NASA SP-7037 (30)



# AERONAUTICAL ENGINEERING

## A SPECIAL BIBLIOGRAPHY WITH INDEXES

Supplement 30

APRIL 1973



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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NASA SP-7037 (30)

# AERONAUTICAL ENGINEERING

## A Special Bibliography

## Supplement 30

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 March 1973 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 423 reports, journal articles, and other documents originally announced in March 1973 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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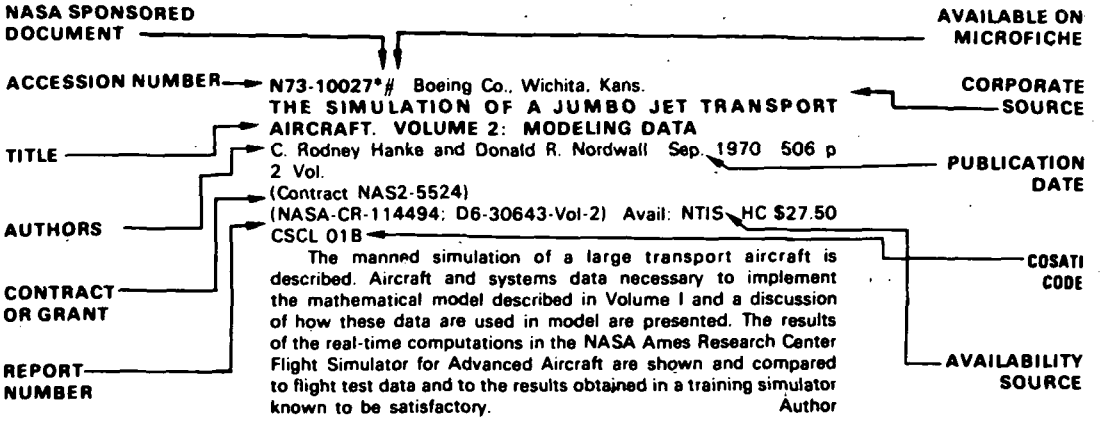


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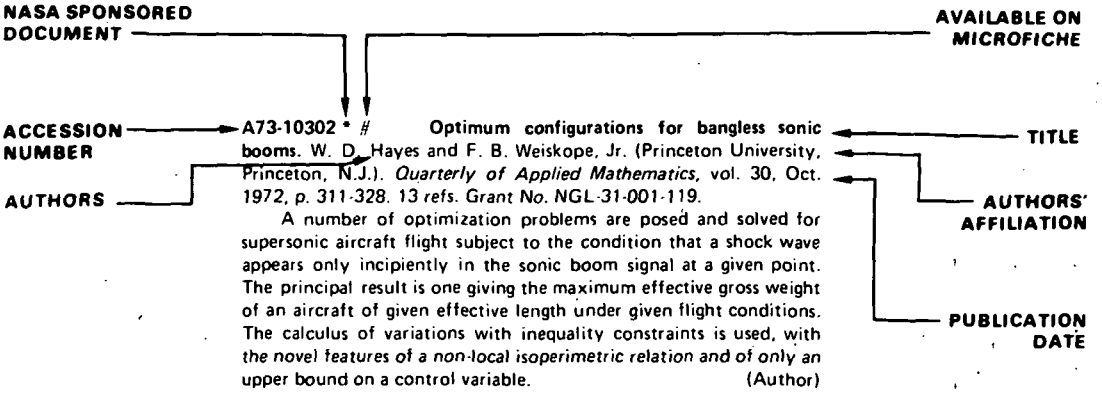

# AERONAUTICAL ENGINEERING

*A Special Bibliography (Suppl. 30)* APRIL 1973

## IAA ENTRIES

**A73-16050** **Automated navigation and the pilot.** C. M. Ramsey (KLM - Royal Dutch Airlines, Schiphol Airport, Netherlands). *Shell Aviation News*, no. 413, 1972, p. 16-21.

A system designed to serve at a high level of automation sophistication has been developed by Douglas and Collins for the KSSU long range version of the DC-10, which is now approaching certification. It will be capable of use on both area navigation and on conventional routes worldwide, from take-off to final approach. This is the cornerstone of the design philosophy. To handle the plethora of data, the Control Display Unit, or CDU, is equipped with a cathode ray tube (CRT) displaying printed data for information or selection, and an extensive keyboard allowing the pilot to type in messages, which appear on the CRT. The message stays there inactive until the pilot, having scrutinized his work, takes a further action to feed it into the computer. For the rest, the CRT is devoted to displaying pertinent information held or derived by the computer. (Author)

**A73-16131** **Eddy current testing of brazed titanium honeycomb.** W. E. Woodmansee and J. C. Kennedy (Boeing Metallurgical Laboratory, Seattle, Wash.). *Journal of Materials*, vol. 7, Dec. 1972, p. 480-485. Research supported by the Boeing Co.

