynamic rotor loads.** K. W. Harvey (Bell Helicopter Co., Fort Worth, Tex.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings.
Moffett Field, Calif., NASA Ames Research Center, 1974. 8 p.

The dynamic loads of a helicopter rotor in forward flight are influenced significantly by the geometric pitch angles between the structural axes of the hub and blade sections and the plane of rotation. An analytical study is made which includes elastic coupling between in-plane and out-of-plane deflections as a function of geometric pitch between the plane of rotation and the principal axes of inertia of each blade. In addition to a mean collective-pitch angle, the pitch of each blade is increased and decreased at a one-per-rev frequency to evaluate the dynamic coupling effects of cyclic feathering motions. The difference in pitch between opposed blades gives periodical coupling terms that vary at frequencies of one- and two-per-rev. Thus, an external aerodynamic force at n-per-rev gives forced responses at n, n plus or minus 1, and n plus or minus 2 per rev. (Author)

A74-37493 # **Control load envelope shaping by live twist.** F. J. Tarzanin, Jr. (Boeing Vertol Co., Philadelphia, Pa.) and P. H. Mirick (U.S. Army, Air Mobility R & D Laboratory, Fort Eustis, Va.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings.
Moffett Field, Calif., NASA Ames Research Center, 1974. 11 p. Grant No. DAAJ02-72-C-0093.

Rapid control load growth is attributed to stall flutter which is a consequence of high angles of attack and resulting blade stall. Visual confirmation of the large stall loads can be found in pitchlink or blade torsional gauge waveforms on which characteristic stall spikes appear in the fourth quadrant of the blade azimuth. These high loads result from an aeroelastic self-excited pitch motion in conjunction with repeated submersion of a large portion of the rotor blade in and out of stall. An aeroelastic rotor analysis program was developed, using unsteady aerodynamic theory that could predict the large stall-induced control loads. Limited analytical studies of a single flight condition indicated that modifications to the blade torsional properties could significantly reduce the stall-induced control loads. F.R.L.

A74-37494 # **Application to rotary wings of a simplified aerodynamic lifting surface theory for unsteady compressible flow.** B. M. Rao and W. P. Jones (Texas A & M University, College Station, Tex.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings.
Moffett Field, Calif., NASA Ames Research Center, 1974. 9 p. 20 refs.

The numerical lifting surface technique developed by Jones and Moore (1973) for calculating airloads on oscillating wings in subsonic flight is applied to helicopter rotor blades on a full three-dimensional basis. The results are compared with values given by two-dimensional strip theory for a rigid rotor hinged at its root. The comparisons indicate the inadequacies of strip theory for airload prediction. M.V.E.

A74-37495 **Rotor aeroelastic stability coupled with helicopter body motion.** W.-L. Miao (Boeing Vertol Co., Philadelphia, Pa.) and H. B. Huber (Messerschmitt-Bölkow-Blohm GmbH, Ottobrun, West Germany). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings.
Moffett Field, Calif., NASA Ames Research Center, 1974. 11 p. 7 refs.

A 5.5-foot-diameter, soft-in-plane, hingeless-rotor system was tested on a gimbal which allowed the helicopter rigid-body pitch and roll motions. With this model, coupled rotor/airframe aeroelastic stability boundaries were explored and the modal damping ratios were measured. The time histories were correlated with analysis with excellent agreement. The effects of forward speed and some rotor

design parameters on the coupled rotor/airframe stability were explored both by model and analysis. Some physical insights into the coupled stability phenomenon were suggested. (Author)

A74-37496 * # **An application of Floquet theory to prediction of mechanical instability.** C. E. Hammond (U.S. Army, Air Mobility R & D Laboratory, Fort Eustis; NASA, Langley Research Center, Hampton, Va.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings. Moffett Field, Calif., NASA Ames Research Center, 1974. 12 p. 7 refs.

The problem of helicopter mechanical instability is considered for the case where one blade damper is inoperative. It is shown that, if the hub is considered to be nonisotropic, the equations of motion have periodic coefficients which cannot be eliminated. However, if the hub is isotropic, the equations can be transformed to a rotating frame of reference and the periodic coefficients eliminated. The Floquet transition matrix method is shown to be an effective way of dealing with the nonisotropic hub and nonisotropic rotor situation. Time history calculations are examined and shown to be inferior to the Floquet technique for determining system stability. (Author)

A74-37497 * # **Theory and comparison with tests of two full-scale proprotors.** W. Johnson (NASA, Langley Research Center, Large-Scale Aerodynamics Branch; U.S. Army, Air Mobility R & D Laboratory, Moffett Field, Calif.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings. Moffett Field, Calif., NASA Ames Research Center, 1974. 11 p. 6 refs.

A nine-degrees-of-freedom theoretical model has been developed for investigations of the dynamics of a prop rotor operating in high inflow axial flight on a cantilever wing. The theory is described, and the results of the analysis are presented for two prop rotor configurations: a gimbaled, stiff in-plane rotor, and a hingeless, soft in-plane rotor. The influence of various elements of the theory is discussed, including the modeling used for the blade and wing aerodynamics and the influence of the rotor lag degree of freedom. The results from full-scale tests of these two prop rotors are presented and compared with the theoretical results. (Author)

A74-37498 * # **Experimental and analytical studies in tilt-rotor aeroelasticity.** R. G. Kvaternik (NASA, Langley Research Center, Hampton, Va.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings. Moffett Field, Calif., NASA Ames Research Center, 1974. 14 p. 12 refs.

An overview of an experimental and analytical research program for studying the aeroelastic and dynamic characteristics of tilt-rotor VTOL aircraft is presented. Selected results from several investigations of scaled models in the Langley transonic dynamics tunnel as well as some results from a test of a flight-worthy prop rotor in the NASA Ames full-scale wind tunnel are shown and discussed with a view toward delineating various aspects of dynamic behavior peculiar to prop rotor aircraft. Included are such items as prop rotor pylon stability, whirl flutter, gust response, and blade flapping. Theoretical predictions, based on analyses developed at Langley, are shown to be in agreement with the measured stability and response behavior. (Author)

A74-37499 # **Comparison of flight data and analysis for hingeless rotor regressive inplane mode stability.** W. D. Anderson and J. F. Johnston (Lockheed California Co., Burbank, Calif.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings. Moffett Field, Calif., NASA Ames Research Center, 1974. 13 p. 6 refs.

During the development of the AH-56A, a considerable amount of analytical and experimental data were obtained on the stability of the regressive in-plane mode, including coupling with other modes such as body roll and rotor plunge. The data were obtained on two distinctly different control systems; both gyro controlled, but one with feathering moment feedback and the other with direct flapping feedback. A review of the analytical procedures employed in investigating the stability of this mode is presented, a comparison is made between analytical and experimental data, and the effect of certain parameters, including blade droop, sweep, pitch flap coupling angle, pitch lag coupling, vehicle roll inertia, in-plane frequency, rpm, and forward speed is considered. It is shown that the stability of this mode is treatable by analysis and that adequate stability is achievable without recourse to auxiliary in-plane damping devices. (Author)

A74-37500 # **Hub moment springs on two-bladed teetering rotors.** W. Sonneborn and J. Yen (Bell Helicopter Co., Fort Worth, Tex.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings. Moffett Field, Calif., NASA Ames Research Center, 1974. 6 p.

Two-bladed teetering rotors with elastic flapping hinge restraint are shown to be suitable for zero-g flight. The alternating moment component introduced into the fuselage by the hinge spring can be balanced about the aircraft center of gravity by alternating hub shears. Such shears can be produced in proper magnitude, frequency, and phase by additional underslinging of the hub and by judicious choice of the location of the first inplane cantilevered natural frequency. Trends of theoretical results agree with test results from a small scale model and a modified OH-58A helicopter. (Author)

A74-37501 # **Open and closed loop stability of hingeless rotor helicopter air and ground resonance.** M. I. Young, D. J. Bailey, and M. S. Hirschbein (Delaware, University, Newark, Del.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings. Moffett Field, Calif., NASA Ames Research Center, 1974. 14 p. 16 refs. Grant No. DA-ARO(D)-1247-G112.

The air and ground resonance instabilities of hingeless rotor helicopters are examined on a relatively broad parametric basis. An evolutionary approach to closed-loop stabilization of both the air and ground resonance instabilities is considered by utilizing a conventional helicopter swash-plate-blade cyclic pitch control system in conjunction with roll, roll rate, pitch and pitch rate sensing and control action. The study shows that nominal to moderate and readily achieved levels of blade internal hysteresis damping in conjunction with a variety of tuning and/or feedback conditions are highly effective in dealing with these instabilities. Tip weights and reductions in pre-coning angles are also shown to be effective means for improving the air resonance instability. (Author)

A74-37502 # **Vertical-plane pendulum absorbers for minimizing helicopter vibratory loads.** K. B. Amer and J. R. Neff (Hughes Aircraft Co., Culver City, Calif.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings. Moffett Field, Calif., NASA Ames Research Center, 1974. 4 p.

This paper discusses the use of pendulum dynamic absorbers mounted on the blade root and operating in the vertical plane to minimize helicopter vibratory loads. The paper describes qualitatively the concept of the dynamic absorbers and presents results of analytical studies showing the degree of reduction in vibratory loads attainable. Operational experience of vertical plane dynamic absorbers on the OH-6A helicopter is also discussed. (Author)

A74-37503 # **Evaluation of a stall-flutter spring-damper pushrod in the rotating control system of a CH-54B helicopter.** W. E. Nettles (U.S. Army, Air Mobility R & D Laboratory, Fort Eustis, Va.), W. F. Paul, and D. O. Adams (United Aircraft Corp., Sikorsky Aircraft Div., Stratford, Conn.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings. Moffett Field, Calif., NASA Ames Research Center, 1974. 10 p. 9 refs.

The results of a design and flight test program are presented that was conducted to define the effect of rotating pushrod damping on stall-flutter induced control loads. The program proved that stall-induced high-frequency control loads can be reduced significantly by providing a rotating system spring damper. M.V.E.

A74-37504 * # **Multicyclic jet-flap control for alleviation of helicopter blade stresses and fuselage vibration.** J. L. McCloud, III (NASA, Ames Research Center, Moffett Field, Calif.) and M. Kretz (NASA, Ames Research Center, Moffett Field, Calif.; Giravions Dorand, Suresnes, Hauts-de-Seine, France). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings. Moffett Field, Calif., NASA Ames Research Center, 1974. 6 p. 6 refs.

and frequencies and forced response are reviewed. Methods for obtaining a simultaneous rotor and fuselage vibratory response, determining effectiveness of vibration control devices, and energy methods for structural optimization are also discussed. Application of these methods is shown for the vibration prediction of the Model 347 helicopter. (Author)

A74-37505 # **Identification of structural parameters from helicopter dynamic test data.** N. Giansante and W. G. Flannelly (Kaman Aerospace Corp., Bloomfield, Conn.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings. Moffett Field, Calif., NASA Ames Research Center, 1974. 10 p.

A method is presented for obtaining the mass, stiffness, and damping parameters of a linear mathematical model, having fewer degrees of freedom than the structure it represents, directly from dynamic response measurements on the actual helicopter without a priori knowledge of the physical characteristics of the fuselage. The only input information required in the formulation is the approximate natural frequency of each mode and mobility data measured proximate to these frequencies with sinusoidal force excitation applied at only one point on the vehicle. This dynamic response information acquired from impedance testing of the actual structure over the frequency range of interest yields the second-order structurally damped linear equations of motion. (Author)

A74-37506 # **Engine/airframe interface dynamics experience.** C. Fredrickson (Boeing Vertol Co., Philadelphia, Pa.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings. Moffett Field, Calif., NASA Ames Research Center, 1974. 12 p. 5 refs.

An attempt is made to highlight some recently encountered problems in the area of helicopter engine and drive system dynamics. It is shown that solutions were attained by the application of basic engineering principles to state-of-the-art analytical and test techniques. Also, having encountered these problems, there is greater cognizance of these potential 'show-stoppers', the manner in which they manifest themselves, and the available courses of corrective action. It is essential that the knowledge gained through these programs be judiciously applied to new helicopters, and growth versions of existing models. F.R.L.

A74-37507 * # **Hingeless rotor theory and experiment on vibration reduction by periodic variation of conventional controls.** G. J. Sissingh and R. E. Donham (Lockheed-California Co., Burbank, Calif.). In: Specialists Meeting on Rotorcraft Dynamics, Moffett Field, Calif., February 13-15, 1974, Proceedings.
Moffett Field, Calif., NASA Ames Research Center, 1974. 17 p. 12 refs. Contract No. NAS2-7245.

A preliminary evaluation is made of the concept of vibration reduction by properly selected oscillatory collective and cyclic control applications. The investigations are based on experimental frequency response data covering advance ratios from approximately 0.2 to 0.85. Because there was no instrumentation for the measurement of the pitch and roll vibrations, these values were obtained by properly adding up the flap-bending moments at 3.3 in. Any other quantity representing pitch/roll vibrations can be compensated for in the same fashion. The calculated control inputs required for vibration reduction stay within acceptable limits. For four of the five conditions tested they are smaller than the values used for the frequency response tests. As to be expected, the compensating controls greatly affect the blade loads, i.e., torsion, flap- and chordwise bending. F.R.L.

A74-37533 # **Development of noise-reduction concepts for the 707 airplane.** M. D. Nelsen (Boeing Co., Wichita, Kan.) and V. E. Callaway (Boeing Commercial Airplane Co., Seattle, Wash.). *Acoustical Society of America, Meeting, 87th, New York, N.Y., Apr. 23-26, 1974, Paper.* 9 p. 14 refs. Research sponsored by the Boeing Co.; U.S. Department of Transportation Contract No. FA71WA-2728.

Flyover noise characteristics are presented for the Boeing 707-300B/C equipped with standard production nacelles and with experimental quiet nacelles modified by the addition of sound-vortex noise is found to be a very important noise source at landing approach lift coefficients, dominating the frequency spectra from beyond 100 Hz. The wing profile drag with deflected flap effects dominates the low frequency spectra. F.R.L.

A74-37534 # **Aircraft noise retrofit feasibility program results and applications.** R. J. Koenig (FAA, Systems Research and Development Service, Washington, D.C.). *Acoustical Society of America, Meeting, 87th, New York, N.Y., Apr. 23-26, 1974, Paper.* 10 p. 11 refs.

Government/Industry cooperation has led to a successful noise retrofit feasibility program. Technologically feasible, economically reasonable solutions are available for the problem of quieting the JT3D and JT8D powered aircraft fleet. Results previously presented are reviewed and their potential applications are covered. Attention is given to FAA rule making activity directed toward implementation of retrofit. Acoustic treatment of nacelle inlets and exhaust ducts proved to be effective in attainment of FAA lower acoustic goals. F.R.L.

A74-37535 # **Aircraft noise retrofit feasibility program objectives and scope.** R. J. Koenig (FAA, Systems Research and Development Service, Washington, D.C.). *Acoustical Society of America, Meeting, 87th, New York, N.Y., Apr. 23-26, 1974, Paper.* 10 p. FAA-sponsored research.

Government and the air transport industry have been faced with the problem of quieting existing low-bypass-ratio turbofan-powered aircraft which constitute nearly 90% of the current U.S. air carrier fleet. A description is given of the FAA-sponsored retrofit feasibility program and related NASA and industry-funded efforts. The program was designed to provide test data for use in determining whether the older-design aircraft could be modified for meaningful noise reduction. The modifications were required to be technologically practicable, economically reasonable, and appropriate for the aircraft type. The program included ground and flight tests of flight-weight hardware capable of airworthiness certification. (Author)

A74-37536 # **Jet propulsion for quiet aircraft.** F. B. Bossler (Bell Aerospace Co., Buffalo, N.Y.) and D. L. Smith (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *Acoustical Society of America, Meeting, 87th, New York, N.Y., Apr. 23-26, 1974, Paper.* 31 p. 12 refs. USAF-supported research.

A novel method of jet noise reduction has been subjected to bench and wind tunnel tests. This method uses very small nozzles arranged on struts protruding from the upper surface of an aircraft wing. Bench tests included various arrangements of nozzles on each strut; tests with heated air; test of noise power and directivity versus number of struts, strut spacing, and location of struts on a simulated wing; and tests of discharge coefficients and velocity coefficients. Wind-tunnel tests included induced aerodynamic effects of upper-surface-blowing, effects of tunnel flow on discharge and velocity coefficients of the nozzles, acoustic effects of tunnel flow on the jet noise, and effects of jet flow on aerodynamic noise. A full-scale test of aerodynamic noise was made using dummy struts on a sailplane. Preliminary design of a Quiet Research Test Vehicle was prepared and its aural detectability was predicted (on the basis of the test data) to be significantly superior to other approaches. (Author)

A74-37537 # **The spectrum of rotor noise caused by atmospheric turbulence.** D. B. Hanson (United Aircraft Corp., Hamilton Standard Div., Windsor Locks, Conn.). *Acoustical Society of America, Meeting, 87th, New York, N.Y., Apr. 23-26, 1974, Paper.* 75 p. 24 refs. Research supported by the United Aircraft Corp.

The spectra of noise and blade loading caused by interference of a propeller, helicopter rotor, or fan rotor with inlet turbulence are studied experimentally and theoretically. One test with hot wire anemometers in a static inlet and another test with pressure transducers on the blades of a fan rotor reveal inlet turbulence to be highly anisotropic. Evidence indicates that the source of these disturbances is atmospheric turbulence. The associated noise is partially coherent with spectrum peaks which are so narrow as to be difficult to distinguish from true harmonics. Theoretical spectrum predictions, performed with methods from random-pulse modulation theory, indicate for the test fan that the peak at blade passing frequency and the high frequency broadband noise are due to inflow turbulence. It appears that this narrowband random mechanism explains spectrum peaks which have previously been described as harmonic noise due to fixed inflow distortion. (Author)

A74-37540 # **The calculation of aerodynamic noise generated by large aircraft at landing approach.** J. D. Revell (Lockheed-California Co., Burbank, Calif.). *Acoustical Society of America, Meeting, 87th, New York, N.Y., Apr. 23-26, 1974, Paper.* 43 p. 18 refs.

The radiated aerodynamic noise of gliding aircraft is of interest since it represents a 'floor' to aircraft noise if the engine or propulsive noise could be completely eliminated, and is of special significance for landing approach. The study is semiempirical, using gliding flyover test data for small aircraft, and more recently published data from C5-A tests at flight-idle power which provide a 'data window' for aerodynamic noise below 500 Hz. These data were used to estimate aerodynamic noise radiation from the major aircraft drag components. The three major components were found to be the wing profile drag, including flap deflection increments, the fuselage drag, including the landing gear, and the wing induced drag associated with trailing vortices from the wing tip. The wing tip vortex noise is found to be a very important noise source at landing approach lift coefficients, dominating the frequency spectra from beyond 100 Hz. The wing profile drag with deflected flap effects dominates the low frequency spectra. F.R.L.

A74-37541 * # **The noise environment of a school classroom due to the operation of utility helicopters.** D. A. Hilton and R. J. Pegg (NASA, Langley Research Center, Hampton, Va.). *Acoustical Society of America, Meeting, 87th, New York, N.Y., Apr. 23-26, 1974, Paper.* 14 p.

A74-37542 # **Effects of non-uniform inflow on fan noise.** G. F. Pickett (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *Acoustical Society of America, Meeting, 87th, New York, N.Y., Apr. 23-26, 1974, Paper.* 45 p. 9 refs.

A prominent source of turbomachinery noise is due to high-speed unsteady flows interacting with blades and vanes. In particular, inlet distortions such as atmospheric turbulence, cross-wind effects, the fan inlet boundary layer, and the 'ground vortex' apparent during most static test conditions can interact with the fan on turbofan engines to produce significant levels of noise. An analysis is presented that models this noise-generating mechanism and is capable of predicting propagating acoustic energy, accepting as input various inlet turbulence structures, temperature fluctuations, and flow distortions. Because of the random nature of most inflow disturbances, a statistical approach is used to develop the model which is a modification and extension of a previous analysis presented by Mani (1971). The analysis shows that the level of fan blade passing tone and harmonics and their relative forward and rearward radiated intensities are critically dependent on both the inlet turbulence intensity and correlation length scales in the axial, circumferential, and spanwise directions. (Author)

A74-37545 # **Aircraft community noise research and development - A historical overview.** V. L. Blumenthal, R. E. Russell, and J. M. Streckenbach (Boeing Commercial Airplane Co., Seattle, Wash.). *Acoustical Society of America, Meeting, 87th, New York, N.Y., Apr. 23-26, 1974, Paper.* 19 p. 110 refs.

Continuing work has advanced the noise-reduction state of the art significantly, to the extent that acoustic treatment concepts have been developed and proven that will permit all current Boeing turbofan-powered to comply with Federal Aviation Administration (FAA) FAR Part 36 and International Civil Aviation Organization (ICAO) Annex 16 noise rules. Work is continuing toward developing means of further reducing aircraft noise levels through advanced acoustic treatment techniques, through noise-abatement operating procedures, and through changes in airplane/engine basic designs. Unsolved problems that need attention to permit continuing reductions in aircraft noise are discussed. F.R.L.

A74-37546 # **Development of noise-reduction concepts for 727 and 737 airplanes.** C. L. Arctander, C. G. Hodge, and R. B. Tate (Boeing Commercial Airplane Co., Seattle, Wash.). *Acoustical Society of America, Meeting, 87th, New York, N.Y., Apr. 23-26, 1974, Paper.* 16 p. 9 refs.

A review is given of various noise-reduction concepts pertinent to JT8D-powered 727 and 737 airplanes, with emphasis on acoustic technology. Two jet noise suppression concepts aimed at further 727 noise reduction are discussed. An ejector/suppressor concept that has been demonstrated in an FAA-sponsored ground and flight test program is shown to achieve 6 to 8 EPNdB suppression of jet noise at engine takeoff power. Airplane performance penalties, however, have precluded production application of this configuration. The refan concept, currently under development on a NASA contract, involves JT8D engine modifications to incorporate a higher work-extraction fan. This modification realizes lower jet noise that, when coupled with extensive acoustic treatment, results in significant noise reductions with a minimum impact on airplane performance. (Author)

A74-37547 # **Validity of aircraft noise data.** C. A. Sekyra, W. C. Storey, and R. Yates (Boeing Commercial Airplane Co., Seattle, Wash.). *Acoustical Society of America, Meeting, 87th, New York, N.Y., Apr. 23-26, 1974, Paper.* 5 p. 5 refs.

An analysis of noise measurements taken at various distances from a number of aircraft during noise flight testing is presented. Data scatter is shown to increase with distance and with decreasing aircraft/observer angle. Data normalization techniques, utilizing current standards, are inadequate at large distances and low airplane/observer angles. Aircraft noise measurements taken under uncontrolled situations are of doubtful value in predicting future community noise. Noise measurements obtained directly beneath the airplane flightpath, under carefully controlled conditions, are highly repeatable and adjustable for moderate distances (within plus or minus 1 EPNdB); however, when adjusted to sideline distances, these data can lead to variations on the order of 5 EPNdB. The accuracy of this type of information is of prime concern, since it is used to determine aircraft noise 'footprints' in noise exposure studies. Because a 3-EPNdB change in EPNL can lead to area halving or doubling, it is concluded that the value of footprints in community noise impact studies is extremely dubious. (Author)

A74-37548 * # **Noise reduction programs for DC-8 and DC-9 airplanes.** R. L. Frasca (Douglas Aircraft Co., Long Beach, Calif.). *Acoustical Society of America, Meeting, 87th, New York, N.Y., Apr. 23-26, 1974, Paper.* 18 p. 12 refs. Research supported by the Douglas Aircraft Co.; U.S. Department of Transportation Contracts No. FA72WA-3116; No. FA73WA-3161; Contracts No. NAS3-16814; No. NAS3-17841.

A summary review is presented of the results of current and recently completed noise-reduction programs for DC-8 and DC-9 airplanes. The relationship of these programs to other efforts by Douglas to develop quieter CTOL airplanes is briefly outlined. The engine/nacelle concepts studied were: (1) application of nacelle

acoustic treatment, (2) variable-area exhaust nozzles, (3) jet exhaust noise suppressors, and (4) engines with larger-diameter new front fans. Acoustic analyses leading to the selection of certain engine/nacelle configurations are described, as well as design constraints which limit the noise reduction capability of certain designs. Acoustic design features of the modified engine/nacelles are discussed along with estimates of the changes in aircraft community noise levels, as well as estimates of the changes in aircraft weight, performance, cost, and operational restrictions. (Author)

A74-37549 # **Sources of unsteady flow in subsonic aircraft inlets.** L. T. Clark (Boeing Commercial Airplane Co., Renton, Wash.). *Acoustical Society of America, Meeting, 87th, New York, N.Y., Apr. 23-26, 1974, Paper.* 57 p. Research supported by the Boeing Commercial Airplane Co.

Results of an experimental program to measure the steady-state and dynamic distortion in subsonic inlets are presented. Two inlet designs were considered. The first was a 35% cowl lip contraction ratio design and the second a 34% contraction ratio design. The inlets were operated in crosswind and angle of attack. Experiments were conducted in a 9 by 9 ft low-speed wind tunnel. Results presented are for severe operating conditions which are outside the normal operating envelopes for the inlets. Two-point total pressure correlations were used to characterize the structure of the turbulent flows. Total pressures were also used to represent the mean flow data. It was observed that the scale of turbulence generated inside the inlet is of a size on the order of the separated flow. When turbulence is convected through the inlet in a static condition (no approach velocity), there is significant stretching of the turbulence. The structure of inlet turbulence is considerably affected by the contraction ratio of the flow through the inlet. (Author)

A74-37550 # **Noise due to jet motion caused by internal unsteadiness.** E. G. Plett and M. Summerfield (Princeton University, Princeton, N.J.). *Acoustical Society of America, Meeting, 87th, New York, N.Y., Apr. 23-26, 1974, Paper.* 7 p. Contract No. N00014-67-A-0151-0029.

Attention is given to the smaller amplitude undulations occurring at the edge of a subsonic jet, which are due to the flow unsteadiness through the nozzle, due to internal pressure fluctuations. An attempt is made to find how much of the noise from such an unsteady jet flow is due to this intermittent oscillation of the jet surface. The jet motion envisioned is a pulsating motion involving intermittent expansions and contractions of the jet due to the unsteadiness in momentum flux or pressure at the nozzle exit. To obtain a relationship between the jet motion and internal pressure unsteadiness, a quasi-steady relationship is adopted obtained from supersonic jet experiments, relating the maximum jet radius to the exit plane pressure which in turn is related to the chamber pressure. F.R.L.

A74-37634 **Failure analyses of aircraft accidents.** I. J. B. Shah (Canadian Air Transportation Administration, Engineering Laboratory, Ottawa, Canada). *Metals Engineering Quarterly*, vol. 14, Aug. 1974, p. 10-15.

This report covers case histories of failures in fixed-wing light aeroplane and helicopter components. Investigated during a five-year period, these cases represent various modes of failures and describe remedial actions taken to assure flight safety. Material failures were due mainly to either of both improper maintenance (or overhaul) and insufficient inspection. (Author)

A74-37648 **Bending-torsional flutter of a cantilevered wing containing a tip mass and subjected to a transverse follower force.** W. T. Feldt (Wisconsin, University, Kenosha, Wis.) and G. Herrmann (Stanford University, Stanford, Calif.). *Franklin Institute, Journal*, vol. 297, June 1974, p. 467-478. 14 refs.

Study of the bending-torsional flutter of a cantilevered wing subjected to a follower force, and containing a lumped mass at the free end. In addition, a distributed aerodynamic loading is introduced along the wing. This results in a set of nonself-adjoint differential equations with variable, complex coefficients whose solutions are obtainable only in series form. Using the Frobenius method, a direct procedure is employed which retains the exact expression of the Theodorsen function. It is found that, as a result of the interaction of the two sources of nonconservative loadings, the follower force reduces considerably the critical speed of flows in all cases studied. An increase in the tip mass, however, has a stabilizing influence. The effect of structural damping is also examined, and it is shown that internal damping forces may have pronounced influences on the flutter speed of the system. (Author)

A74-37652 # **Resolution of a conflict between weight and component resistance in an aircraft (K zadache razresheniia protivorechii mezhdu vesom i soprotivleniem chastei samoleta).** V. P. Gogolin. *Aviatsionnaia Tekhnika*, vol. 17, no. 1, 1974, p. 13-16. In Russian.

Theoretical considerations are given as to how an optimal weight-strength tradeoff can be found in aircraft structure designs. A solution is proposed for this weight-strength tradeoff problem which differs from that proposed by Badiagin et al. (1972). Expressions are derived on which the three-step solution is based. The method is demonstrated on a theoretical aircraft model similar to the Tu-134 aircraft. V.Z.

A74-37656 # **Transient processes in an aircraft stabilization system with jet-driven flywheels (Perekhodnye protsessy v sistema stabilizatsii letatel'nogo apparata s reaktivnymi makhovikami).** E. F. Fatkhullin, G. L. Degtiarev, and I. P. Ul'trivanov. *Aviatsionnaia Tekhnika*, vol. 17, no. 1, 1974, p. 31-37. 7 refs. In Russian.

The angular motion of an aircraft controlled by three jet-propelled flywheels is analyzed by treating this aircraft as a coupled, open, three-channel, nonlinear control system. Expressions are derived to interrelate the moments of inertia of the aircraft, the masses, mass-center coordinates and polar and equatorial moments of inertia of the flywheels, the projections of the instantaneous angular velocity vector of the aircraft on its axes, the revolution rates of the flywheels, the control moments, the control functions, and the electromechanical parameters of the flywheel drives. The problem of stabilization of this aircraft is formulated and solved. A numerical example of the application of the results is included. V.Z.

A74-37662 # **Consideration of control elasticity in calculating the deformation of gyroplane rotor blades (Uchet uprugosti upravleniia pri raschete deformatsii lopastei nesushchego vinta vertoleta).** A. Iu. Liss. *Aviatsionnaia Tekhnika*, vol. 17, no. 1, 1974, p. 64-71. 7 refs. In Russian.

Theoretical analysis of the deformation of a rotor blade in flight taking into account the effect of cyclic pitch control compliance. The case of steady flight regime is considered, whereby the deformation of each blade repeats with a given time lag that of the preceding blades, so that only one blade need be considered. P.T.H.

A74-37663 # **Multi-hinge rudder unit design with allowance for rudder deflection (Raschet mnogosharnirnogo operenila s uchetom otkloneniia rulei).** V. A. Pavlov. *Aviatsionnaia Tekhnika*, vol. 17, no. 1, 1974, p. 72-76. In Russian.

Rudder responses are analyzed in rudder unit designs using three or more hinges for rudder suspension. Particular attention is given to rudder unit and tail section designs where the rudder and stabilizer have a high torsional rigidity, where the stabilizer has a high head-on bending rigidity, and where the rudder stress vector is normal to the rudder plane. Expressions describing all these conditions are given. Curves are plotted to show the responses of rudder as a function of rudder deflection. V.Z.

A74-37673 # **Effect of the structural elasticity of an aircraft on safety and comfort during flights in a turbulent atmosphere (Vliianie uprugosti konstruktsii samoleta na bezopasnost' i komfortabel'nost' poleta v turbulentnoi atmosfere).** V. Z. Shestakov. *Aviatsionnaia Tekhnika*, vol. 17, no. 1, 1974, p. 130-133. In Russian.

A74-37681 # **Effect of erosive wear on the fatigue life of cantilever blades of axial-flow compressors of aircraft turbojet engines (Vliianie erozionnogo iznosa na vynoslivost' konsol'nykh lopatok osevykh kompressorov aviatsionnykh GTD).** V. M. Kapralov. *Aviatsionnaia Tekhnika*, vol. 17, no. 1, 1974, p. 160-162. In Russian.

A74-37786 # **The future of avionics.** G. E. Beck (Marconi-Elliott Avionic Systems, Ltd., Rochester, Kent, England). *Aircraft Engineering*, vol. 46, July 1974, p. 11-13, 16, 17.

A speculative discussion of the future of avionics is presented, based not on the extension of current technologies and procedures but on an imaginative view of the possibilities inherent in modern research. Large scale integration of electronic circuits is seen as the key to developments in communications, navigation, flight control and display, air traffic control, and military technology. Some of the ideas noted are those involving such digital LSI technologies as automatic HF channel selection, Aerosat: active antennas, differential Omega, strapped down inertial navigation, collision avoidance, control configuration, fly-by-wire, integrated displays, cheap universal transponders, surveillance, computers and displays and others. An estimated probable time scale for these items is presented. J.K.K.

A74-37797 # **Stability characteristics of skewed wing aircraft.** J. B. Barlow and W. W. Kelley (Maryland, University, College Park, Md.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-772.* 12 p. 9 refs. Members, $1.50; nonmembers, $2.00.

The stability characteristics of a skewed-wing asymmetrical aircraft at subsonic and supersonic speeds are explored. The method is classical, consisting in writing a set of coupled linearized equations including the effects of inertial and aerodynamic asymmetry. The scope is limited to rigid-body results. Evaluation of the aerodynamic coupling derivatives is discussed, and it is shown that they can be directly related to conventional derivatives corresponding to symmetrical swept wings. Characteristic modes are computed for example cases. Coupled modes can easily be identified as evolving from the classical phugoid, short-period, lateral oscillation, rolling convergence and spiral modes. The only troublesome mode is the lateral oscillation which in this case includes significant angle of attack variations. (Author)

A74-37798 * # **A passive gust alleviation system for light aircraft.** P. Roesch and R. B. Harlan (MIT, Cambridge, Mass.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-773.* 12 p. 5 refs. Members, $1.50; nonmembers, $2.00. NASA-supported research.

A passive aeromechanical gust alleviation system has been examined for application to a Cessna 172. The system employs small auxiliary wings to sense changes in angle of attack and to drive the wing flaps to compensate the resulting incremental lift. The flaps also can be spring loaded to neutralize the effects of variations in dynamic pressure. Conditions for gust alleviation are developed and shown to introduce marginal stability if both vertical and horizontal gusts are compensated. Satisfactory behavior is realized if only vertical gusts are absorbed; however, elevator control is effectively negated by the system. Techniques to couple the elevator and flaps are demonstrated to restore full controllability without sacrifice of gust alleviation. (Author)

A74-37799 # **The dynamic behavior of an aircraft encountering aircraft wake turbulence.** R. C. Nelson (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) and B. W. McCormick (Pennsylvania State University, University Park, Pa.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-774.* 12 p. 21 refs. Members, $1.50; nonmembers, $2.00.

A simplified analysis is presented in which the various factors influencing the vortex-induced rolling moment of an aircraft are examined. Based upon this simplified analysis, a method is developed which allows a rapid estimate of the vortex induced rolling moment to be made. Results from a digital computer simulation of the aircraft vortex penetration are presented. The computer predictions indicate that relatively large aircraft (80,000 lb jet transport) can experience unacceptable vortex-induced roll excursions. In addition to evaluating the vortex-induced responses, the effect of pilot control input was assessed. It was found that pilot control inputs were momentarily out of phase with the vortex-induced disturbance. Thus the pilot's control inputs tended to aggravate the vortex-induced upsets. (Author)

A74-37800 # **An analytical method valid up to the critical speed for predicting store separation characteristics from modern aircraft.** M. F. E. Dillenius, F. K. Goodwin, and J. N. Nielsen (Nielsen Engineering and Research, Inc., Mountain View, Calif.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-775.* 16 p. 15 refs. Members, $1.50; nonmembers, $2.00. Contracts No. F33615-69-C-1337; No. F33615-71-C-1116; No. F33615-72-C-1375.

The method considered makes it possible to determine analytically flow fields induced by a parent aircraft, taking into account the effects of a swept wing, pylons, stores, and a fuselage with a noncircular cross section. Load distributions and forces on a store with or without empennage in a nonuniform flow field can also be investigated along with the six-degree-of-freedom trajectory characteristics of a store released from the parent aircraft. G.R.

A74-37801 # **Theoretical store separation analyses of a prototype store and comparison with a flight drop test.** H. R. Spahr (Sandia Laboratories, Albuquerque, N. Mex.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-776.* 11 p. 14 refs. Members, $1.50; nonmembers, $2.00. AEC-supported research.

Recently developed theoretical store separation and visual documentation computer programs were used to simulate the separation trajectory of a canard-controlled prototype store ejected from an F-4D aircraft. Computer-generated pictures of the store separation process are presented for normal separations and abnormal separations involving control system failures. Critical control system failures, which resulted in aircraft and store contact, were defined and were significantly reduced in probability by minor control system modifications. Also, since the computer simulation showed no store separation problems for the normal separations or separations involving control system failures with significant probabilities of occurrence, the need for store separation wind tunnel tests was eliminated. (Author)

A74-37810 * # **Estimation of nonlinear aerodynamic derivatives of a variable geometry fighter aircraft from flight data.** S. Ramachandran and W. R. Wells (Cincinnati, University, Cincinnati, Ohio). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-790.* 11 p. 13 refs. Members, $1.50; nonmembers, $2.00. Grant No. NGR-36-004-061.

This paper is concerned with the estimation of stability and control parameters of a high performance fighter aircraft from data obtained from high angle of attack flight. The estimation process utilizes a maximum likelihood algorithm derived for the case of a nonlinear aerodynamic force and moment model. The aircraft used was a high speed variable sweep heavy weight fighter with twin vertical tails. Comparisons of results from the nonlinear analysis are made with linear theory and wind tunnel results when available. (Author)

A74-37811 # **Status of design criteria for predicting departure characteristics and spin susceptibility.** R. Weissman (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-791.* 8 p. 13 refs. Members, $1.50; nonmembers, $2.00.

The most familiar criteria for predicting aircraft departure characteristics and spin susceptibility are based on lateral-directional static stability parameters. Data correlating the criteria with experimental results for several aircraft are considered. It is found that the criteria currently in use can be employed with a reasonable degree of confidence during preliminary design. The analysis suggested by Larson (1973) for predicting lateral-directional stability characteristics shows considerable promise. However, there are also some drawbacks. G.R.

A74-37812 # The effect of non-symmetric flight on aircraft high angle of attack handling qualities and departure characteristics. D. E. Johnston and J. R. Hogge (Systems Technology, Inc., Hawthorne, Calif.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-792.* 10 p. 13 refs. Members, $1.50; nonmembers, $2.00. Contract No. F33615-73-C-3101.

Analysis and simulation of an aircraft in unsymmetric flight has resulted in identification of new open- and closed-loop parameters which relate to a coupled longitudinal-lateral divergence known as nose slice departure. The coupling produces nonminimum phase zeros in the pitch attitude numerator at angle of attack below that for stall and at relatively small sideslip angles. Pilot control of pitch attitude via elevator then produces a lateral divergence. The phenomenon is traced through the equation of motion, effective stability derivative, transfer function, and root aerodynamic flow relationships. The results are verified by open- and closed-loop time histories from a nonlinear six-degree-of-freedom digital simulation and by fixed-base piloted simulation. (Author)

A74-37814 # Design for departure prevention in the YF-16. J. P. Lamers (General Dynamics Corp., Convair Aerospace Div., Fort Worth, Tex.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-794.* 8 p. Members, $1.50; nonmembers, $2.00.

During the analysis, design and wind tunnel testing of the YF-16, particular attention was paid to stability and control/flight control system requirements to ensure that the aircraft would have excellent handling qualities and maneuverability up to its maximum usable lift coefficient. Undesirable characteristics such as wing rock, pitchup, yaw divergence, excessive aileron yaw and pro-spin tendencies were eliminated within the operational flight envelope. This paper reviews the departure prevention aspects of the YF-16 design effort and provides selected examples of configuration decisions which have enhanced the ability of the aircraft to be flown safely and precisely throughout its intended flight envelope. (Author)

A74-37821 * # Jet transport energy management for minimum fuel consumption and noise impact in the terminal area. J. S. Bull and J. D. Foster (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-811.* 11 p. 6 refs. Members, $1.50; nonmembers, $2.00.

Significant reductions in both noise and fuel consumption can be gained through careful tailoring of approach flightpath and airspeed profile, and the point at which the landing gear and flaps are lowered. For example, the noise problem has been successfully attacked in recent years with development of the 'two-segment' approach, which brings the aircraft in at a steeper angle initially, thereby achieving noise reduction through lower thrust settings and higher altitudes. A further reduction in noise and a significant reduction in fuel consumption can be achieved with the 'decelerating approach' concept. In this case, the approach is initiated at high airspeed and in a drag configuration that allows for low thrust. The landing flaps are then lowered at the appropriate time so that the airspeed slowly decelerates to V sub r at touchdown. The decelerating approach concept can be applied to constant glideslope flightpaths or segmented flightpaths such as the two-segment approach. F.R.L.

A74-37822 # Sensitivity of suboptimal fixed-range flight paths. J. K. Hedrick (Arizona State University, Tempe, Ariz.) and M. A. Nichols (Arizona State University, Tempe, Ariz.; USAF, Weapons Laboratory, Kirtland AFB, N. Mex.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-813.* 8 p. 11 refs. Members, $1.50; nonmembers, $2.00.