Single coil eddy current probes were used to detect the presence and distribution of aluminum braze alloy in titanium honeycomb sandwich panels. Impedance plane analysis demonstrating the largest eddy current signal from normally filleted samples was obtained with the coil centered over a single core cell. The circulating currents induced in the loop of braze alloy in the individual cell fillets modified the coil impedance more significantly than when the probe was over a cell wall or node. Lack of braze flow, very large fillets, and formation of TiAl3 were separable by their respective effects upon the probe impedance. The eddy current response to normally filleted honeycomb appeared useful in nondestructively predicting fillet sizes and flatwise tensile strengths if the face sheet thickness is known. The eddy current techniques described will probably not be responsive to face sheet-core unbonds. (Author)

**A73-16179** **Performance and stability of hypervelocity aircraft flying on a minor circle.** A. M. Drummond (National Research Council, Ottawa, Canada; Auburn University, Auburn, Ala.). In: Progress in aerospace sciences. Volume 13. (A73-16176 05-31) Oxford, Pergamon Press, Ltd., 1972, p. 137-221. 48 refs.

The equations of motion pertinent to the study of steady and perturbed motions of a rigid vehicle flying on a minor circle at constant altitude above a spherical nonrotating earth are presented. Solutions to the steady-state equations (performance) and perturbation equations (stability) are presented in the form of altitude-speed regions where flight is possible, and root loci, respectively. The linearized equations and performance boundaries are discussed. The principal conclusions are that steady flight is limited mainly by available thrust, and that characteristic oscillations about the steady-flight condition are poorly damped. Minor instabilities were found in all cases examined. New characteristic modes, not present in conventional flight, are discussed. They involve the movement of the vehicle mass-center relative to the equilibrium flight trajectory. A representative vehicle was chosen for which numerical values were obtained. (Author)

**A73-16185** **Bright future forecast for composites in aerospace.** I. Stambler. *Interavia*, vol. 27, Dec. 1972, p. 1363-1366.

It is considered that glass fibers will remain the major composite reinforcement well into the 1980's, and that other systems will replace metals in new applications. However, glass fibers face challenges from graphite and boron and new kinds of organic fibers. Experience indicates that graphite composites can perform as well as, if not better than, aluminum and boron. Graphite design and manufacturing techniques were found to be simpler than those for boron due to graphite prepreg drapability and ease of matching. The material provides a significant structural weight saving over aluminum. Graphite or other composites may have a potential for engine applications. F.R.L.

**A73-16186** **A method of early failure detection for gas turbines.** J. K. Barugh (Vactric Control Equipment, Ltd., England). *Interavia*, vol. 27, Dec. 1972, p. 1367, 1368.

Some techniques are considered that can detect incipient failure in those components of a gas turbine which are subject to the highest stress levels, such as ball and roller bearings and gears. Wear particles, the bulk of which are ferrous, are captured by means of a magnet, and when a sufficient quantity has been captured, an electric circuit is closed which lights a warning lamp. When the quantity of particles collected begins to increase, as well as the size of the particles, this constitutes the first indication of an impending failure. With a moderate degree of experience an observer can say what was their probable source. F.R.L.

**A73-16200** # **The 600 knot Yankee escape system.** J. Rivedal (Stanley Aviation Corp., Denver, Colo.). *SAFE Engineering*, vol. 2, 2nd Quarter, 1972, p. 12-18.

The tractor rocket concept was conceived and developed as an escape system that would eliminate some of the problems associated with ejection seats. The Yankee escape system is now operational in three aircraft, including the A-1E, the A-1H, and the T-28. Tests of the high-speed version of the system which was developed for a four-place Navy aircraft are presently being conducted. This system can remove all four men from the aircraft in less than one second at speeds ranging from zero to 600 knots. Yankee systems have been designed to requirements as widely varying as those of a high-speed fighter and of a helicopter. G.R.

**A73-16297** # **Stability of a thin-wing model with one and two degrees of freedom (Ob ustoichivosti modeli tonkogo kryla s odnoi i dvumia stepeniami svobody).** G. V. Aronovich and P. L. Zhirov (Gor'kovskii Gosudarstvennyi Universitet, Gorki, USSR). *Radiofizika,* vol. 15, no. 11, 1972, p. 1707-1717. 10 refs. In Russian.

The flutter dynamics of a thin wing-aileron system are examined by analyzing the stability of a wing model treated as a system with one and two degrees of freedom in a flow of ideal incompressible fluid. Cases of flexural-torsional flutter and of torsional aileron flutter are examined for aerodynamic forces calculated by the quasi-stationary theory, while cases of purely torsional wing flutter are studied for aerodynamic forces calculated by the nonstationary theory. The results may be used to solve (by the Galerkin method) the flutter problem for a wing with an infinite number of degrees of freedom. T.M.

**A73-16355 Flight propulsion systems: Principles, systematics, and technology of aeronautical and astronautical propulsion systems (Flugantriebe: Grundlagen, Systematik und Technik der Luft- und Raumfahrtantriebe).** H. G. Münzberg (München, Technische Universität, Munich, West Germany). Berlin, Springer-Verlag, 1972. 598 p. 281 refs. In German. $59.60.