The sensitivity of fuel consumption to variations in aircraft and atmospheric parameters is investigated using aerodynamic data for a F-4 type aircraft and atmospheric data as specified by MIL-STD-210A. The flight paths considered contain a full throttle 'Rutowski' energy climb arc, a classical minimum fuel cruise arc, and a maximum range glide arc. Aircraft parameters considered were maximum available thrust, induced and zero-lift drag coefficients, aircraft weight, and specific fuel consumption; atmospheric parameters considered were temperature and density variations. The results show that fuel consumption is sensitive to variations in the drag coefficients, aircraft weight, and specific fuel consumption. However, compensating by flying trajectories adjusted to be fuel optimal for each variation does not appreciably improve the fuel penalty. (Author)

A74-37823 # Differential-turning tactics. H. J. Kelley (Analytical Mechanics Associates, Inc., Jericho, N.Y.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-815.* 9 p. 8 refs. Members, $1.50; nonmembers, $2.00. Contract No. N00014-73-C-0328.

Turning chases in air-to-air combat are studied using the differential-game formulation of a companion paper by the author (1974). Energy-state vehicle models are employed and horizontal-plane kinematics are treated in terms of a turn-angle difference representation. Of the three simplest evasive tactics, out-climbing, out-turning, and out-dashing the adversary, the first two are encompassed by the modelling adopted. The tactics exploration focuses mainly upon open-loop and closed-loop control policies; however, a necessary condition for capture in a long-duration chase is obtained which appears useful for design purposes when used in conjunction with the conditions previously presented by the author. F.R.L.

A74-37824 * # High attitude delta wing unsteady aerodynamics. L. E. Ericsson and J. P. Reding (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-817.* 14 p. 40 refs. Members, $1.50; nonmembers, $2.00. Contract No. NAS8-28130.

An analysis of the steady and unsteady aerodynamics of sharp-edged slender wings has been performed. The results show that slender wing theory can be modified to give the potential flow static and dynamic characteristics in incompressible flow. A semiempirical approximation is developed for the vortex-induced loads, and it is shown that the analytic approximation for sharp-edged slender wings gives good prediction of experimentally determined steady and unsteady aerodynamics. The results indicate that the effects of delta planform lifting surfaces can be included in a simple manner when determining the aeroelastic characteristics of the space shuttle lift-off configuration. (Author)

A74-37829 # Application of parameter optimization methods to trajectory optimization. D. G. Hull (Texas, University, Austin, Tex.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-825.* 7 p. Members, $1.50; nonmembers, $2.00.

The application of a second-order parameter optimization method to the computation of optimal aerospace vehicle trajectories is discussed. Optimal trajectories are computed for a spacecraft, a reentry vehicle and a supersonic aircraft. Each example illustrates some aspect of the second-order method, that is, approximating the control, handling inequality constraints, scaling the correction vector, and computing derivatives. (Author)

A74-37833 * # **Closed loop analysis of manual flare and landing.** R. K. Heffley (Systems Technology, Inc., Mountain View, Calif.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-834.* 9 p. 5 refs. Members, $1.50; nonmembers, $2.00. Contract No. NAS2-7926.

This paper describes an approach to analyzing the manual flare and landing of an airplane. The basis of this approach is a mathematical model of the flare maneuver which is derived from manual landings of both real and simulated aircraft. This flare model in turn lends itself to a linear closed loop system description of the combined pilot/vehicle. Furthermore, simple Laplace transform methods can be used to map flare performance as functions of the flare maneuver. Having this link between flare maneuver and landing performance, we can estimate the pilot's ease in achieving desired levels of landing performance. Examples of this approach will be given using the results of a STOL airplane approach and landing simulation. (Author)

A74-37834 * # **Configuration management during transition for a powered lift STOL aircraft.** W. A. Johnson and S. J. Craig (Systems Technology, Inc., Hawthorne, Calif.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-836.* 6 p. 5 refs. Members, $1.50; nonmembers, $2.00. Contract No. NAS2-6441.

Presented in this paper are the analytical and moving-base simulation results of a study to improve flight safety and operations of V/STOL type aircraft. One of the more significant and novel aspects of the work accomplished has been the concept and implementation of a configuration management flight control system designed to take the guesswork out of, and improve the operational safety of, transition flight in the region from cruise to STOL. (Author)

A74-37849 # **Design philosophy of a three axis separate surface stability augmentation system for a small turboprop airliner.** W. R. Bolton (Sandia Laboratories, Livermore, Calif.) and D. J. Collins (Gates Learjet Corp., Wichita, Kan.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-860.* 9 p. 6 refs. Members, $1.50; nonmembers, $2.00.

This paper describes a design and development project undertaken to provide the benefits of full-time stability augmentation at a cost low enough to encourage application in general aviation aircraft. The stability augmentation investigated was attitude command mechanized through separate control surfaces. With attitude command, the automatic control system maintains aircraft attitude proportional to pilot control deflection despite disturbances such as atmospheric turbulence. Piloted flight simulation indicates that significant improvements in aircraft flying qualities may be provided by attitude command. The separate surface attitude command concept will be investigated and demonstrated in a flight test program on a Beech Model 99 modified for this purpose. (Author)

A74-37850 * # **Spoilers for roll control of light airplanes.** J. Roskam, D. L. Kohlman (Kansas, University, Lawrence, Kan.), and W. H. Wentz (Wichita State University, Wichita, Kan.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-861.* 14 p. 80 refs. Members, $1.50; nonmembers, $2.00. Grant No. NGR-17-002-072.

The paper presents an overview of the state-of-the-art of roll control spoilers for light airplanes. Reasons for using spoilers on light airplanes are presented. Several classical objections to the use of spoilers of such airplanes are critically examined. It is shown that mechanically driven spoiler systems can be designed. Flight test results of a new mechanically driven spoiler on the Redhawk airplane are discussed. Tunnel data of spoilers on the new general aviation airfoil GA(W)-1 are presented. Finally, a bibliography on spoiler data is included. (Author)

A74-37851 # **A method for preventing airplane stall/spin.** H. L. Chevalier, J. R. Brown, and R. A. Wilke (Texas A & M University, College Station, Tex.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-863.* 12 p. 5 refs. Members, $1.50; nonmembers, $2.00. U.S. Department of Transportation Contract No. FA73WA-3192.

A summary is given of the design considerations and operational characteristics of an aerodynamic spoiler system for preventing airplane stall. The spoiler is mounted on the under surface of the horizontal tail. The spoiler deploys to limit tail power at large angles of attack thereby preventing the airplane from reaching the angle of attack required for stall. The operation of the system is independent of pilot reaction and increases the stick force at high angles of attack. Flight test results show the method to be effective for both a single-engine and a twin engine airplane with different horizontal tail configurations. (Author)

A74-37855 # **A new concept for angular rate flight control sensors.** C. R. Abrams (U.S. Naval Material Command, Naval Air Development Center, Warminster, Pa.) and W. D. Weinstein (Grumman Aerospace Corp., Bethpage, N.Y.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-868.* 14 p. 11 refs. Members, $1.50; nonmembers, $2.00.

A redundant arrangement of angular rate sensors with skewed input axes, dispersed on an aircraft bulkhead, has been designed for fly-by-wire control applications. Compared to other redundant configurations, it best satisfied system reliability, survivability, and maintenance requirements. By also utilizing a high reliability 'solid-state' angular rate sensor expected maintenance costs will be decreased. The data management system designed for the sensor configuration featured a parallel-path failure detection and isolation algorithm. A unique method of selecting failure thresholds was developed to ensure that false-alarm probability and system errors were minimized. (Author)

A74-37863 # **DFW AIRTRANS transit system simulation.** R. A. Huffman (LTV Aerospace Corp., Vought Systems Div., Dallas, Tex.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-878.* 5 p. Members, $1.50; nonmembers, $2.00.

Description of a mathematical model of an intra-airport rapid transit system designed to transport passengers and baggage at the new Dallas - Fort Worth International Airport. The proposed simulation model moves trains and passengers over a guideway by processing time as an independent variable. All events such as train and passenger movement are associated with a specific simulation time and are processed at that time. At a particular simulation time, a type of event to occur in the future and the time of occurrence are determined. When the simulation time is incremented to the event occurrence time, the event is processed. A.B.K.

A74-37867 # **Sample rate selection for aircraft digital control.** J. D. Powell and P. Katz (Stanford University, Stanford, Calif.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-885.* 8 p. 20 refs. Members, $1.50; nonmembers, $2.00.

The identification and evaluation of the important considerations in selecting sample rates for aircraft digital control systems are discussed. The design method used in the evaluation is a discrete optimal synthesis technique which possesses no artificial sample rate constraints due to discretization approximations. As an illustration of the sample rate selection criteria, the methods were applied to an F-4 longitudinal design including wind gusts and a bending mode. The dominant limitations on the sample rate were found to be the transient response characteristics and the response due to wind disturbances. Stabilization of the bending mode was not a limiting factor on the sample rate, although it was necessary to desensitize the design for acceptable performance with imperfect knowledge of the bending mode frequency. (Author)

A74-37868 * # **Digital adaptive model following flight control.** G. S. Atag and H. Kaufman (Rensselaer Polytechnic Institute, Troy, N.Y.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-886.* 8 p. 11 refs. Members, $1.50; nonmembers, $2.00. Grant No. NGR-33-018-183.

Simple mechanical linkages are often unable to cope with the many control problems associated with high performance aircraft maneuvering over a wide flight envelope. One procedure for retaining uniform handling qualities over such an envelope is to implement a digital adaptive controller. Towards such an implementation an explicit adaptive controller, which makes direct use of online parameter identification, has been developed and applied to the linearized equations of motion for a typical fighter aircraft. The system is composed of an online weighted least squares identifier, a Kalman state filter, and a single stage real model following control law. The corresponding control gains are readily adjustable in accordance with parameter changes to ensure asymptotic stability if the conditions for perfect model following are satisfied and stability in the sense of boundedness otherwise. (Author)

A74-37869 * # **Digital explicit model following with unstable model dynamics.** E. S. Armstrong (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-888.* 10 p. 13 refs. Members, $1.50; nonmembers, $2.00.

In the optimal regulator formulation of discrete explicit model following the Riccati equation may fail to reach a steady-state value for model dynamics which are not asymptotically stable. Such conditions often arise in aircraft applications when flying quality criteria based on step inputs are used to define the model equations. Mathematical conditions are presented which insure a steady-state value of the model-following gain matrix regardless of the behavior of the underlying Riccati equation. These results are applied to the design of a model-following controller for the lateral motion of a typical fighter aircraft using unstable model equations. (Author)

A74-37886 # **The Hazeltine Doppler microwave landing system - Specialized techniques and features.** S. P. Litt, H. W. Redlien, J. J. Zeltser, P. W. Hannan (Hazeltine Corp., Greenlawn, N.Y.), and S. H. Black (Sperry Rand Corp., Sperry Flight Systems Div., Phoenix, Ariz.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-905.* 18 p. Members, $1.50; nonmembers, $2.00. U.S. Department of Transportation Contract No. FA72WA-2804.

Review of the implementation and performance of a Doppler microwave landing system for use in high-density, high-category landing situations. The proposed system consists of angle guidance equipment operating at C-band and Ku-band for azimuth, elevation, and flare guidance and a C-band DME for ranging. A distinctive feature of the system is the way planar guidance coordinates are provided in unitary Doppler antennas in only a single time slot for each azimuth and elevation function. A small selection of performance data is presented which shows the effectiveness of the system design. A.B.K.

A74-37889 # **System design and flight test results of the Bendix/Bell MLS category II/III elevation approach guidance function.** R. J. Kelly (Bendix Corp., Communications Div., Towson, Md.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-909.* 17 p. 10 refs. Members, $1.50; nonmembers, $2.00. FAA-sponsored research.

A74-37890 * # **Flight evaluation of a Mach 3 cruise longitudinal autopilot.** G. B. Gilyard, J. W. Smith (NASA, Flight Research Center, Edwards, Calif.), and V. L. Falkner (Honeywell, Inc., Minneapolis, Minn.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-910.* 11 p. 6 refs. Members, $1.50; nonmembers, $2.00.

At high Mach numbers (approximately 3) and altitudes greater than 70,000 feet, the original altitude and Mach hold modes of the YF-12 autopilot produced aircraft excursions that were erratic or divergent or both. Data analysis and simulator studies showed that static pressure port sensitivity to angle of attack had a detrimental effect on the performance of both altitude and Mach hold modes. Good altitude hold performance was obtained when a high-passed pitch rate feedback was added to compensate for angle-of-attack sensitivity and the altitude error and integral altitude gains were reduced. Good Mach hold performance was obtained with the removal of angle-of-attack sensitivity. (Author)

A74-37893 # **A classical approach to the design of model-following control systems.** P. R. Motyka (Calspan Corp., Buffalo, N.Y.). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-913.* 10 p. 6 refs. Members, $1.50; nonmembers, $2.00. Contract No. N62269-73-C-0937.

This paper presents the development of a classical design technique for determining feedback gains which lessen the sensitivity of model-following flight control systems to parameter variations. The gains are chosen to achieve suitable stable closed-loop poles as defined by parameters such as frequency, damping, bandwidth, etc. A model-following flight control system for a fighter aircraft is designed to demonstrate the technique. A brief development of linear model-following theory is presented. The design of both the longitudinal and lateral-directional feedback systems using the classical approach is considered. The use of sideslip angle feedback and y-direction acceleration feedback for the lateral-directional system are contrasted. Time histories of the model and plant responses are compared throughout to demonstrate the validity of the design technique. (Author)

A74-37894 # **Impact of new MIL-F-9490D requirements on future flight control developments.** J. L. Townsend (Boeing Co., Wichita, Kan.) and P. E. Blatt (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Mechanics and Control of Flight Conference, Anaheim, Calif., Aug. 5-9, 1974, Paper 74-914.* 7 p. 9 refs. Members, $1.50; nonmembers, $2.00. Contract No. F33615-72-C-1090.

The task objective was to develop a general purpose quantitative flight control specification having long-term applicability for all Air Force piloted aircraft. These aircraft span the entire range of fighters, transports, bombers, trainers, STOL, VTOL, helicopters, and utility vehicles. Mechanizations span the gamut of mechanical, electrical (both analog and digital), hydraulic, pneumatic, and optical designs with many combinations of elements. Requirements were to be specified in such a way as to provide maximum designer freedom for design, since progressive improvement in the state-of-the-art is desired. At the same time, quantitative system requirements (safety, mission reliability, stability margins, failure transients, AFCS modes, etc.) were to be established based on state-of-the-art knowledge. Past experience and recent technology development programs formulate these state-of-the-art requirements. F.R.L.

A74-37920 Solid particle erosion of graphite-epoxy composites. J. H. Williams, Jr. and E. K. Lau (MIT, Cambridge, Mass.). *Wear*, vol. 29, Aug. 1974, p. 219-230. 8 refs. NSF-supported research.

Research to determine the quantitative effects of the various solid particle impingement erosion factors on the wear of uncoated graphite-epoxy composites is summarized. The investigation was primarily experimental and phenomenological. The erosion factors that are considered are the particle size, velocity, and impact angle. Clearly the erosion of a particular specimen depends on the properties of the target material as well. These properties are accounted for by the experimentally determined erosion system constants which are defined. A limited investigation of the rain erosion behavior was conducted at Mach 1.5 and 2.0. F.R.L.

A74-37921 # **The quantitative description of a traffic control process.** S. Ratcliffe and H. Gent (Royal Radar Establishment, Malvern, Worcs., England). *Journal of Navigation*, vol. 27, July 1974, p. 317-322.

An attempt is made to develop a qualitative method for the evaluation of the service quality provided by an automatic air traffic control system. Essential in the method is the selection of a suitable technique for condensation of the information contained in an Index of Orderliness plot with or without information on the time response of the system. A block diagram is included to demonstrate the relationship between an Index of Orderliness and automatic air traffic control system. V.Z.

A74-37923 # **Digital computing and the display requirements in modern aircraft. II - Modern display techniques.** D. E. Humphries (Royal Aircraft Establishment, Bedford, Hants., England). *Journal of Navigation*, vol. 27, July 1974, p. 331-341.

The ingredients of the man/computer interface in single-seat and two-seat aircraft are discussed, with particular attention to the insertion of pre-mission data and of revised target data in flight. It is assumed that the long-range navigation system uses an inertial platform coupled through a statistical filter to the main computer with a Doppler velocity measuring unit. Details are given on the use of a mapping radar and on the display devices, including multipurpose displays used by modern display technology. V.Z.

A74-37999 # **Manual of the aviation engineer (Spravochnik aviatsionnogo inzhenera).** V. G. Aleksandrov, V. V. Myrtsymov, S. P. Ivtev, A. V. Maiorov, K. V. Borshchov, and I. A. Khaimovich. Moscow, Izdatel'stvo Transport, 1973. 400 p. In Russian.

Questions of practical aerodynamics of aircraft including helicopters are examined, giving attention to basic characteristics of the air, fundamental aerodynamic equations, aircraft parameters, aircraft takeoff and landing operations, and various flight considerations. External loads and the strength of aircraft components are discussed along with safety considerations, operational life, maintenance problems, economical questions, the interchangeability of aircraft components, glider design, aircraft engines, and aspects of aviation instrumentation. G.R.

STAR ENTRIES

N74-27471# Joint Publications Research Service, Arlington, Va.
AERODYNAMICS OF AIRFOILS
1 Jul. 1974 45 p refs Transl. into ENGLISH from the publ. "Gidrodinamika Nesushchikh Poverkhnostey" Moscow, 1966 44 p
(JPRS-62363) Avail: NTIS HC $5.25
The aerodynamic stability of moving airfoils is considered in relation to a barrier surface.

N74-27472 Joint Publications Research Service, Arlington, Va.
MOTION OF AN AIRFOIL WITH VARIABLE DISTANCE FROM A BARRIER
A. N. Panchenkov *In its* Aerodyn. of Airfoils (JPRS-62363) 1 Jul. 1974 p 1-6 refs Transl. into ENGLISH from the publ. "Gidrodinamika Nesushchikh Poverkhnostey" Moscow, 1966 p 200-205
During motion of a wing at variable distances from the barrier the problem will become nonstationary due to a change of influence of the barrier, and evaluation of the influence of this effect on the hydrodynamic characteristics of the wing is of tremendous importance in connection with problems of take-off and landing instability of air cushioned vehicles and aircraft. Thus, during analysis of a nonstationary motion of a wing near a barrier it is necessary to take into consideration two forms of nonstationary perturbations: perturbations of velocity and perturbations of distance from the barrier. Author

N74-27473 Joint Publications Research Service, Arlington, Va.
LONGITUDINAL STATIC STABILITY OF VEHICLES WITH TWO LIFTING WINGS **c02**
V. I. Korolev *In its* Aerodyn. of Airfoils (JPRS-62363) 1 Jul. 1974 p 7-13 Transl. into ENGLISH from the publ. "Gidrodinamita Nesushchikh Poverkhnostey" Moscow, 1966 p 216-222

The static stability of vehicles with two foils - leading and trailing (tandem system) separated by some distance, determined by the length of the hull of the vehicle, is analyzed.
Author

N74-27478# Joint Publications Research Service, Arlington, Va.
MOTION OF VEHICLE WITH LIFTING AIRFOILS OVER RIPPLED WATER SURFACE
V. I. Korolev 27 Jun. 1974 6 p Transl. into ENGLISH from Gidrodinamika Bolshikh Skorostey (Moscow), no. 2, 1966 p 75-80
(JPRS-62337) Avail: NTIS HC $4.00
The motion of vehicles with lifting airfoils over rippled water surfaces is considered. It is shown that the calculations are acceptable in terms of frequency for waves of the length not exceeding 2L. The amplitude of the waves also must not exceed a determined height. With the vehicle in such motion, the increment of forces on the lifting surfaces depends only on the distance between the surfaces and the surface of the water. The nonstationary nature of the aerodynamic forces and the mutual influence of the airfoils are ignored. Mathematical models are developed to show the relationships of the parameters.
Author

N74-27479*# Kanner (Leo) Associates, Redwood City, Calif.
WIND TUNNEL INVESTIGATIONS AIMED AT DEVISING TESTS OF AIRCRAFT SPIN
J. Gobeltz and M. Vanmansart Washington NASA Jun. 1974 50 p Transl. into ENGLISH from the 10th Aerodyn. Appliquee (Lille), 7-9 Nov. 1973 42 p
(Contract NASw-2481)
(NASA-TT-F-15726) Avail: NTIS HC $5.50 CSCL 01A
The nature and characteristics, and the conditions of aircraft spin are studied in a conventional, and spin wind tunnel. An anemometer technique was adapted for this purpose. The results provide better insight into the spin phenomenon, and form a basis for developing means of recovering from spin. The use of a parachute and auxiliary jets as means of mastering aircraft spin are studied. Author

N74-27483*# Kanner (Leo) Associates, Redwood City, Calif.
ANALYSIS OF THE AERODYNAMIC CHARACTERISTICS OF DEVICES FOR INCREASING WING LIFT. 3: INFLUENCE OF GROUND PROXIMITY ON THE AERODYNAMIC CHARACTERISTICS OF THE FLAPS
Rafael Gamcarek Washington NASA Jul. 1974 7 p Transl. into ENGLISH from Tech. Lotnicza Astronaut. (Warsaw), v. 28, Jun. 1973 p 21-29
(Contract NASw-2481)
(NASA-TT-F-15762) Avail: NTIS HC $4.00 CSCL 01A
The effect of ground proximity on the aerodynamic characteristics of flaps is discussed. Diagrams are presented which can be used to plot the aerodynamic characteristic of the aircraft taking into account the proximity of the ground. The conclusions based on the discussion are presented. Author

N74-27484*# Kanner (Leo) Associates, Redwood City, Calif.
TURBULENT LIFT. COMMENTS ON SOME PRELIMINARY WIND TUNNEL TESTS
R. A. Westesson and U. Clareus Washington NASA Jun. 1974 33 p refs Transl. into ENGLISH from the Swedish report TP-74-51
(Contract NASw-2481)
(NASA-TT-F-15743; TP-74-51) Avail: NTIS HC $4.75 CSCL 01A
Three-dimensional tests were carried out to establish a stable and useful vortex in the tangential direction over a straight wing using tangential blowing on the upper side of the wing. When the tangential blowing was sufficiently strong, contact flow was obtained at very high angles of incidence. Quantitative data indicated that there was a decreased total drag at increasing tangential blowing and constant angle of incidence. Author

N74-27485*# Boeing Commercial Airplane Co., Seattle, Wash.
STUDY OF THE SINGLE BODY YAWED-WING AIRCRAFT CONCEPT Contractor Report, 1 Jul. - 1 Dec. 1973
Robert M. Kulfan, James W. Nisbet, Frank D. Neuman, Edward J. Hamilton, James K. Murakami, John P. McBarron, and Kazuo Kumasaka May 1974 97 p refs
(Contract NAS2-7031)
(NASA-CR-137483) Avail: NTIS HC $8.00 CSCL 01B
Areas relating to the development and improvement of the single-fuselage, yawed-wing transonic transport concept were investigated. These included: (1) developing an alternate configuration with a simplified engine installation;(2) determining a structural design speed placard that would allow the engine-airframe match for optimum airplane performance; and (3) conducting an aeroelastic stability and control analysis of the yawed-wing configuration with a flexible wing. A two-engine, single-fuselage, yawed-wing configuration was developed that achieved the Mach 1.2 design mission at 5560 km (3000 nmi) and payload of 18,140 kg (40,000 lb) with a gross weight of 217,700 kg (480,000 lb). This airplane was slightly heavier than the aft-integrated four-engine configuration that had been developed in a previous study. A modified structural design speed placard, which was determined, resulted in a 6% to 8% reduction in the gross weight of the yawed-wing configurations. The dynamic stability characteristics of the single-fuselage yawed-wing configuration were found to be very dependent on the magnitude of the pitch/roll coupling, the static longitudinal stability, and the dihedral effect. Author

N74-27486# Naval Postgraduate School, Monterey, Calif.
AN EXPERIMENTAL STUDY OF A VANE CONTROLLED JET FLAP GUST ALLEVIATION SYSTEM M.S. Thesis

Leonard Joseph Deal, Jr. Mar. 1974 77 p refs
(AD-777987) Avail: NTIS CSCL 01/1

An experimental effort to demonstrate the feasibility of an active gust alleviator using a fluidically actuated jet flap control system was undertaken. The wing model had a variable deflection jet at the trailing edge and was free to move in pitch only. A vane mounted ahead of the wing served as gust sensor and provided the signal which controlled jet angle. Experimental results showed the system capable of alleviating up to 92% of the motion caused by a sinusodial gust at constant amplitude. RMS values of wing rotation angle were found to be 0.68 degrees with control off and 0.29 degrees with control on when excited by a random two-dimensional gust. Author (GRA)

N74-27490* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
JET EXHAUST NOISE SUPPRESSOR Patent
Ronald G. Huff, inventor (to NASA) Issued 28 Jun. 1974 4 p Filed 9 Mar. 1973 Supersedes N73-21066 (11 - 12, p 1364)
(NASA-Case-LEW-11286-1; US-Patent-3,820,630; US-Patent-Appl-SN-339806; US-Patent-Class-181-33HB; US-Patent-Class-239-265.17) Avail: US Patent Office CSCL 01C

Noise suppression for a jet engine exhaust is provided by an annular divergent body attached to an exhaust nozzle. The smallest diameter of the divergent body is larger than the diameter of the exhaust nozzle exit to form an annular step which produces a shock wave in the exhaust as it passes the step. An annular shroud is disposed around the divergent body and causes outside air to pass through voids in the divergent body to mix with the jet exhaust gas. The divergent body includes a plurality of channels with separators between the channels.
Official Gazette of the U.S. Patent Office

N74-27491*+ National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
BIBLIOGRAPHY ON AIRCRAFT FIRE HAZARDS AND SAFETY. VOLUME 1: HAZARDS. PART 1: KEY NUMBERS 1 TO 817
James J. Pelouch, Jr., comp. and Paul T. Hacker, comp. May 1974 272 p refs
(NASA-TM-X-71553-Vol-1-Pt-1; E-7986-Vol-1-Pt-1) Avail: NTIS HC $6.50 CSCL 01C

Ignition temperatures of n-hexane, n-octane, n-decane, JP-6 jet fuel, and aircraft engine oil MIL-7-7808 (0-60-18) were determined in air using heated Pyrex cylinders and Nichrome wires, rods, or tubes. Ignition temperature varied little with fuel-air ratio, but increased as the size of the heat source was decreased. Expressions are given which define the variation of the hot surface ignition temperatures of these combustibles with the radius and the surface area of the heat source. The expressions are applicable to stagnant or low velocity flow conditions (less than 0.2 in./sec.). In addition, the hot gas ignition temperatures of the combustible vapor-air mixtures were determined with jets of hot air. These ignition temperatures also varied little with fuel-air ratio and increased as the diameter of the heat sources was decreased. Author

N74-27492*+ National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
BIBLIOGRAPHY ON AIRCRAFT FIRE HAZARDS AND SAFETY. VOLUME 2: SAFETY. PART 1: KEY NUMBERS 1 TO 524
James J. Pelouch, Jr., comp. and Paul T. Hacker, comp. May 1974 397 p refs
(NASA-TM-X-71553-Vol-2-Pt-1) Avail: NTIS HC $8.25 CSCL 01C

Bibliographic citations are presented to describe and define aircraft safety methods, equipment, and criteria. Some of the subjects discussed are: (1) fire and explosion suppression using whiffle balls, (2) ultraviolet flame detecting sensors, (3) evaluation of flame arrestor materials for aircraft fuel systems, (4) crash fire prevention system for supersonic commercial aircraft, and (5) fire suppression for aerospace vehicles. Author

N74-27493*# Scientific Translation Service, Santa Barbara, Calif.
FLIGHT CONTROL PROBLEMS FOR STEEP APPROACHES
R. Brockhaus Washington NASA Jun. 1974 34 p refs Transl. into ENGLISH of "Flugfuehrungsprobleme des Steilanfluges", Tech. Univ. Braunschweig, Zentralstelle der Luftfahrtdokumentation, DGLR-Paper-73-027 presented at the Symp. on New Approach and Landing Tech., 2-4 May 1973, 34 p
(Contract NASw-2483)
(NASA-TT-F-15617; DGLR-Paper-73-027) Avail: NTIS HC $4.75 CSCL 01C

STOL approach methods are discussed including trajectory angles of 6 deg and 12 deg. Past STOL American projects are reviewed. It is found that STOL steep approaches involve the following: (1) design of flight control system, (2) area navigation system, (3) thrust control system, (4) development of microwave guide beam systems, (5) retraining of pilots, and (6) greatly increased reliability requirements on all systems. The information requirements for these approaches are compared with the information required for conventional ILS landings. Traffic control problems and traffic integration problems with conventional traffic are discussed. Author

N74-27494# Royal Aircraft Establishment, Farnborough (England).
GROUND LOADS ON THE NOSE UNDERCARRIAGE OF THE F-104G AIRCRAFT
O. Buxbaum Mar. 1974 68 p refs Transl. into ENGLISH from the German report TB-103
(RAE-Lib-Trans-1744; BR40625; TB-103) Avail: NTIS HC $6.50

The report gives the results of a statistical analysis of the forces measured on the nose landing gear of two F-104G aircraft during take-off, landing, and taxiing. Most, but not all, of the information required to build-up a fatigue loading spectrum was obtained. Author

N74-27497*# Aerospace Corp., El Segundo, Calif.
AN ECONOMIC ASSESSMENT OF STOL AIRCRAFT POTENTIAL INCLUDING TERMINAL AREA ENVIRONMENTAL CONSIDERATIONS, VOLUME 1 Final Report
H. L. Solomon and S. Sokolsky Washington NASA May 1974 126 p refs 2 Vol.
(Contract NAS2-6473)
(NASA-CR-2424) Avail: NTIS HC $4.75 CSCL 01C

The results of an economic and environmental study of short haul airline systems using short takeoff and landing (STOL) aircraft are presented. The STOL system characteristics were optimized for maximum patronage at a specified return on investment, while maintaining noise impact compatibility with the terminal area. Supporting studies of aircraft air pollution and hub airport congestion relief were also performed. The STOL concept specified for this study was an Augmentor Wing turbofan aircraft having a field length capability of 2,000 ft. and an effective perceived noise level of 95 EPNdB at 500 ft. sideline distance. An economic and environmental assessment of the defined STOL system and a summary of the methodology, STOL system characteristics and arena characteristics are provided. Author

N74-27498*# McDonnell Aircraft Co., St. Louis, Mo.
CONCEPTUAL DESIGN STUDIES OF A V/STOL CIVIL LIFT FAN TRANSPORT INCLUDING EFFECT OF SIZE AND FAN PRESSURE RATIO
Washington NASA Jul. 1974 64 p refs
(Contract NAS2-5499)
(NASA-CR-2426) Avail: NTIS HC $3.75 CSCL 01C

Conceptual design studies of V/STOL Lift Fan Commercial short-haul transport aircraft for the 1980-85 time period were studied to determine their technical and economic feasibility. The remote lift fan configurations with a variation in fan pressure ratio from 1.2 to 1.5 were investigated. Also studied were variation in stage length from 200 nautical miles to 800 nautical miles and cruise Mach numbers of 0.75 and 0.85. These results indicate a four engine configuration was feasible. The 95 PNdb noise footprint would be approximately 45 acres and the DOC's would be about 60% greater than conventional transports. Author

N74-27499*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
FLIGHT EVALUATION OF ADVANCED CONTROL SYSTEMS AND DISPLAYS ON A GENERAL AVIATION AIRPLANE
Paul C. Loschke, Marvin R. Barber, Einar K. Enevoldson, and Thomas C. McMurtry Washington Jun. 1974 51 p refs
(NASA-TN-D-7703; H-783) Avail: NTIS HC $3.75 CSCL 01C

A flight-test program was conducted to determine the effect of advanced flight control systems and displays on the handling qualities of a light twin-engined airplane. A flight-director display and an attitude-command control system, used separately and in combination, transformed a vehicle with poor handling qualities during ILS approaches in turbulent air into a vehicle with good handling qualities. The attitude-command control system also improved the ride qualities of the airplane. A rate-command control system made only small improvements to the airplane's ILS handling qualities in turbulence. Both the rate- and the attitude-command control systems reduced stall warning in the test airplane, increasing the likelihood of inadvertent stalls. The final approach to the point of flare was improved by both the rate- and the attitude-command control systems. However, the small control wheel deflections necessary to flare were unnatural and tended to cause overcontrolling during flare. Airplane handling qualities are summarized for each control-system and display configuration. Author

N74-27500*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DYNAMICS OF TILTING PROPROTOR AIRCRAFT IN CRUISE FLIGHT
Wayne Johnson May 1974 257 p refs Prepared in cooperation with Army Air Mobility Research and Development Lab., Moffett Field, Calif.
(NASA-TN-D-7677; A-5032) Avail: NTIS HC $6.50 CSCL 01C

A nine degree-of-freedom theoretical model is developed for investigations of the dynamics of a proprotor operating in high inflow axial flight on a cantilever wing. The basic characteristics of the rotor high inflow aerodynamics and the resulting rotor aeroelastic behavior are discussed. The problems of classical whirl flutter, the two-bladed rotor, and the influence of the proprotor on the stability derivatives of the aircraft are treated briefly. The influence of various elements of the theoretical model is discussed, including the modeling used for the blade and wing aerodynamics, and the influence of the rotor lag degree of freedom. The results from tests of two full-scale proprotors - a gimballed, stiff-inplane rotor and a hingeless, soft-inplane rotor - are presented; comparisons with the theoretical results show good correlation. Author

N74-27501*# Giravions Dorand Co., Paris (France).
ANALYTICAL STUDY OF STRESSES RECORDED IN THE DH 2011 ROTOR BLADES Final Report
Marcel Kretz, Jean-Noel Aubrun, and Marc Larche Jul. 1973 92 p refs Sponsored in part by Army Air Mobility R and D Lab.
(Contract NAS2-3673)
(NASA-CR-137527; DH-2011-C-E1) Avail: NTIS HC $7.75 CSCL 01C

An analytical study of stresses in the blades recorded during the tests of the DH 2011 jet flap rotor was performed. The main objective of the study was to compare the experimental results with analytically determined stresses. The comparison extended over 15 specific flight cases has been only partially successful. In fact computed 3P and 4P stress components showed only a poor correlation with the test data obtained. It is believed that the simplified model of aeroelastic effects used is mainly responsible for this lack of agreement with test results. Author

N74-27502# Joint Publications Research Service, Arlington, Va.
MINIMA FOR LANDING AIRCRAFT
S. L. Belogorodskiy 17 Jun. 1974 8 p Transl. into ENGLISH from Grazhdanskaya Aviatsiya (Moscow), no. 10, 1971 p 20-21
(JPRS-62252) Avail: NTIS HC $4.00

A method for determining takeoff and landing minimum conditions for civil aviation aircraft operators is described. Instead of cloud base altitude as the basis for determining minimum landing conditions, it is recommended that decision altitude be used. Using the decision altitude, it is possible for the pilot to obtain the information required for range of visibility along the runway in time to make necessary corrections. This in turn determines the conditions under which it is permissible to begin the landing approach. Author

N74-27503*# Kanner (Leo) Associates, Redwood City, Calif.
ON THE USE OF BRANCH MODES FOR THE CALCULATION OF HELICOPTER STRUCTURAL DYNAMIC CHARACTERISTICS
C. T. Tran, W. Twomey, and R. Dat Washington NASA Jul 1974 45 p refs Transl. into ENGLISH from Rech. Aerosp. (France) no. 6, Nov. - Dec. 1973 p 337-354
(Contract NASw-2481)
(NASA-TT-F-15713) Avail: NTIS HC $5.25 CSCL 01C

The dynamic characteristics of the complete helicopter structure, including fuselage and rotor, are determined from the normal branch modes which characterize separately the fuselage and the blades. With an appropriate choice of coordinates, a set of second order linear differential equations with constant coefficients is obtained. The solutions define natural vibration modes which vary with the blade rotational speed. The results obtained on a helicopter model agree with the experiment. Author

N74-27504# Defence and Civil Inst. of Environmental Medicine, Downsview (Ontario). Behavioural Sciences Div.
NOISE LEVELS IN THE CH-113A AND CUH-IN HELICOPTER
R. A. Strong and R. B. Crabtree Dec. 1973 10 p ref
(DCIEM-73-R-993) Avail: NTIS HC $4.00

Noise levels were measured on board the CUH-IN and CH-113A helicopters. Properly fitted flight helmets provide adequate hearing protection for personnel in the cockpits of both aircraft and in the cargo/passenger area of the CUH-IN. However ear plugs or ear muffs do not provide adequate hearing protection for flight exceeding two hours in the cargo/passenger area of the CH-113A. Author

N74-27505*# Pennsylvania State Univ., University Park.
INVESTIGATION OF THE LARGE SCALE COHERENT STRUCTURE IN A JET AND ITS RELEVANCE TO JET NOISE
Roger E. A. Arndt and W. K. George [1974] 20 p refs
(Grant NGR-39-009-270)
(NASA-CR-138908) Avail: NTIS HC $4.00 CSCL 20A

A study was conducted to determine the causes of aircraft noise in large jet aircraft. It was determined that jet noise varies strongly with velocity and that significant pure tones are generated by rotor-stator interaction in the jet engines. An objective method for deducing the large eddy structure in a large jet is described. The provisions of lighthill's theory are analyzed and applied to investigating the nature of jet noise. There is considerable evidence that a large scale coherent structure exists in a jet and that this structure can play a major role in sound radiation. Mathematical models are developed to define the parameters of orthogonal decomposition, finite extent velocity field, homogeneous fields, and periodic velocity fields. Author

N74-27506# Royal Aircraft Establishment, Farnborough (England).
DETERMINATION OF THE DERIVATIVES OF LONGITUDINAL MOTION OF AN AIRCRAFT FROM FLIGHT DATA BY A MODEL WITH AUTOMATIC PARAMETER ADJUSTMENT
R. Koehler Jan. 1974 27 p refs Transl. into ENGLISH from the German report DLR-FB-73-13
(RAE-Lib-Trans-1740; BR39731; DLR-FB-73-13) Avail: NTIS HC $4.50

A circuit is discussed for determining the derivatives of an aircraft from flight data, which needs relatively few computing elements in an analogue computer. Since the analysis also covers quadratic terms, the polar can be determined from the coefficients as found in the neighbourhood of a point. The results of an evaluation of flight data are discussed. Author

N74-27507# Technology, Inc., Dayton, Ohio.
T-38 STRUCTURAL FLIGHT LOADS DATA FOR JUNE 1970 THROUGH DECEMBER 1971 Final Report, 1 Jun. 1970 - 31 Mar. 1972
Larry E. Clay and Ronald I. Rockafellow Mar. 1972 148 p refs
(Contracts F33657-70-D-1161; F33657-71-D-0662)
(AD-758891; ASD-TR-72-54) Avail: NTIS HC $3.00 CSCL 01/3

In a fifth part of a continuing T-38 Service Loads Recording Program (SLRP) to cover the period from 1 June 1970 through 31 December 1971, 4265 hours of VGH data were recorded by A/A24U-10 magnetic tape recording systems installed in

N74-27508# Westinghouse Electric Corp., Baltimore, Md. Systems Development Div.
COBRA WINDOW DESIGN ANALYSIS AND NO GLARE CANOPY DESIGN Final Report
Richard H. Daumit and James B. Kiesel Mar. 1974 37 p ref
(Contracts DAAD05-72-C-0284; DAAD05-73-C-0305)
(AD-778165; LWL-CR-06P72) Avail: NTIS CSCL 01/3

The report details the work related to the redesign and modification of the canopy of the Attack Helicopter (AH-1G) to minimize sun reflections and thereby reduce the probability of detection through visual observation. There were two objectives in this effort, namely: Canopy redesign through analysis of directional components of reflections; and computer analysis of the design in a modified version of a special program developed in earlier work entitled Cobra Glint Model, AH-1G. (Modified author abstract) GRA

N74-27509# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering.
THE EFFECT OF WIPICS ON THE F4-B TO N CONVERSION PROGRAM Final Report, Jun. 1973 - Apr. 1974
Norman K. Womer Apr. 1974 47 p refs
(AD-777256; AFIT-TR-74-5; AU-5-1974-AFIT-ENS) Avail: NTIS CSCL 15/5

The report provides the underlying theory and methods used to determine the affect of the Work in Process Inventory Control System (WIPICS) on the F4-B to N conversion program and the Naval Air Rework Facility, North Island, California. The report documents cost savings of 3.24% of the before WIPICS. It also concludes that these cost savings are statistically significant at the 10% level. Author (GRA)

N74-27510# Honeywell, Inc., Minneapolis, Minn. Government and Aeronautical Products Div.
HYDROFLUIDIC YAW SAS ANALYSIS DESIGN AND DEVELOPMENT Final Report, 1 Apr. 1972 - 1 Oct. 1973
Harvey D. Ogren Mar. 1974 62 p refs
(Contract DAAJ02-72-C-0051; DA Proj. 1F1-62204-AA-44)
(AD-777804; GAPD-W0517-FR; USAAMRDL-TR-74-4) Avail: NTIS CSCL 01/3

The objective of this program was to design and develop the integrated sensor/controller/series servoactuator package of a hydrofluidic stability augmentation system which will be subsequently demonstrated during operational suitability tests. The sensor/controller was designed based on the performance of a breadboard model that was flight tested in the OH-58A helicopter. From the flight test program, the system gain was increased and a straight rate loop was added as a result of pilot requests. The final system gain was 0.023 inch of servoactuator per degree per second of rate input. The straight rate loop gain was set at 10% of the system gain. Temperature compensation was incorporated into the various circuits by adding negative feedback that contained a viscous resistor. This technique reduced the gain change versus temperature that was obtained in the past. (Modified author abstract) GRA

N74-27512# Army Aviation Systems Command, St. Louis, Mo.
MAJOR ITEM SPECIAL STUDY (MISS), OH-6 A TAIL ROTOR ASSEMBLY Interim Report, Jan. 1964 - Jul. 1973
Apr. 1974 22 p
(AD-778166; USAAVSCOM-TR-74-22) Avail: NTIS CSCL 01/3

The report is designed to illustrate cost savings which would result from specific efforts in the areas of product improvement in quality and design. For the purpose of this study the cost savings produced in the area of product improvement are based on total elimination of a certain failure mode or modes. Appropriate modes are chosen because of their proportion of the total removals or their proportion in combination with other similar modes. These eliminated removals are then assumed to follow the distribution of the remaining removal modes. The actual cost savings are determined from the increase in the mean time to removal based on the new removal distributions. GRA

N74-27514# Army Air Mobility Research and Development Lab., Fort Eustis, Va.
AN EXPERIMENTAL AND ANALYTICAL INVESTIGATION OF THE POTENTIAL FLOW FIELD, BOUNDARY LAYERS, AND DRAG OF VARIOUS HELICOPTER FUSELAGE CONFIGURATIONS
James Gillespie, Jr. and Richard I. Windsor Jan. 1974 62 p refs
(AD-777798; USAAMRDL-TN-13) Avail: NTIS CSCL 01/1

An investigation has been performed to analytically determine the flow field about a helicopter fuselage and to apply the results to the prediction of parasite drag. The analytical method is currently restricted to nonlifting bodies in nonyawed flow. The flow field is determined by using the Douglas-Neumann computer program for the potential field and a boundary layer analysis based upon the small cross-flow assumption. Pressure distribution correlation between test data and the Douglas-Neumann program is very good except for areas of separated flow. Agreement is also good between boundary layer velocity profiles obtained from test data and from the boundary layer analysis. An empirical approach based on test data is used to approximate the pressure in the separated region. Drag is obtained by numerical integration of the pressure and skin friction distribution. Agreement is reasonable between test data and the drag obtained by the summation process. The analytical method has potential application in the design of helicopter fuselages of minimum parasite drag. Author (GRA)

N74-27515# Arkansas Univ., Little Rock. Medical Center.
TRANSMISSION THERMAL MAPPING (UH-1 MAIN ROTOR TRANSMISSION) Final Report, Jul. 1972 - Feb. 1973
J. H. Drennan and R. D. Walker Dec. 1973 88 p
(Contract DAAJ02-72-C-0081; DA Proj. 1G1-62207-AA-72)
(AD-777803; BHC-299-099-652; USAAMRDL-TR-73-90) Avail: NTIS CSCL 01/3

The report contains the results of a series of tests conducted to obtain thermal maps of a UH-1 main rotor transmission. The oil-out temperatures. Also, the thermal growth of the transmission cases at selected locations was measured and recorded. The general conclusions of this report are summarized as follows: the major heat generating area was the input spiral bevel pinion and its related bearings; thermal stability could not be attained at full-bypass of the oil cooler at 60% torque; thermal gradients indicate that the transmission output mast may be efficiently utilized as a heat sink by pressure wetting the surface. Author (GRA)

N74-27516# Firestone Coated Fabrics Co., Magnolia, Ark.
EVALUATION OF VARIOUS SIZES AND CONFIGURATIONS OF FUEL TANKS Final Report
D. L. Byerley Dec. 1973 51 p
(Contract DAAJ02-71-C-0031; DA Proj. 1F1-62203-A-529)
(AD-777801; FCFC-2097; USAAMRDL-TR-73-74) Avail: NTIS CSCL 13/4

Eighteen tanks with a 30-inch x 30-inch base dimension and heights of 48 and 60 inches of qualified crashworthy constructions were impacted from 65 feet. Nine of these failed adjacent to fittings on side panels. All tanks without side fittings

passed the impact test regardless of constructions used and with average densities varying from 1.11 to 1.75. Indicated pressures were in the 130-150 psi range for two tanks of Firestone 1550-1 construction and 170-200 psi for a reinforced, heavier revision of this construction. (Modified author abstract) GRA

N74-27540# Boeing Aerospace Co., Seattle, Wash.
GROSS VOIDED FLAME ARRESTERS FOR FUEL TANK EXPLOSION PROTECTION Final Report, 1 May 1972 - 30 Oct. 1973
Terence Dixon Feb. 1974 522 p refs
(Contract F33615-72-C-1597; AF Proj. 3048)
(AD-777898; AFAPL-TR-73-124) Avail: NTIS CSCL 13/4

In this research test program, new materials were investigated for use as flame arresters within gross voided aircraft fuel tankages. The program was developed to reduce the present weight penalties associated with fully packed (10% to 15% voided) fuel tanks, using reticulated polyurethane foam. Previous work demonstrated a low-density, 25-pore-per-inch (PPI) foam explosion suppression system with 80% to 90% voiding when the source was spark ignition. The ignition sources varied throughout the total program and included a spark, incendiary igniter (developed by AFAPL/SFH) and .50 caliber API gunfire. (Modified author abstract) GRA

N74-27639# Ohio State Univ., Columbus. ElectroScience Lab.
NUMERICAL SOLUTIONS TO SOME ON-AIRCRAFT ANTENNA PATTERN PROBLEMS
R. J. Marhefka and W. D. Burnside Oct. 1973 50 p ref
(Contract N62269-72-C-0354)
(AD-777977; ESL-3390-4) Avail: NTIS CSCL 09/5

The report presents several case studies of numerical solutions to on-aircraft antenna pattern problems. Magnitude and phase pattern comparisons are made for two DF antenna configurations mounted on an F-4 aircraft. A satellite antenna is examined for possible application on P-3, E-2, and S-3 aircraft. Some measured results are presented for comparison with computations and the agreement is quite good. Author (GRA)

N74-27640# Ohio State Univ., Columbus. ElectroScience Lab.
A TECHNIQUE TO COMBINE THE GEOMETRICAL THEORY OF DIFFRACTION AND THE MOMENT METHOD
W. D. Burnside, C. L. Yu, and R. J. Marhefka Aug. 1973 42 p refs
(Contract N62269-72-C-0354)
(AD-777976; ESL-3390-3) Avail: NTIS CSCL 09/5

A technique is developed which can be used to combine the moment method and the Geometrical Theory of Diffraction. Using this approach one should be able to handle a wide variety of new structures which could not have been solved by either technique alone. Many of these new structures occur in the analysis of aircraft antenna patterns and impedance. The approach is developed and verified in terms of simple structures in order to illustrate the approach. Author (GRA)

N74-27641# Ohio State Univ., Columbus. ElectroScience Lab.
ANALYSIS OF ON-AIRCRAFT ANTENNA PATTERNS Final Report
W. D. Burnside May 1973 64 p refs
(Contract N62269-72-C-0354)
(AD-777975; ESL-3390-2) Avail: NTIS CSCL 09/5

High frequency radiation patterns of on-aircraft antennas are analyzed using ray optics techniques. This is a basic study of aircraft-antenna pattern performance in which the analytic aircraft is modelled in its most basic form. The fuselage is assumed to be a perfectly conducting convex surface. The wings are simulated by arbitrarily many sided flat plates and the jet engines are treated as finite circular cylinders. The three principal plane patterns are analyzed in great detail with measured results taken to verify each solution. A volumetric pattern study is initiated with the fuselage modelled by an arbitrary convex surface of revolution. Author (GRA)

N74-27642# Test Group (6585th), Holloman AFB, N.Mex.
ANTENNA GAIN PATTERN MEASUREMENTS ON A BQM-34F TARGET DRONE, VOLUME 5 Final Report
Oct. 1973 276 p refs
(AD-778075; AFSWC-TR-72-20-Vol-5) Avail: NTIS CSCL 17/9

Antenna gain pattern measurements were performed at the U.S. Air Force Radar Target Scatter Facility (RAT SCAT), 6585th Test Group, Holloman Air Force Base, New Mexico, to provide data for the evaluation of scoring and radar cross section augmentation antennas for the BQM-34F supersonic target drone. Wing tip pod located scoring system antennas were measured at ten vehicle roll angles using circular polarization and a frequency of 1775 MHz. Gain pattern data for the antenna system of a prototype BQM-34F active radar cross section augmentation pod were acquired at a frequency of 9130 MHz using both horizontal and vertical polarizations. (Modified author abstract) GRA

N74-27715*# Santa Clara Univ., Calif.
STEADY-STATE DECOUPLING AND DESIGN OF LINEAR MULTIVARIABLE SYSTEMS Research Report, Jun. 1972 - Jun. 1974
G. J. Thaler Jun. 1974 154 p refs
(Grant NGR-05-017-010)
(NASA-CR-138815) Avail: NTIS HC $10.75 CSCL 09C

A constructive criterion for decoupling the steady states of a linear time-invariant multivariable system is presented. This criterion consists of a set of inequalities which, when satisfied, will cause the steady states of a system to be decoupled. Stability analysis and a new design technique for such systems are given: A new and simple connection between single-loop and multivariable cases is found. These results are then applied to the compensation design for NASA STOL C-8A aircraft. Both steady-state decoupling and stability are justified through computer simulations. Author

N74-27872*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
G-LOAD MEASURING AND INDICATOR APPARATUS Patent Application
James C. Howard, inventor (to NASA) Issued 12 Jun. 1974 22 p
(NASA-Case-ARC-10806; US-Patent-Appl-SN-478802) Avail: NTIS HC $4.25 CSCL 01D

A g-load measuring apparatus is described for facilitating pilot control of g-load during maneuvering and to provide an indication of g-load constraint violations. The apparatus includes processing means for receiving the components of the linear acceleration and angular velocity of the aircraft and for generating the first output signal indicative of the critical velocity of the aircraft and a second output signal indicative of the instantaneous maneuvering velocity of the aircraft. Indicating means is connected to the processing means for receiving the two output generated signals. NASA

N74-27920# National Bureau of Standards, Washington, D.C. Inst. for Materials Research.
METALLURGICAL ANALYSIS OF WEAR PARTICLES AND WEARING SURFACES Final Report
A. W. Ruff Apr. 1974 48 p refs
(Contract NAonr-31-7316)
(AD-778340; NBSIR-74-474) Avail: NTIS CSCL 13/9

The initial approach has been concerned primarily with the examination of particles recovered by the ferrographic technique from samples of lubricating oils taken periodically during tests and service of bearings, gears, sliding surfaces, etc., in which such experimental variables as lubricants, lubricant additives, bearing materials, loads, etc., have been studied. Examinations have been conducted principally using both scanning and transmission electron microscopy techniques, observing particle shapes, sizes, surface structures and other parameters as functions of distance along the ferrogram and determining a semi-quantitative elemental chemical analysis of selected and typical particles. These electron microscope techniques have been used to characterize the wear particles and associated surface degradation produced in the bearing and gear tests conducted

by others. They provide information on particles and surface details too small for study by optical microscopy methods.
Author (GRA)

N74-28082# National Weather Service, Silver Spring, Md. Systems Plans and Design Div.
SOME RESULTS FROM APPLYING A COST-EFFECTIVENESS MODEL FOR EVALUATING AVIATION WEATHER DISSEMINATION TECHNIQUES Final Report, Apr. 1972 - Dec. 1973
Henry Newhouse Dec. 1973 77 p refs
(Contract DOT-FA72WAI-283; FAA Proj. 132-422-062)
(AD-777441; FAA-RD-73-128) Avail: NTIS CSCL 04/2

Some results were obtained from a cost-effectiveness model which was developed for evaluating the performance of various combinations of aviation weather dissemination techniques. Basic data on which the model operates consist of distributions of registered general aviation aircraft, air traffic activity and total flight services. FAA forecasts of growth in general aviation during the next decade, and the cost of various dissemination techniques and facilities. These data are used to generate estimates of demand in a 26 x 60 matrix of 1 degree squares covering the 48 states. Dissemination technique effectiveness values are arrived at largely through two factors--accessibility and usefulness--which were obtained via a Delphi approach. As part of the model's output, measures of system performance are given in terms of percentage of demand satisfied by the total system, each technique, and each portion of the flight profile. Computations give cost-per-demand served, cost of the total system plus overhead, and the cost of each technique in terms of capital, operating, and personnel costs. (Modified author abstract) GRA

N74-28101*# Kanner (Leo) Associates, Redwood City, Calif.
SAFETY DURING AUTOMATIC LANDING WITH POOR VISIBILITY
J. P. DeBeachene Washington NASA Jun. 1974 23 p Transl. into ENGLISH from Navigation (France), v. 22, Jan. 1974 p 31-46
(Contract NASw-2481)
(NASA-TT-F-15716) Avail: NTIS HC $4.25 CSCL 17G

Fundamental principles of safety are discussed for automatic landing systems in low visibility. The ILS is briefly described along with automatic control systems, including the monitored, doubly monitored, and quadruple. Aspects of safety regulations are also discussed. E.J.O.

N74-28102*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
FLIGHT INVESTIGATION OF MANUAL AND AUTOMATIC VTOL DECELERATING INSTRUMENT APPROACHES AND LANDINGS
James R. Kelly, Frank R. Niessen, Jerry J. Thibodeaux, Kenneth R. Yenni, and John F. Garren, Jr. Washington Jul. 1974 42 p refs
(NASA-TN-D-7524; L-9311) Avail: NTIS HC $3.25 CSCL 01D

A flight investigation was undertaken to study the problems associated with manual and automatic control of steep, decelerating instrument approaches and landings under simulated instrument conditions. The study was conducted with a research helicopter equipped with a three-cue flight-director indicator. The scope of the investigation included variations in the flight-director control laws, glide-path angle, deceleration profile, and control response characteristics. Investigation of the automatic-control problem resulted in the first automated approach and landing to a predetermined spot ever accomplished with a helicopter. Although well-controlled approaches and landings could be performed manually with the flight-director concept, pilot comments indicated the need for a better display which would more effectively integrate command and situation information.
Author

N74-28229*# Avco Lycoming Div., Stratford, Conn.
DEVELOPMENT OF HELICOPTER ENGINE SEALS
Peter Lynwander Nov. 1973 108 p refs Sponsored in part by Army Air Mobility R and D Lab., Cleveland
(Contract NAS3-16720)
(NASA-CR-134647; LYC-73-48) Avail: NTIS HC $8.50 CSCL 21A

An experimental evaluation of main shaft seals for helicopter gas turbine engines was conducted with shaft speeds to 213 m/s(700 ft/sec), air pressures to 148 N/sq cm (215 psia), and air temperatures to 645 K (675 F). Gas leakage test results indicate that conventional seals will not be satisfactory for high-pressure sealing because of excessive leakage. The self-acting face seal, however, had significantly lower leakage and operated with insignificant wear during a 150-hour endurance test at sliding speeds to 145 m/s (475 ft/sec), air pressures to 124 N/sq cm (180 psia), and air temperatures to 408 K (275 F). Wear measurements indicate that noncontact operation was achieved at shaft speeds of 43,000 rpm. Evaluation of the self-acting circumferential seal was inconclusive because of seal dimensional variations.
Author

N74-28230*# American Airlines, Inc., New York.
ECONOMIC EFFECTS OF PROPULSION SYSTEM TECHNOLOGY ON EXISTING AND FUTURE TRANSPORT AIRCRAFT
G. Philip Sallee Jul. 1974 345 p
(Contract NAS3-17326)
(NASA-CR-134645) Avail: NTIS HC $7.50 CSCL 21A

The results of an airline study of the economic effects of propulsion system technology on current and future transport aircraft are presented. This report represents the results of a detailed study of propulsion system operating economics. The study has four major parts: (1) a detailed analysis of current propulsion system maintenance with respect to the material and labor costs encountered versus years in service and the design characteristics of the major elements of the propulsion system of the B707, b727, and B747. (2) an analysis of the economic impact of a future representative 1979 propulsion system is presented with emphasis on depreciation of investment, fuel costs and maintenance costs developed on the basis of the analysis of the historical trends observed. (3) recommendations concerning improved methods of forecasting the maintenance cost of future propulsion systems are presented. A detailed method based on the summation of the projected labor and material repair costs for each major engine module and its installation along with a shorter form suitable for quick, less detailed analysis are presented, and (4) recommendations concerning areas where additional technology is needed to improve the economics of future commercial propulsion systems are presented along with the suggested economic benefits available from such advanced technology efforts.
Author

N74-28233*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EXHAUST FLOW DEFLECTOR Patent Application
John C. Wilson (Army Air Mobility R and D Lab., Hampton, Va.) and Craig S. Shaw, inventors (to NASA) (Army Air Mobility R and D Lab., Hampton, Va.) Issued 25 Jun. 1974 10 p Sponsored by NASA
(NASA-Case-LAR-11570-1; US-Patent-Appl-SN-482967) Avail: NTIS HC $4.00 CSCL 21E

The development of an exhaust gas deflector for helicopters is discussed. The deflector straightens the swirling exhaust flow to provide better penetration of the freestream. Diagrams are provided to show the operation of the equipment. The device also eliminates heating of the airframe and discoloration of the surface due to the exhaust gases.
NASA

N74-28240*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FLIGHT VELOCITY EFFECTS ON THE JET NOISE OF SEVERAL VARIATIONS OF A 104-TUBE SUPPRESSOR NOZZLE
Richard R. Burley Washington Jul. 1974 53 p refs
(NASA-TM-X-3049; E-7901) Avail: NTIS HC $3.75 CSCL 21E

At the relatively high takeoff speeds of supersonic transport aircraft, an important question concerns whether the flight speed affects the noise of suppressor nozzles. To answer this question,

flyover and static tests using a modified F-106B aircraft were conducted on a 104-tube suppressor nozzle. Comparison of adjusted flyover and static spectra indicated that flight velocity had a small adverse effect on the suppression of the 104-tube suppressor. The adverse effect was larger with the acoustic shroud installed than without it. Author

N74-28241*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
CRUISE PERFORMANCE OF AN ISOLATED 1.15 PRESSURE RATIO TURBOFAN PROPULSION SYSTEM SIMULATOR AT MACH NUMBERS FROM 0.6 TO 0.85
Fred W. Steffen Washington Jun. 1974 52 p refs
(NASA-TM-X-3064; E-7824) Avail: NTIS HC $3.75 CSCL 21E

An isolated 1.15 pressure ratio turbofan engine simulator was tested at Mach numbers from 0.6 to 0.85. At Mach 0.75 the net propulsive force of the fan and nacelle (excluding core thrust) was 73 percent of the ideal fan net thrust. Internal losses amounted to 7 percent, and external drag amounted to 20 percent of the ideal fan net thrust. External pressure and friction drag were about equal. The propulsive efficiency with a 90 percent efficient fan would have been 63 percent. For the aerodynamic characteristics of the nacelle that was tested, increasing the fan pressure ratio to approximately 1.35 would have resulted in a maximum propulsive efficiency of 67 percent. Author

N74-28243# McDonnell Aircraft Co., St. Louis, Mo.
MANUFACTURING METHODS FOR SELF-SEALING FUEL LINES Final Technical Report, 10 May 1972 - 10 Sep. 1973
J. H. Pousson and E. W. Wiggins Sep. 1973 55 p refs
(Contract F33615-72-C-1391; AF Proj. 445-2)
(AD-778083; AFML-TR-73-176) Avail: NTIS CSCL 21/5

The report covers the establishment of manufacturing process parameters to permit the use of the braiding process in manufacturing lightweight, reproducible, and economical self-sealing fuel lines for combat aircraft. Tests were conducted in Phase I to determine the required overbraid on aluminum, stainless steel, and titanium fuel lines to eliminate deformation and control petalling which results from an impact with a .50-caliber, armor-piercing projectile. The Phase II portion of the program involved establishing the braiding process as a means of applying a cover over the sealant material. (Modified author abstract) GRA

N74-28399* Kanner (Leo) Associates, Redwood City, Calif.
USE OF CONVENTIONAL EQUIPMENT TO MEASURE THE EFFECTIVE PERCEIVED NOISE LEVEL OF AIRCRAFT
c14
Nicholas Plom *In its* the 4th Natl. Conf. on Acoustics, Vol. 1A (NASA-TT-F-15375) Jun. 1974 p 224-232 *ref* Transl. into ENGLISH from A 4-A Conferinta Nationala de Acustica, Vol. 1,A, Combaterea Zgomotulu Si Vibratiilor, Bucharest, 29-31 May 1973 p 293-298
CSCL 14B

A real time, computerized, measurement method for the effective perceived noise level is reported that uses comparison of two sounds differing in level and frequency to obtain the noise intensity emitted by aircraft and to calculate human psychoacoustic annoyance reactions. G.G.

N74-28423*# National Aeronautics and Space Administration. Lyndon B Johnson Space Center, Houston, Tex.
FULL-SCALE AIRCRAFT CABIN FLAMMABILITY TESTS OF IMPROVED FIRE-RESISTANT MATERIALS
Robert N. Stuckey, Daniel E. Surpkis, and L. James Price Jun. 1974 64 p refs
(NASA-TM-X-58141; JSC-09060) Avail: NTIS HC $6.25 CSCL 21B

Full-scale aircraft cabin flammability tests to evaluate the effectiveness of new fire-resistant materials by comparing their burning characteristics with those of older aircraft materials are described. Three tests were conducted and are detailed. Test 1, using pre-1968 materials, was run to correlate the procedures and to compare the results with previous tests by other organizations. Test 2 included newer, improved fire-resistant materials. Test 3 was essentially a duplicate of test 2, but a smokeless fuel was used. Test objectives, methods, materials, and results are presented and discussed. Results indicate that the pre-1968 materials ignited easily, allowed the fire to spread, produced large amounts of smoke and toxic combustion products, and resulted in a flash fire and major fire damage. The newer fire-resistant materials did not allow the fire to spread. Furthermore, they produced less, lower concentrations of toxic combustion products, and lower temperatures. The newer materials did not produce a flash fire. Author

N74-28471*+ National Aeronautics and Space Administration, Washington, D.C.
AERONAUTICAL ENGINEERING: A SPECIAL BIBLIOGRAPHY WITH INDEXES, SUPPLEMENT 42, MARCH 1974
Mar. 1974 105 p refs
(NASA-SP-7037(42)) Avail: NTIS HC $4.00 CSCL 01A

This special bibliography lists 338 reports, articles, and other documents introduced into the NASA scientific and technical information system in February 1974. Author

N74-28472*+ National Aeronautics and Space Administration, Washington, D.C.
A CUMULATIVE INDEX TO THE 1973 ISSUES OF AERONAUTICAL ENGINEERING: A SPECIAL BIBLIOGRAPHY
Jan. 1974 830 p refs Supersedes NASA-SP-7037(28)-NASA-SP-7037(39)
(NASA-SP-7037(40); NASA-SP-7037(28); NASA-SP-7037(39)) Avail: NTIS HC $10.00 CSCL 01A

This publication is a cumulative index to the abstracts contained in NASA SP-7037 (28) through NASA SP-7037 (39) of Aeronautical Engineering: A Special Bibliography. NASA SP-7037 and its supplements have been compiled through the cooperative efforts of the American Institute of Aeronautics and Astronautics (AIAA) and the National Aeronautics and Space Administration (NASA). This cumulative index includes subject, personal author, corporate source, contract, and report number indexes. Author

N74-28473 Texas Univ., Austin.
SUPPRESSION OF FLUTTER ON INTERFERING LIFTING SURFACES BY THE USE OF ACTIVE CONTROLS Ph.D. Thesis
Emil Ernest Cwach 1974 173 p
Avail: Univ. Microfilms Order No. 74-14682

An investigation into the possible increase in flutter speed of interfering lifting surfaces by the use of active controls was conducted. Methods were developed to find a control law which related the motion of the control surface to the motion of the main lifting surfaces so that for a given control surface the maximum increase in flutter speed could be achieved. The study was designed so that the methods developed to determine the maximum increase in flutter speed could be applied to complex air vehicle configurations throughout the Mach number/altitude range of modern aircraft. The unsteady aerodynamic forces on the lifting surfaces were computed by using doublet lattice aerodynamic computer programs. The structural features of the lifting surfaces were presented by either experimentally measured or analytically computed vibration frequencies and mode shapes. Dissert. Abstr.

N74-28474*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECT OF CANARD LOCATION AND SIZE ON CANARD-WING INTERFERENCE AND AERODYNAMIC CENTER SHIFT RELATED TO MANEUVERING AIRCRAFT AT TRANSONIC SPEEDS
Blair B. Gloss Washington Jun. 1974 135 p refs
(NASA-TN-D-7505; L-9308) Avail: NTIS HC $4.75 CSCL 01A

A generalized wind-tunnel model, typical of highly maneuverable aircraft, was tested in the Langley 8-foot transonic pressure tunnel at Mach numbers from 0.70 to 1.20 to determine the effects of canard location and size on canard-wing interference effects and aerodynamic center shift at transonic speeds. The

canards had exposed areas of 16.0 and 28.0 percent of the wing reference area and were located in the chord plane of the wing or in a position 18.5 percent of the wing mean geometric chord above or below the wing chord plane. Two different wing planforms were tested, one with leading-edge sweep of 60 deg and the other 44 deg; both wings had the same reference area and span. The results indicated that the largest benefits in lift and drag were obtained with the canard above the wing chord plane for both wings tested. The low canard configuration for the 60 deg swept wing proved to be more stable and produced a more linear pitching-moment curve than the high and coplanar canard configurations for the subsonic test Mach numbers.
Author

N74-28475*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EFFECT OF GROUND PROXIMITY ON THE LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF AN ASPECT-RATIO-1 WING WITH AND WITHOUT WING-TIP BLOWING
Raymond E. Mineck and Arthur W. Carter Washington Jul. 1974 56 p refs Prepared in cooperation with Army Air Mobility Res. and Develop. Lab., Hampton, Va.
(NASA-TM-X-3048; L-9539) Avail: NTIS HC $3.75 CSCL 01A

An investigation has been conducted to determine the effect of ground proximity on the aerodynamic characteristics of an aspect-ratio-1 wing with and without wing-tip blowing. This investigation was conducted in the Langley towing tank no. 1 with the model towed over the water to eliminate the effects of walls and of wind-tunnel ground-board boundary layers. The results indicate that the model is stable with height and pitch at positive angles of attack and that the lift-drag ratio is improved at small ground heights with some blowing at the wing tips.
Author

N74-28479*# Lockheed-Georgia Co., Marietta.
SMALL SCALE WIND TUNNEL MODEL INVESTIGATION OF HYBRID HIGH LIFT SYSTEMS COMBINING UPPER SURFACE BLOWING WITH THE INTERNALLY BLOWN FLAP
W. L. Waites and Y. T. Chin Jun. 1974 204 p refs
(Contract NAS2-7812)
(NASA-CR-114758; LG74ER0070) Avail: NTIS HC $13.25 CSCL 01A

A small-scale wind tunnel test of a two engine hybrid model with upper surface blowing on a simulated expandable duct internally blown flap was accomplished in a two phase program. The low wing Phase I model utilized 0.126c radius Jacobs/Hurkamp flaps and 0.337c radius Coanda flaps. The high wing Phase II model was utilized for continued studies on the Jacobs/Hurkamp flap. Principal study areas included: basic data both engines operative and with an engine out, control flap utilization, horizontal tail effectiveness, spoiler effectiveness, USB nacelle deflector study and USB/IBF pressure ratio effects.
Author

N74-28483*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
INVESTIGATION OF THE STATIC LIFT CAPABILITY OF A LOW-ASPECT-RATIO WING OPERATING IN A POWERED GROUND-EFFECT MODE
Jarrett K. Huffman and Charlie M. Jackson, Jr. Washington Jul. 1974 33 p refs
(NASA-TM-X-3031; L-9368) Avail: NTIS HC $3.25 CSCL 01B

A preliminary experimental investigation has been made to evaluate the powered ground-effect capability of a low-apsect-ratio, wing-body configuration with forward-mounted propulsion. The tests were limited to static ground-effect conditions in order to obtain information on an air-cushion mode of operation. The results indicate, in general, that an air-cushion mode is within the capability of the type of configuration examined. The conditions examined indicated the possibility of hover mode and also forward acceleration capability in near-ground effect. Center-of-pressure movement did not appear to be a problem. However, it was recognized that longitudinal trim would be a problem to consider in both the hover and acceleration modes. Author

N74-28487# Cambridge Univ. (England). Dept. of Engineering.
NUMERICAL STUDIES OF HYPERSONIC DELTA WINGS WITH DETACHED SHOCK WAVES
V. V. Shanbhag London Aeron. Res. Council 1974 41 p refs Supersedes ARC-34617
(ARC-CP-1277; ARC-34617) Avail: NTIS HC $5.25; HMSO 70p; PHI $2.95

A numerical procedure for calculating the inviscid hypersonic flow about the lower surface of a conical wing of general cross section is described. The method is based on thin-shock-layer theory and cross section of the wing may be either described by a polynomial (up to fourth deg) or given as tabulated data. The actual numerical scheme is an improvement on that used by earlier workers and the computation time is much shorter. This reduction in computation time has been exploited to produce a complete iterative procedure for the calculation of the pressure distribution and shock shape on a given wing at given flight conditions. A complete set of tabulated nondimensional pressures and shock shapes for flat wings with detached shocks for reduced aspect ratios from 0.1 to 1.99 is included as well as some sample results for wings with caret and bi-convex cross section.
Author (ESRO)

N74-28493# Aeronautical Research Associates of Princeton, Inc., N.J.
UPDATED GUST DESIGN VALUES FOR USE WITH AFFDL-70-106 Final Report, 1 Mar. - 1 Nov. 1973
John C. Houbolt Nov. 1973 40 p refs
(Contract F33615-73-C-3048; AF Proj. 1367)
(AD-778821; ARAP-204; AFFDL-TR-73-148) Avail: NTIS CSCL 01/1

Further efforts are made by this report to establish better representative parameters applicable to the mathematical modeling of atmospheric turbulence and to establish associated design values for the structural design of aircraft due to gusts. An evaluation is made of the results that are presented in AGARD Report No. 586-71, which summarizes an extensive data gathering program of gust loads on many aircraft. Updated gust design values and curves are developed herein. These design values were used in a separate study which was made as a check validation of the gust design procedures that are outlined in an Air Force Technical Report, AFFDL-TR-70-106, and which was conducted on several specific existing aircraft. (Modified author abstract)
GRA

N74-28497 Pennsylvania State Univ., University Park.
OPTIMAL CONTROL AIRCRAFT LANDING ANALYSIS Ph.D. Thesis
Robert Raymond Huber, Jr. 1973 133 p
Avail: Univ. Microfilms Order No. 74-16026

A digital computer analysis technique was developed to predict aircraft longitudinal landing performance from the FAA Category II window to touchdown. A Microwave Landing System provided sampled data elevation angle guidance and assumed continuous DME (Distance Measuring Equipment) information. The linearized longitudinal equations for perturbations about trimmed flight were used for the aircraft model. Atmospheric disturbances including deterministic winds and random gusts were modeled. The deterministic gusts included headwinds and wind shears. The random gusts included longitudinal and normal gusts which were modeled as first order Gauss Markov processes. The Microwave Landing System (MLS) noise was also included. The MLS noise modeled consisted of a low frequency noise representing beam bend noise and a higher frequency noise attributed to the sampled data nature of elevation angle measurement.
Dissert. Abstr.

N74-28498 Texas Univ., Arlington.
A DIGITAL CALCULATION OF THE RESPONSE OF A PILOTED SUBSONIC JET-TRANSPORT AIRPLANE TO SEVERE VERTICAL GUSTS Ph.D. Thesis
Kenneth Lloyd Strong 1973 210 p
Avail: Univ. Microfilms Order No. 74-14864

A digital computer investigation has been made to study the response characteristics of a first generation, four-engine, subsonic jet transport airplane flying through severe vertical gusts.

The analytical simulation includes the pertinent factors suspected of contributing to the turbulence-induced jet-upset problem. The analysis is confined to the three-degree-of-freedom, longitudinal, rigid-body dynamics. Nonlinear time-dependent aerodynamic and control gradients including both positive and negative stall characteristics are included in the digital simulation. The dynamic behavior of the pilot controlling pitch attitude with the elevator in basically compensatory tasks is incorporated into the mathematical description of the total system. Dissert. Abstr.

N74-28500*# Techtran Corp., Glen Burnie, Md.
NOISE REDUCING METHODS FOR STOL AIRCRAFT APPROACH AND TAKEOFF
K. Weise and H. Anders Washington NASA Jun. 1974 36 p refs Transl. into ENGLISH of "Laermreduzierende an-und Abflugverfahren fuer STOL-Flugzeuge", Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn, West Germany, report, MBBUH-06-73-0; DGLR-Paper-73-039 presented at Symp. on New Approach and Landing Tech., 3 May 1973 43 p Original announced as N73-31968
(Contract NASw-2485)
(NASA-TT-F-15612; MBB-UH-06-73-0; DGLR-Paper-73-039) Avail: NTIS HC $5.00 CSCL 01C

Noise propagation from STOL aircraft taking off and in the landing approach is investigated on 3 STOL designs. It shows that takeoff noise can be reduced by several db by reducing the thrust (three segment takeoff) in areas near airports. Just as with CTOL aircraft, the landing paths should be as steep as possible and landing flaps and gears should only be lowered at a reduced height. The noise reduction achievable by using all possibilities in landing is considerable. Sticking to the path also diminishes noise. Author

N74-28501*# Scientific Translation Service, Santa Barbara, Calif.
PROPELLER TESTS IN THE LARGE SONIC WIND TUNNEL OF MONDANE-AVRIEUX
Alain Masson Washington NASA Jun. 1974 65 p refs Transl. into ENGLISH of "Essais d'Helices dans la Grande Soufflerie Sonique de Mondane-Avrieux", ONERA, Paris, report ONERA-NT-161, 1970 35 p Original announced as N71-31813
(Contract NASw-2483)
(NASA-TT-F-15704; ONERA-NT-161) Avail: NTIS HC $6.25 CSCL 01B

The installation for investigations on fullscale or large-scale models of conventional aircraft or convertiplane propellers in a large sonic wind tunnel is described. Some examples of tests carried out and typical results obtained illustrate the use capability of the equipment, which is also suitable for helicopter rotor tests. Author

N74-28502# Royal Aircraft Establishment, Farnborough (England).
THE FLIGHT CONTROL SYSTEM FOR THE CONCORDE SUPERSONIC CIVIL TRANSPORT AIRCRAFT
Cado and Broihanne Jul. 1973 33 p Transl. into ENGLISH of "Le Systeme de Commandes de Vol de l'Avion de Transport Civil Supersonique Concorde", paper presented at 35th AGARD Colloq. on the Mech. of Flight
(RAE-Lib-Trans-1615; BR36912) Avail: NTIS HC $4.75

The advanced design concepts and technologies of military aircraft find their applications, after a certain time delay due to industrial economy reasons, in civil aircraft. However, these concepts must be reviewed in the light of safety rules applicable to civil aircraft. Hence civil design concepts have some original aspects which in this paper are illustrated with the example of the flight control system used in the Concorde supersonic civil transport aircraft. The aims of performance and confidence (in the sense of navigability and operational usage) will be considered first. The design concepts and technology necessary to realize these aims will then be given. Author

N74-28503# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
AIRCRAFT ACCIDENT REPORT: OZARK AIRLINES, INCORPORATED, FAIRCHILD HILLER FH-227B, N4215 NEAR THE LAMBERT-SAINT LOUIS INTERNATIONAL AIRPORT, SAINT LOUIS, MISSOURI, 23 JULY 1973
24 Apr. 1974 43 p
(NTSB-AAR-74-5) Avail: NTIS HC $5.25

The crash of a Fairchild-Hiller FH-227 aircraft near St. Louis International Airport is reported. The aircraft was making an ILS approach during a severe thunderstorm with heavy rain when it descended below the glide slope, was struck by lightning, and crashed. The probable cause of the accident is the encounter of the aircraft with a downdraft and the pilot's decision to continue the instrument approach. Author

N74-28504*# Aerospace Corp., El Segundo, Calif.
SMALL V/STOL AIRCRAFT ANALYSIS, VOLUME 1 Final Report
K. R. Smith, Jr. and F. W. Belina Washington NASA May 1974 88 p refs
(Contract NAS2-6473)
(NASA-CR-2425) Avail: NTIS HC $4.00 CSCL 01C

A study has been made of the economic viability of advanced V/STOL aircraft concepts in performing general aviation missions. A survey of general aviation aircraft users, operators, and manufacturers indicated that personnel transport missions formulated around business executive needs, commuter air service, and offshore oil supply are the leading potential areas of application using VTOL aircraft. Advanced VTOL concepts potentially available in the late 1970 time period were evaluated as alternatives to privately owned contemporary aircraft and commercial airline service in satisfying these personnel transport needs. Economic analysis incorporating the traveler's value of time as the principle figure of merit were used to identify the relative merits of alternative VTOL air transportation concepts. Author

N74-28506*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A METHOD OF AUTOMATICALLY STABILIZING HELICOPTER SLING LOADS
Joseph Gera and Steve W. Farmer, Jr. Washington Jul. 1974 42 p refs
(NASA-TN-D-7593; L-9371) Avail: NTIS HC $3.25 CSCL 01C

The effect of geometric and aerodynamic characteristics on the stability of the lateral degrees of freedom of a typical helicopter sling load is examined. The feasibility of stabilizing the suspended load by controllable fins was also studied. Linear control theory was applied to the design of a simple control law that stabilized the load over a wide range of helicopter airspeeds. Author

N74-28507*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
PRELIMINARY PERFORMANCE ESTIMATES OF AN OBLIQUE, ALL-WING, REMOTELY PILOTED VEHICLE FOR AIR-TO-AIR COMBAT
Walter P. Nelms, Jr. and Rodney O. Bailey Washington Jul. 1974 105 p refs
(NASA-TN-D-7731; A-5338) Avail: NTIS HC $4.50 CSCL 01C

A computerized aircraft synthesis program has been used to assess the effects of various vehicle and mission parameters on the performance of an oblique, all-wing, remotely piloted vehicle (RPV) for the highly maneuverable, air-to-air combat role. The study mission consists of an outbound cruise, an acceleration phase, a series of subsonic and supersonic turns, and a return cruise. The results are presented in terms of both the required vehicle weight to accomplish this mission and the combat effectiveness as measured by turning and acceleration capability. This report describes the synthesis program, the mission, the vehicle, and results from sensitivity studies. An optimization process has been used to establish the nominal RPV configuration of the oblique, all-wing concept for the specified mission. In comparison to a previously studied conventional wing-body canard design for the same mission, this oblique, all-wing nominal vehicle is lighter in weight and has higher performance. Author

N74-28508*# General Dynamics/Convair, San Diego, Calif.
FEASIBILITY STUDY OF AN INTEGRATED PROGRAM FOR

AEROSPACE VEHICLE DESIGN (IPAD). VOLUME 1. SUMMARY An Early Domestic Dissemination Report
C. A. Garrocq, M. J. Hurley et al 30 Aug. 1973 78 p refs 7 Vol.
(Proj. FEDD; Contract NAS1-11431)
(NASA-CR-132401) Avail: NASA Regional Dissemination Centers only to US Requestors: HC $7.00/MF $1.45 CSCL 01C

The development and characteristics of an Integrated Program for Aerospace Vehicle Design (IPAD) System are discussed. The principal characteristic of the design philosophy is its consistency in treating the various aspects of the design with a uniform depth of attention so that the end product can have a balanced consideration of all factors involved. IPAD is defined as a system of automated procedures providing a framework within which aerospace vehicle design can be accomplished with speed, efficiency, and confidence. The overall goals and objectives of the IPAD study effort are developed. Author

N74-28509*# General Dynamics/Convair, San Diego, Calif. **FEASIBILITY STUDY OF AN INTEGRATED PROGRAM FOR AERSOPACE-VEHICLE DESIGN (IPAD) SYSTEM. VOLUME 2: CHARACTERIZATION OF THE IPAD SYSTEM (PHASE 1, TASK 1) An Early Domestic Dissemination Report**
C. A. Garrocq and J. J. Hosek 30 Aug. 1973 128 p refs 7 Vol.
(Proj. FEDD; Contract NAS1-11431)
(NASA-CR-132402) Avail: NASA Regional Dissemination Centers only to US Requestors: HC $4.75/MF $1.45 CSCL 01C

The feasibility of an Integrated Program for Aerospace Vehicle Design (IPAD) was conducted. The operating philosophy and organization of IPAD are defined. The IPAD system design features were generated based on the best approach determined during the study. By reviewing the participation of various disciplines with a project design team, a usage philosophy was evolved in which the engineer is the focal point of the IPAD concept. The two major parameters involved in the concept are: (1) an engineering capability consisting of a battery of operational modules and a computer software/hardware complex where the capability will be installed and exercised. The principal mode of operation is using interactive graphics equipment. The system also includes less sophisticated interactive terminals as well as the common batch mode of operation. Author

N74-28510*# General Dynamics/Convair, San Diego, Calif. **FEASIBILITY STUDY OF AN INTEGRATED PROGRAM FOR AEROSPACE-VEHICLE DESIGN (IPAD) SYSTEM. VOLUME 3: ENGINEERING CREATIVE/EVALUATION PROCESSES (PHASE 1, TASK 2) An Early Domestic Dissemination Report**
C. A. Garrocq, J. J. Hosek et al 30 Aug. 1973 184 p refs 7 Vol.
(Proj. FEDD; Contract NAS1-11431)
(NASA-CR-132403) Avail: NASA Regional Dissemination Centers only to US Requestors: HC $5.50/MF $1.45 CSCL 01C

An evaluation of the design process associated with the Integrated Program for Aerospace Vehicle Design (IPAD) was performed to segregate the basic creative and evaluation procedures used in the design of an aircraft project. A specific set of disciplinary functions required was determined. The available automated procedures that can be used in an IPAD system were identified. A series of functional flowcharts are presented to properly identify and record the degree of participation of the disciplines considered in the feasibility study and the type of data required in the design process. Author

N74-28511*# General Dynamics/Convair, San Diego, Calif. **FEASIBILITY STUDY OF AN INTEGRATED PROGRAM FOR AEROSPACE-VEHICLE DESIGN (IPAD) SYSTEM. VOLUME 4: DESIGN OF THE IPAD SYSTEM. PART 1: IPAD SYSTEM DESIGN REQUIREMENTS (PHASE 1, TASK 2) An Early Domestic Dissemination Report**
C. A. Garrocq, M. J. Hurley et al 20 Aug. 1973 250 p refs 7 Vol.
(Proj. FEDD; Contract NAS1-11431)
(NASA-CR-132404) Avail: NASA Regional Dissemination Centers only to US Requestors: HC $6.00/MF $1.45 CSCL 01C

An Integrated Program for Aerospace Vehicle Design (IPAD) system is defined as consisting of four major components, (1) a management engineering capability represented by a battery of automated operational modules for various management/design/engineering disciplines, (2) an IPAD framework software which supports and augments the engineering capability, (3) an operating system software, which features a comprehensive data base management system, and (4) a computer complex hardware, on which all the engineering, IPAD, and system software will be mounted and exercised. From this statement, it can be inferred that the management/engineering capability can and should be tailored to the specific needs of the management/design/engineering team. The IPAD framework software, the operating system software, and the computer complex hardware could have essentially the same basic capabilities for all users, with freedom of choice in specific software, and type and quality of equipment desired within each computer complex. Author

N74-28512*# General Dynamics/Convair, San Diego, Calif. **FEASIBILITY STUDY OF AN INTEGRATED PROGRAM FOR AEROSPACE-VEHICLE DESIGN (IPAD) SYSTEM. VOLUME 5: DESIGN OF THE IPAD SYSTEM. PART 2: SYSTEM DESIGN. PART 3: GENERAL PURPOSE UTILITIES (PHASE 1, TASK 2) An Early Domestic Dissemination Report**
C. A. Garrocq and M. J. Hurley 30 Aug. 1973 437 p refs 7 Vol.
(Proj. FEDD; Contract NAS1-11431)
(NASA-CR-132405) Avail: NASA Regional Dissemination Centers only to US Requestors: HC $9.00/MF $1.45 CSCL 01C

The organization, engineering usage philosophy, and design concept for the Integrated Program for Aerospace Vehicle Design (IPAD) are discussed. The flexibility required to satisfy the project needs of any management/design/engineering team which will use the system is analyzed. The various elements of the computer software associated with IPAD are illustrated. The major classes of software are identified. The five general purpose utilities in the IPAD, some of which are highly modular, and the various release levels are analyzed. The viable designs of various elements of the IPAD framework software, data base management system, and required new languages in relation to the capabilities of operating systems software are explained. Author

N74-28513*# General Dynamics/Convair, San Diego, Calif. **FEASIBILITY STUDY OF AN INTEGRATED PROGRAM FOR AEROSPACE-VEHICLE DESIGN (IPAD) SYSTEM. VOLUME 6: IMPLEMENTATION SCHEDULE, DEVELOPMENT COSTS, OPERATIONAL COSTS, BENEFIT ASSESSMENT, IMPACT ON COMPANY ORGANIZATION, SPIN-OFF ASSESSMENT (PHASE 2, TASKS 3 TO 8) An Early Domestic Dissemination Report**
C. A. Garrocq, M. J. Hurley, M. Dublin et al 30 Aug. 1973 168 p refs 7 Vol.
(Proj. FEDD; Contract NAS1-11431)
(NASA-CR-132406) Avail: NASA Regional Dissemination Centers only to US Requestors: HC $5.00/MF $1.45 CSCL 01C

A baseline implementation plan for the Integrated Program for Aerospace Vehicle Design (IPAD) System is presented. Alternative implementation approaches for critical software elements and variants to the plan are included. The basic philosophy of the implementation plan is defined. Several areas of operational cost increases and decreases are identified. The benefits of an IPAD system relate mainly to potential savings in engineering man-hours, reduction of design-cycle calendar time, and indirect upgrading of product quality and performance. It is estimated that first release capability for IPAD is 45 months after go-ahead, a five-year total implemental schedule and a total development cost of 2027 man-hours and 1074 computer hours. Author

N74-28514*# Boeing Commercial Airplane Co., Seattle, Wash.
FEASIBILITY STUDY OF AN INTEGRATED PROGRAM FOR AEROSPACE VEHICLE DESIGN (IPAD). VOLUME 1A: SUMMARY An Early Domestic Dissemination Report
R. E. Miller, Jr., D. D. Redhed, A. S. Kawaguchi, S. D. Hansen, and J. W. Southall 21 Sep. 1973 69 p refs 7 Vol.
(Proj. FEDD; Contract NAS1-11441)
(NASA-CR-132390; D6-60181-1A) Avail: NASA Regional Dissemination Centers only to US Requestors: HC $6.50/MF $1.45 CSCL 01C

An integrated program for aerospace vehicle design (IPAD) is discussed. The goal of the IPAD system is to increase the productivity of the product design organization. It is shown that increases in individual productivity were feasible through automation and computer support of routine information handling. It was also determined that such automation can directly decrease cost and flowtime in the product design process. The principal elements of IPAD are: (1) a host computer and its interactive system software, (2) executive and data management software, and (3) an open-ended IPAD library of technical programs to match the intended product design process. Author

N74-28515*# Boeing Commercial Airplane Co., Seattle, Wash.
FEASIBILITY STUDY OF AN INTEGRATED PROGRAM FOR AEROSPACE VEHICLE DESIGN (IPAD). VOLUME 1B: CONCISE REVIEW An Early Domestic Dissemination Report
R. E. Miller, Jr., J. W. Southall, A. S. Kawaguchi, and D. D. Redhed 21 Sep. 1973 211 p refs 7 Vol.
(Proj. FEDD; Contract NAS1-11441)
(NASA-CR-132391; D6-60181-1B) Avail: NASA Regional Dissemination Centers only to US Requestors: HC $13.75/MF $1.45 CSCL 01C

A feasibility study of an Integrated Program for Aerospace Vehicle Design (IPAD) is reviewed. The approach used to define the design process is described. Major activities performed during the product development cycle are identified. The computer system requirements necessary to support the design process are given as computational requirements of the host system, technical program elements, and system features. The IPAD computer system design is presented as concepts, a functional description, and an organizational diagram of its major components. The cost and schedules and a three phase plan for implementing IPAD are included. Author

N74-28516*# Boeing Commercial Airplane Co., Seattle, Wash.
FEASIBILITY STUDY OF AN INTEGRATED PROGRAM FOR AEROSPACE VEHICLE DESIGN (IPAD). VOLUME 2: THE DESIGN PROCESS An Early Domestic Dissemination Report
W. B. Gillette, M. J. Turner, J. W. Southall, P. C. Whitener, and J. S. Kowalik 21 Sep. 1973 293 p refs 7 Vol.
(Proj. FEDD; Contract NAS1-11441)
(NASA-CR-132392; D6-60181-2) Avail: NASA Regional Dissemination Centers only to US Requestors: HC $6.75/MF $1.45 CSCL 01C

A study was conducted to determine the extent to which an integrated program for aerospace vehicle design (IPAD) supports the design process was conducted. Case studies of representative aerospace products were developed as models to characterize the design process and to provide design requirements for the IPAD computing system. The two projects selected for study are a subsonic commercial transport and a supersonic transport. A study was also made of a naval hydrofoil. Optimization techniques and a recommended strategy for their application to the design networks are discussed. Author

N74-28517*# Boeing Commercial Airplane Co., Seattle, Wash.
FEASIBILITY STUDY OF AN INTEGRATED PROGRAM FOR AEROSPACE VEHICLE DESIGN (IPAD). VOLUME 3: SUPPORT OF THE DESIGN PROCESS An Early Domestic Dissemination Report
W. B. Gillette, S. D. Hansen, R. E. Bateman, and J. W. Southall 21 Sep. 1973 136 p refs 7 Vol.
(Proj. FEDD; Contract NAS1-11441)
(NASA-CR-132393; D6-60181-3) Avail: NASA Regional Dissemination Centers only to US Requestors: HC $4.75/MF $1.45 CSCL 01C

A study was conducted to determine the user requirements for computer support of the integrated program for aerospace vehicle design (IPAD). The parameters considered are: (1) the user-system interface, (2) language, (3) equipment, and (4) computational requirements. The need for a management information system is presented. The required computational capabilities of the host hardware are developed from the design networks. It is concluded that a computing system which satisfies the user requirements of the study will provide improved control of complex design problems and improved technical communications. Author

N74-28518*# Boeing Commercial Airplane Co., Seattle, Wash.
FEASIBILITY STUDY OF AN INTEGRATED PROGRAM FOR AEROSPACE VEHICLE DESIGN (IPAD). VOLUME 4: IPAD SYSTEM DESIGN An Early Domestic Dissemination Report
W. Goldfarb, L. C. Carpenter, D. D. Redhed, S. D. Hansen, L. O. Anderson, and A. S. Kawaguchi 21 Sep. 1973 367 p refs 7 Vol.
(Proj. FEDD; Contract NAS1-11441)
(NASA-CR-132394; D6-60181-4) Avail: NASA Regional Dissemination Centers only to US Requestors: HC $8.00/MF $1.45 CSCL 01C

The computing system design for the integrated program for aerospace vehicle development (IPAD) and optimization is discussed. The requirements which form the basis for the system design are analyzed. The system is presented in terms of a functional design description and technical design specifications. The functional design description gives the conceptual organization of the system. The technical design specifications give the detailed description of the system design using top-down structured programming methodology. Detailed specifications of the two most common computing system types in use by the major aerospace companies which could support the IPAD system are presented. Author

N74-28519*# Boeing Commercial Airplane Co., Seattle, Wash.
FEASIBILITY STUDY OF AN INTEGRATED PROGRAM FOR AEROSPACE VEHICLE DESIGN (IPAD). VOLUME 5: CATALOG OF IPAD TECHNICAL PROGRAM ELEMENTS An Early Domestic Dissemination Report
W. B. Gillette, ed. and J. W. Southall, ed. 21 Sep. 1973 391 p refs 7 Vol.
(Proj. FEDD; Contract NAS1-11441)
(NASA-CR-132395; D6-60181-5) Avail: NASA Regional Dissemination Centers only to US Requestors: HC $8.25/MF $1.45 CSCL 01C

The technical program elements which are required to support the integrated program for aerospace vehicle design (IPAD) are presented. Emphasis is placed on the design activity for a subsonic and supersonic commercial transport. Information for each element consists of: (1) usage and storage information, (2) ownership, (3) status, and (4) a description of the purpose of each element. Author

N74-28520*# Boeing Commercial Airplane Co., Seattle, Wash.
FEASIBILITY STUDY OF AN INTEGRATED PROGRAM FOR AEROSPACE VEHICLE DESIGN (IPAD). VOLUME 6: IPAD SYSTEM DEVELOPMENT AND OPERATION An Early Domestic Dissemination Report
D. D. Redhed, L. L. Tripp, A. S. Kawaguchi, and R. E. Miller, Jr. 21 Sep. 1973 115 p refs 7 Vol.
(Proj. FEDD; Contract NAS1-11441)
(NASA-CR-132396; D6-60181-6) Avail: NASA Regional Dissemination Centers only to US Requestors: HC $4.50/MF $1.45 CSCL 01C

The implementation plan for the integrated program for aerospace vehicle design (IPAD) is presented. The strategy proposes a three phase development of the IPAD system and technical modules, and the transfer of this capability from the development environment to the aerospace vehicle design environment. The system and technical module programming languages are recommended. The cost of developing the IPAD is estimated. A schedule displaying the flowtime required for each development task is given. Author

N74-28521*# Boeing Commercial Airplane Co., Seattle, Wash.
FEASIBILITY STUDY OF AN INTEGRATED PROGRAM FOR AEROSPACE VEHICLE DESIGN (IPAD). VOLUME 7: IPAD BENEFITS AND IMPACT An Early Domestic Dissemination Report
S. D. Hansen and J. W. Southall 21 Sep. 1973 119 p refs 7 Vol.
(Proj. FEDD; Contract NAS1-11441)
(NASA-CR-132397; D6-60181-7) Avail: NASA Regional Dissemination Centers only to US Requestors: HC $4.50/MF $1.45 CSCL 01C

The potential benefits, impact, and spinoff of the integrated program for aerospace vehicle design (IPAD) are discussed. The benefits are projected from a flowtime and labor cost analysis of the design process and a study of the flowtime and labor cost savings being experienced ir. existing integrated systems. Benefits in terms of design productivity, company effectiveness, and IPAD as a national resource are developed. The results of a personal survey of aerospace, non-aerospace, government, and university sources are given. Author

N74-28522*# Kanner (Leo) Associates, Redwood City, Calif.
BUFFETING TESTS WITH A SWEPT WING IN THE TRANSONIC RANGE
B. Monnerie and F. Charpin Washington NASA Jul. 1974 40 p refs Transl. into ENGLISH of the publ. "Essais de Buffeting d'une Aile en Fleche en Transonique" Lille, Nov. 1973 30 p
(Contract NASw-2481)
(NASA-TT-F-15803) Avail: NTIS HC $5.00 CSCL 01B

A model of the transport-aircraft M6 wing was used to study the characteristics of three-dimensional subsonic and transonic flows in general and the phenomenon of buffeting in particular. In spite of their preliminary tentative nature, the data obtained indicate that the motion of the model has little effect on the aerodynamics and that if this finding is confirmed by future tests with various geometries, it should be possible to study buffeting quantitatively from the nonstationary pressures measured on the wing. Author

N74-28524*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EXHAUST-NOZZLE CHARACTERISITCS FOR A TWIN-JET VARIABLE-WING-SWEEP FIGHTER AIRPLANE MODEL AT MACH NUMBERS TO 2.2
David E. Reubush and Charles E. Mercer Washington Jun. 1974 137 p refs
(NASA-TM-X-2947; L-9273) Avail: NTIS HC $4.75 CSCL 01C

A wind-tunnel investigation has been conducted to determine the exhaust-nozzle aerodynamic and propulsive characteristics for a twin-jet variable-wing-sweep fighter airplane model. The powered model was tested in the Langley 16-foot transonic tunnel and in the Langley 4-foot supersonic pressure tunnel at Mach numbers to 2.2 and at angles of attack from about minus 2 to 6 deg. Compressed air was used to simulate the nozzle exhaust flow at values of jet total-pressure ratio from approximately 1 (jet off) to about 21. Effects of configuration variables such as speed-brake deflection, store installation, and boundary-layer thickness on the the nozzle characteristics were also investigated. Author

N74-28525*# Vizex Inc., Amherst, N.Y.
A THEORETICAL STUDY OF THE APPLICATION OF JET FLAP CIRCULATION CONTROL FOR REDUCTION OF ROTOR VIBRATORY FORCES
Raymond A. Piziali and Andrew R. Trenka May 1974 143 p refs
(Contract NAS2-7307)
(NASA-CR-137515) Avail: NTIS HC $10.25 CSCL 01C

The results of a study to investigate the theoretical potential of a jet-flap control system for reducing the vertical and horizontal non-cancelling helicopter rotor blade root shears are presented. A computer simulation describing the jet-flap control rotor system was developed to examine the reduction of each harmonic of the transmitted shears as a function of various rotor and jet parameters, rotor operating conditions and rotor configurations. The computer simulation of the air-loads included the influences of nonuniform inflow and blade eaistic motions. (no hub motions were allowed.) The rotor trim and total rotor power (including jet compressor power) were also determined. It was found that all harmonics of the transmitted horizontal and vertical shears could be suppressed simultaneously using a single jet control. Author

N74-28527# Sheffield Univ. (England).
LANDING TRANSITION PATHS WHICH OPTIMIZE FUEL, TIME OR DISTANCE FOR JET-LIFT VTOL TRANSPORT AIRCRAFT IN STEEP APPROACHES
E. Huntley London Aeron. Res. Council 1974 30 p refs Supersedes ARC-33388
(ARC-R/M-3732; ARC-33388) Avail: NTIS HC $4.50; HMSO £1.10; PHI $4.30

Optimal landing transition maneuvers were studied for jet lift VTOL aircraft in which the range of engine-tilt is sufficient to allow approach angles up to 20 deg. The optimal use of incidence, thrust vector angle and thrust to control the transition was studied using simple physics arguments. All the natural constraints such as incidence, engine tilt, maximum permissible decelerations, minimum permissible lift engine thrust, etc. can thus be taken into account and simple rules formulated for the optimal strategy. It is shown that provided control programs are formulated as functions of aircraft speed, flight path shape and the control program can be dealt with as separate problems. It is known that for minimum distance transitions the optimum path shape involves selecting a let-down speed V at which the deceleration function for horizontal flight is a maximum. The optimal maneuver is then to decelerate horizontally to V, to lose height at this speed and to conclude the transition with a further horizontal deceleration to the hover point. However, for the minimum fuel or time transition the ideal is to use the same steeped maneuver but to select the let-down speed as high as is compatible with considerations of the danger of high rates of descent near the ground and the need to avoid obstacles near the airfield. Author (ESRO)

N74-28528# Aeronautical Quality Assurance Directorate, Uxbridge (England).
ENDURANCE TEST ON FLEXIBLE STEEL WIRE ROPE FOR AIRCRAFT CONTROLS AT VARIOUS PULLEY ROPE DIAMETER RATIOS
H. A. Senior and A. New [1974] 19 p
(AQD/D-14; BR39988) Avail: NTIS HC $4.00

A program of tests was carried out to investigate the effects of test pulley size on the endurance of 1/8 in diameter carbon and corrosion resistant steel ropes for aircraft controls. A range of test pulley/rope diameter ratios between 7 and 30 was investigated and the results of these tests are given. The indications are that pulley to rope ratios of the order of 20 to 1 are desirable to ensure good endurance properties. It is also shown that under certain test conditions corrosion resistant steel shows better endurance properties. Author (ESRO)

N74-28531# Naval Air Development Center, Warminster, Pa. Air Vehicle Technology Dept.
STATISTICAL REVIEW OF COUNTING ACCELEROMETER DATA FOR NAVY AND MARINE FLEET AIRCRAFT Semiannual Summary Report, 1 Jan. 1962 - 31 Dec. 1973
Thomas A. DeFiore 1 May 1974 134 p
(AD-778645) Avail: NTIS CSCL 01/3

The report is a specialized summary of normal acceleration data recorded by counting accelerometers. Data are separated by calendar time and mission category. Only data reported in the counting accelerometer program are included. Author (GRA)

N74-28532# Franklin Inst. Research Labs., Philadelphia, Pa.
NONSCRATCHING WINDSHIELD WIPER BLADE Final Report
John W. Woestman Apr. 1974 33 p refs
(Contract DAAD05-71-C-0422)
(AD-778759; FIRL-F-C3120-11; LWL-CR-06P72D) Avail: NTIS CSCL 01/3

The program was undertaken to assess the possible utilization of low friction and/or porous materials in making wiper blades for helicopter plastic windshields. It was, therefore, directed to a search for new materials in current use. A literature search was made to acquire the most recent information on the theories of wear and abrasion plus any specific literature on wiper blades for plastic windows. A synopsis of wear theory is presented, emphasizing the facets of the theory that apply to this problem. Ideal material characteristics are defined and a list of materials which approach one or more of these characteristics is presented. Some testing of promising materials was done. The test fixture used and the initial results are described. Recommendations for additional materials to be tested are made. Author (GRA)

N74-28549# Royal Aircraft Establishment, Farnborough (England).
CONTACTORS FOR IMPROVED AIRCRAFT ELECTRICAL POWER DISTRIBUTION SYSTEMS
R. J. K. Splatt Feb. 1974 70 p refs
(RAE-TR-73157; BR39345) Avail: NTIS HC $6.50

Simple modifications to reduce the control signal current requirements and improve performance of existing electromechanical contactors are discussed in detail. The design of experimental ac and dc solid state contactors is given together with a detailed discussion of their advantages, disadvantages, and performance. Certain performance characteristics, important in contactor operation, are explained. Both solid state and electromechanical contactors, in their modified form, are likely to be required for use in improved aircraft electrical power distribution systems of the future. Author (ESRO)

N74-28550# AiResearch Mfg. Co., Phoenix, Ariz.
HYDRAULIC-TO-PNEUMATIC POWER SUPPLY FOR AIRCRAFT FLUIDIC SYSTEMS Final Report, 2 Feb. 1973 - Jan. 1974
R. S. McCarty and J. T. Cox Feb. 1974 68 p
(Contract N00019-73-C-0311; AIR Proj. 52022)
(AD-778764; Airesearch-74-410484) Avail: NTIS CSCL 13/7

The program activities encompassed analysis, development, design, fabrication, and test of a hydraulic-to-pneumatic power supply suitable for use in supplying the total power required for any of a number of different aircraft fluidic systems. The unit uses a hydrofluidic oscillator to drive a double-ended reciprocating bellows compressor. The input is Type MIL-H-5606 hydraulic fluid at a supply pressure of 3,000 psi. The pneumatic output is at a discharge pressure of 30 psia with a flow of 0.25 lb per minute. Author (GRA)

N74-28706*# Ohio State Univ., Columbus. ElectroScience Lab.
DIFFRACTION BY A PERFECTLY CONDUCTING RECTANGULAR CYLINDER WHICH IS ILLUMINATED BY AN ARRAY OF LINE SOURCES
R. G. Kouyoumjian and N. Wang Washington NASA Jun. 1974 73 p refs
(Grant NGR-36-008-144)
(NASA-CR-2405; ESL-3001-7) Avail: NTIS HC $3.75 CSCL 20N

The geometrical theory of diffraction (GTD) is employed to analyze the radiation from a perfectly-conducting rectangular cylinder illuminated by an array of line sources. The excitation of the cylinder by a single electric or magnetic current line source is considered first, and a solution which includes contributions from the geometrical optics rays and all singly- and doubly-diffracted rays is obtained. A new diffraction coefficient valid in the transition regions of the shadow and reflection boundaries is employed to obtain a continuous total field, except for negligible discontinuities in the doubly-diffracted field at its shadow boundaries. Patterns calculated by the GTD method are found to be in excellent agreement with those calculated from an integral equation formulation. Using superposition the solution for array or aperture excitation of the rectangular cylinder is obtained. A computer program for this solution is included. Author

N74-28707*# Ohio State Univ., Columbus. ElectroScience Lab.
FLUSH-MOUNTED ANTENNAS RADIATING ON AIRCRAFT TYPE SURFACES Progress Report
W. D. Burnside, C. L. Yu, and R. J. Marhefka Washington NASA Jun. 1974 55 p refs
(Grant NGR-36-008-144)
(NASA-CR-2403; ESL-3001-5) Avail: NTIS HC $3.75 CSCL 09A

The roll plane radiation patterns of on-aircraft antennas are analyzed using high frequency solutions. This is a basic study of aircraft-antenna pattern performance in which the aircraft is modelled in its most basic form. The fuselage is assumed to be a perfectly conducting elliptic cylinder with the antennas mounted near the top or bottom. The wings are simulated by arbitrarily many sided flat plates. Author

N74-28709*# Ohio State Univ., Columbus. ElectroScience Lab.
THE RADIATION FROM SLOTS IN TRUNCATED DIELECTRIC-COVERED SURFACES
Y. M. Hwang, R. G. Kouyoumjian, and P. H. Pathak Washington NASA Jun. 1974 43 p refs
(Grant NGR-36-008-144)
(NASA-CR-2397; ESL-3001-8) Avail: NTIS HC $3.25 CSCL 20N

A theoretical approach based on the geometrical theory of diffraction is used to study the electromagnetic radiation from a narrow slot in a dielectric-covered perfectly-conducting surface terminated at an edge. The total far-zone field is composed of a geometrical optics field and a diffracted field. The geometrical optics field is the direct radiation from the slot to the field point. The slot also generates surface waves which are incident at the termination of the dielectric cover, where singly-diffracted rays and reflected surface waves are excited. The diffraction and reflection coefficients are obtained from the canonical problem of the diffraction of a surface wave by a right-angle wedge where the dielectric-covered surface is approximated by an impedance surface. This approximation is satisfactory for a very thin cover; however, the radiation from its vertical and faces cannot be neglected in treating the thicker dielectric cover. This is taken into account by using a Kirchhoff-type approximation, which contributes a second term to the diffraction coefficient previously obtained. The contributions from the geometrical optics field, the singly-diffracted rays and all significant multiply-diffracted rays are summed to give the total radiation. Calculated and measured patterns are found to be in good agreement. Author

N74-28710*# Ohio State Univ., Columbus. ElectroScience Lab.
THE DYADIC DIFFRACTION COEFFICIENT FOR A CURVED EDGE Progress Report
R. G. Kouyoumjian and P. H. Pathak Washington NASA Jun. 1974 94 p refs
(Grant NGR-36-008-144)
(NASA-CR-2401; ELS-3001-3) Avail: NTIS HC $4.00 CSCL 09C

A compact dyadic diffraction coefficient for electromagnetic waves obliquely incident on a curved edge formed by perfectly conducting curved or plane surfaces is obtained. This diffraction coefficent remains valid in the transition regions adjacent to shadow and reflection boundaries, where the diffraction coefficients of Keller's original theory fail. The method is on Keller's method of the canonical problem, which in this case is the perfectly conducting wedge illuminated by plane, cylindrical, conical, and spherical waves. When the proper ray fixed coordinate system is introduced, the dyadic diffraction coefficient for the wedge is found to be the sum of only two dyads, and it is shown that this is also true for the dyadic diffraction coefficients of higher order edges. One dyad contains the acoustic soft diffraction coefficient; the other dyad contains the acoustic hard diffraction coefficient. The expressions for the acoustic wedge diffraction coefficients contain Fresnel integrals, which ensure that the total field is continuous at shadow and reflection boundaries. The diffraction coefficients have the same form for the different types of edge illumination; only the arguments of

the Fresnel integrals are different. Since diffraction is a local phenomenon, and locally the curved edge structure is wedge shaped, this result is readily extended to the curved edge.
Author

N74-28719# Aerospace Corp., El Segundo, Calif. Electronics Research Lab.
A WIDEBAND SHALLOW CAVITY-BACKED SLEEVE DIPOLE AIRCRAFT ANTENNA Report for Apr. - Aug. 1973
Jimmy L. Wong and Howard E. King 19 Apr. 1974 24 p refs
(Contract F04701-73-C-0074)
(AD-778930; TR-0074(4401)-2; SAMSO-TR-74-101) Avail: NTIS CSCL 09/5

A shallow-cavity, open-sleeve cross dipole antenna is described for operation in the 240- to 400-MHz band. The cavity is confined within a volume of 21 75 in. square by 6 in. deep. These dimensions were constrained by the allowable space of the FB-111 aircraft. Measured VSWR and radiation patterns with the cavity mounted on a finite-size ground plane are shown. Author (GRA)

N74-28734*# Colorado State Univ., Fort Collins. Fluid Dynamics and Diffusion LAb.
A WIND MODEL FOR AN ELEVATED STOL-PORT CONFIGURATION Final Report
J. A. Peterka and J. E. Cermak Washington NASA Jul. 1974 41 p refs
(Contract NAS2-7396)
(NASA-CR-2450) Avail: NTIS HC $3.25 CSCL 01E

Measurements of mean velocity magnitude and direction as well as three-dimensional turbulence intensity were made in the flow over a model of an elevated STOL-port. A 1:300 scale model was placed in a wind tunnel flow simulating the mean velocity profile and turbulence characteristics of atmospheric winds over a typical city environment excluding detailed wake structures of possible nearby buildings. Hot-wire anemometer measurements of velocity and turbulence were made along approach and departure paths of aircraft operating on the runway centerline and at specified lateral distances from the centerline. Approach flow directions simulated were 0 and 30 degrees to the runway centerline. Author

N74-28737*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
THE USE OF AN AIRCRAFT TEST STAND FOR VTOL HANDLING QUALITIES STUDIES
Frank A. Pauli, Lloyd D. Corliss (Army Air Mobility Res. and Develop. Lab., Moffett Field, Calif.), Sidney D. Selan, Ronald M. Gerdes, and Terrence D. Gossett (Army Air Mobility Res. and Develop. Lab., Moffett Field, Calif.) Jun. 1974 30 p refs
(NASA-TM-X-62218) Avail: NTIS HC $4.50 CSCL 14B

The VTOL flight tests stand for testing control concepts on the X-14B VSS aircraft in hover, is described. This stand permits realistic and safe piloted evaluation and checkout of various control systems and of parameter variations within each system to determine acceptability to the pilot. Pilots can use it as a practical training tool to practice procedures and flying techniques and become familiar with the aircraft characteristics. Some examples of test experience are given. The test stand allows the X14B to maneuver in hover from centered position + or - 9.7 deg in roll and + or - 9.3 deg in pitch, about + or - 6 deg in yaw, and + or - 15 cm in vertical translation. The unique vertical free flight freedom enables study of liftoffs and landings with power conditions duplicated. The response on the stand agrees well with that measured in free hovering flight, and pilot comments confirm this. Author

N74-28782# Aeronautical Research Associates of Princeton, Inc., N.J.
A PROGRAM TO COMPUTE THE BEHAVIOR OF A THREE DIMENSIONAL TURBULENT VORTEX Final Report, 19 Jun. 1972 - 19 Jun. 1973
Roger D. Sullivan Feb. 1974 54 p refs
(Contract F33615-72-C-2116; AF Proj. 7071)
(AD-778433; ARAP-200; ARL-TR-74-0009) Avail: NTIS CSCL 20/4

A program to compute the downstream behavior of a turbulent vortex has been prepared. The mathematical basis and the numerical technique of the program are set forth. Subsidiary calculations are described. Finally, the structure of the program is explained and the information needed to run it is given.
Author (GRA)

N74-29012# Boeing Aerospace Co., Seattle, Wash.
EXPLORATORY INVESTIGATION OF RAPID CRACK PROPAGATION AND CRACK ARREST Final Report, 15 Dec. 1971 - 7 Feb. 1973
R. C. Shah Aug. 1973 102 p refs
(Contract F33615-72-C-1063)
(AD-778822; D180-17529-1; AFFDL-TR-73-95) Avail: NTIS CSCL 11/6

The experimental program was undertaken to study aircraft structural alloys. Materials tested included 2219-T851 and 7075-T6 Aluminum, 6Al-4V beta-annealed Titanium, 9Ni-4Co-0.2C and 4340 steel alloys. Tests were conducted with radially flared and uniform height DCB (Double Cantiler Beam) specimens containing either sharp cracks or notches with finite root radii. The specimens were instrumented to measure crack velocity, crack length, crack opening displacement, instantaneous load, strain and crack lengths and the stress intensity factors at the initiation and the arrest of the crack propagation. An instrumentation system for the measurement of crack velocities from zero to several thousands of feet per second is presented. Experimental results indicate that a cracked DCB specimen of any configuration under static loading is not suitable for investigating the dynamic behavior of rapidly running cracks or crack arrest conditions. Recommendations for suitable test specimens are provided. (Modified author abstract) GRA

N74-29016*# Aerotherm Corp., Mountain View, Calif.
ANALYTICAL MODELING OF INTUMESCENT COATING THERMAL PROTECTION SYSTEM IN A JP-5 FUEL FIRE ENVIRONMENT Final Report
Kimble J. Clark, Allen B. Shimizu, Kurt E. Suchsland, and Carl B. Moyer Jun. 1974 87 p refs
(Contract NAS2-7709; Aerotherm Proj. 7080)
(NASA-CR-137531; AEROTHERM-FR-74-101) Avail: NTIS HC $7.50 CSCL 11C

The thermochemical response of Coating 313 when exposed to a fuel fire environment was studied to provide a tool for predicting the reaction time. The existing Aerotherm Charring Material Thermal Response and Ablation (CMA) computer program was modified to treat swelling materials. The modified code is now designated Aerotherm Transient Response of Intumescing Materials (TRIM) code. In addition, thermophysical property data for Coating 313 were analyzed and reduced for use in the TRIM code. An input data sensitivity study was performed, and performance tests of Coating 313/steel substrate models were carried out. The end product is a reliable computational model, the TRIM code, which was thoroughly validated for Coating 313. The tasks reported include: generation of input data, development of swell model and implementation in TRIM code, sensitivity study, acquisition of experimental data, comparisons of predictions with data, and predictions with intermediate insulation. Author

N74-29040*# Scientific Translation Service, Santa Barbara, Calif.
APPLICATION OF QUARTERNIONS TO RIGID BODY ROTATION PROBLEMS
V. N. Branets and I. P. Shmyglevskiy Washington NASA Jul. 1974 352 p refs Transl. into ENGLISH of the book "Primeneniye Kvaternionov v Zadachakh Orientatsii Tevrdogo Tela" Moscow, Nauka, 1973 320 p
(Contract NASw-2483)
(NASA-TT-F-15414) Avail: NTIS HC $20.75 CSCL 20K

Questions are presented of applying quaternions to general theoretical problems of the kinematics of rigid body rotation and to practical problems of control. The theory of finite rotations and the kinematics of rigid body rotation are presented on the basis of quaternion product operations. Questions in the study of the kinematic equations and their numerical integration, problems in the use of quaternions in problems of rigid body rotation control, and optimization of spatial turns are consid-

ered. A number of examples indicate the convenience and advantage of using quaternions in control problems. The book will be of interest to specialists in the area of aircraft control systems and for everyone-interested in general problems of rigid body mechanics. Author

N74-29118*# Linguistic Systems, Inc., Cambridge, Mass.
A MONITOR DISPLAY FOR AUTOMATICALLY REGULATED STEEP APPROACHES
Hans-Dieter Schenk and Josef Thomas Washington NASA Jul. 1974 16 p refs Transl. into ENGLISH of "Ein Monitordisplay fur automatisch geregelte Steilanfluge", DEVLR, Brunswick, Inst. fur Flugfuhrung, DGLR-73-031, 1973 44 p
(Contract NASw-2482)
(NASA-TT-F-15615; DGLR-73-031) Avail: NTIS HC $4.00 CSCL 01D

A monitor display is discussed for automatically regulating steep approaches. Advantages of the standard ILS approach profile are presented, and the problem of V/STOL flight guidance is treated with respect to the operational requirements of the ICAO. A steep landing aircraft is proposed to handle these problems; a reduced noise burden for residents of the airport also results from this approach profile. Author

N74-29119*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
PRELIMINARY STUDY OF A POSSIBLE AUTOMATIC LANDING SYSTEM
Windsor L. Sherman and Sylvia W. Winfrey Washington Jul. 1974 68 p refs
(NASA-TN-D-7611; L-9246) Avail: NTIS HC $3.75 CSCL 17G

Navigation and control laws for a possible automatic landing system have been investigated. The system makes use of data from an inertial table and either an airborne or ground radar to generate signals that guide the airplane to a landing. All landing maneuvers take place within a zone that extends 6000 m out from the touchdown point, 4000 m on each side of the runway center line, and 540 m high. The results show that the system can adequately control the airplane on steep, curved decelerating approaches to a landing that takes place with small errors from the desired landing point and desired airplane attitude. The system studied would interface well with the scanning beam microwave landing system (MLS). The use of this system with the MLS makes it possible to incorporate an independent landing monitor. Author

N74-29207# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
FUEL FOR SUPERSONIC PASSENGER AIRCRAFT
I. P. Blagovidov, I. E. Bespolov, V. M. Vul, K. V. Minkner, V. V. Malyshev, A. A. Tupolev, Ye. R. Tereshchenko, M. D. Khayin, and V. V. Yakolevskiy 17 Apr. 1974 16 p Transl. into ENGLISH of the publ. "Neftyanye Topliva Dlya Dvigatelei Vnutrennego Sgoraniya i Gazovykh Turbin" USSR, 1971 p 3-13
(AD-778801; FTD-HT-23-701-74) Avail: NTIS CSCL 21/4

The feasibility of obtaining a base fuel for supersonic airliners has been examined and the problems of improving the antiwear, anticorrosive, de-icing, antistatic and other properties connected with operating conditions have not been touched upon. For these purposes it is possible to use special additives, as well as to saturate fuel with nitrogen. Author (GRA)

N74-29225# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
THE POWER PLANTS OF VERTICAL TAKEOFF AND LANDING AIRCRAFT
V. F. Pavlenko 21 Mar. 1974 340 p refs Transl. into ENGLISH of the publ. "Silovye Ustanovki Letatelnykh Apparatov Vertikalnogo Vzleta i Posadki" USSR, 1972 p 1-283
(AD-778791; FTD-MT-24-715-73) Avail: NTIS CSCL 21/5

In the book are described the types of power plants of vertical takeoff and landing (VTOL) aircraft, their operating conditions, the characteristics and features of construction. Considerable attention is given to the effect of the exhaust jets of power plants on the takeoff and landing areas, the aircraft and engine. The measures which reduce the adverse phenomena connected with this effect are shown. The questions of the arrangement of power plants on VTOL aircraft are examined also. GRA

N74-29228# Naval Postgraduate School, Monterey, Calif.
CALCULATING METHOD FOR MULTI-STAGE AXIAL COMPRESSORS WITH IMPLUSE BLADINGS AND CONSTANT TIP DIAMETER Interim Report, Jul. 1973 - Jun. 1974
M. H. Vavra Mar. 1974 73 p refs
(AD-778808; NPS-57VA74031) Avail: NTIS CSCL 21/5

The report gives an approximate calculating method for the design point performance of multi-stage axial compressors with impulse-type bladings and constant tip diameters. Computing programs for Monroe-1180 programmable calculators are presented to establish the compressor performance and the blading parameters for arbitrary conditions with minimum effort. The report was prepared to permit evaluations of the applicability of such compressors in advanced propulsion units for air-superiority aircraft, or in light-weight lift engines for military VTOL aircraft. Author (GRA)

N74-29358 European Space Research Organization, Paris (France).
THE PREDICTION OF THE VARIATION OF MODES FOLLOWING MODIFICATION TO A STRUCTURE c32
Gabriel Coupry *In its* Aerospace Res., Bi-monthly Bull. No. 1973-3 (ESRO-TT-52) May 1974 p 79-105 refs Transl. into ENGLISH from La Rech. Aerospatiale, Bull. Bimestriel No. 1973-3, 1973 p 173-187

It is proposed to establish the evolution of its first modes as a result of known modifications to mass and stiffness. Should all modes of the initial structure not be known, an upper limit to the error which results from truncation of the modal representation will be determined. In all cases, the number of modes of the initial structure which must be introduced into the calculation in order to estimate the first p modes of the modified structure with a given degree of accuracy will be defined. Author (ESRO)

N74-29361 European Space Research Organization, Paris (France).
LABORATORY FOR AUTOMATIC PROCESSING OF ANALOG SIGNALS c11
Jean-Paul Boisseau, Guy Gori, Edmond Gratieux, Jacques Hay et al *In its* Aerospace Res., Bi-monthly Bull. No. 1973-3 (ESRO-TT-52) May 1974 p 112-122 Transl. into ENGLISH from La Rech. Aerospatiale, Bull. Bimestriel No. 1973-3, 1973, p 191-195

This system which was designed to satisfy extensive requests for the use of a limited number of fixed procedures, has a high level of automation; manual operations are confined to the elementary tasks of data input and control. This system and its present capability are described. Author (ESRO)

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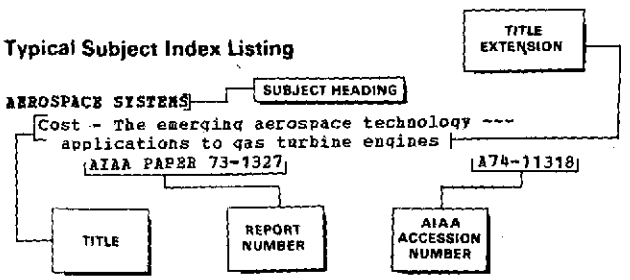

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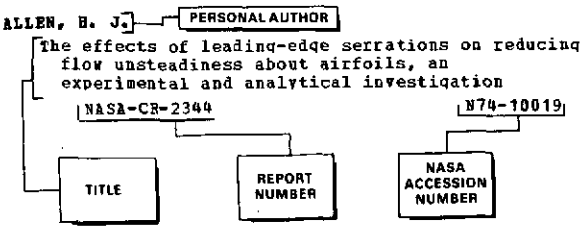

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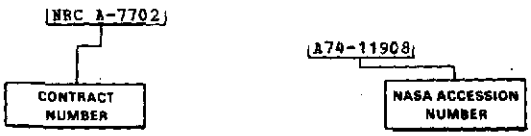

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