Factors common to propulsion systems of various types are considered, giving attention to energy flow, fundamental design questions, forces, analogies regarding the acceleration of the operational medium, and definitions of jet propulsion technology. Principles of propulsion technology are examined together with pressure generation, aspects of energy supply and energy transformation, pressure relaxation in processes involving the transfer of energy within the turbine, and the acceleration of cold and hot media of operation. Individual propulsion systems discussed include atmospheric propulsion units, chemical rockets, nuclear-thermal rockets, and electrical propulsion units. G.R.

**A73-16360 The local service airline experiment.** G. C. Eads (George Washington University, Washington, D.C.). Research supported by the Ford Foundation. Washington, D.C., Brookings Institution (Studies in the Regulation of Economic Activity, No. 6), 1972. 234 p. 325 refs. $7.95.

Questions regarding the demand for short-haul air service are investigated, giving attention to the demand for passenger transportation, the size of the short-haul air travel market, and the factors affecting the demand for short-haul air service. The costs of short-haul air service are discussed together with aspects of local service, route strengthening, transition to trunkline status, and policy options open to the federal government. Questions of the quality of 'local' air service and its cost to the government are also examined. It is concluded that on economic grounds a strong case can be made for ending the local service subsidy altogether. G.R.

**A73-16402** # **General problems of guidance theory (Obshchie voprosy teorii navedeniia).** E. A. Fedosov, A. M. Batkov, V. F. Levitin, and V. A. Skripkin. In: Control of moving objects. Moscow, Izdatel'stvo Nauka, 1972, p. 8-29. In Russian.

Development of a unified approach to the design of spacecraft control systems, and discussion of the formulation of the general guidance problem. The general traits and specific features of remote-control, self-guidance, and autonomous-guidance systems are illustrated in the case of a linear system. The problem of optimization of the guidance system is considered, and an analysis is made of the specific features of the solutions for various information sources and with allowance for various types of power constraints. The effect of counteraction on the characteristics of the guidance system is investigated. Methods of analyzing a guidance system with allowance for incomplete information concerning the spacecraft characteristics are described. A.B.K.

**A73-16415** # **Flight vehicle /FV/ control optimization taking into account control-function and phase-coordinate constraints (Ob optimizatsii upravleniia letatel'nym apparatom /LA/ s uchetom ogranichenii na upravliaiushchuiu funktsiiu i fazovye koordinaty).** V. I. Piatakov. In: Control of moving objects. Moscow, Izdatel'stvo Nauka, 1972, p. 187-200. In Russian.

**A73-16416** # **Synthesis of optimal control problems with allowance for a prescribed reliability (K sintezu optimal'nykh sistem upravleniia s uchetom zadannoi nadezhnosti).** V. A. Bodner, K. B. Alekseev, and R. A. Zakirov. In: Control of moving objects. Moscow, Izdatel'stvo Nauka, 1972, p. 200-212. In Russian.

An attempt is made to derive a procedure for synthesis of optimal control systems which satisfy prescribed reliability requirements at the initial stage of design. Maximum structural reliability is the criterion on which the synthesis is based. The probability of smooth performance and quality-functional optimization are the principal ingredients of the reliability criterion. Several examples of the application of this procedure are given for the synthesis of controlled plants with different dynamic characteristics and optimized reliability. V.Z.

**A73-16418** # **Some structure synthesis problems for systems controlling the three-dimensional motion of orbital-aircraft in the earth's atmosphere (Nekotorye voprosy sinteza struktur sistem upravleniia prostranstvennym dvizheniem orbital'nogo samoleta v atmosfere zemli).** B. N. Petrov, N. P. Kolpakova, V. A. Vasil'ev, and A. I. Pavlenko. In: Control of moving objects. Moscow, Izdatel'stvo Nauka, 1972, p. 224-242. 5 refs. In Russian.

**A73-16565 Regional airports - For whom.** A. R. Marsh (International Aeradio, Ltd., Southall, Middx., England). *Airport Forum,* Dec. 1972, p. 49, 50, 53, 55, 57-59. In English and German.

Well aware of its controversial nature, the paper argues the point that the only way to control the alarming rate of air traffic development in order to avoid being prematurely engulfed by a situation which has not been sufficiently studied to know how to cope with it, is to 'think small, plan small, and implement slowly.' The dangers of planning regional airports on a grand scale are pointed out. V.P.

**A73-16566 Advanced transport systems for airports.** R. Allen (Aviation Literary Services, Northampton, England). *Airport Forum,* Dec. 1972, p. 86-94. In English and German.

The design philosophies and characteristics of the major existing inter-terminal transport systems, known as People Movers, are discussed. The systems devised by the Westinghouse Electric Corporation, Vought Aeronautics, Hawker Siddeley, and Matra (France) are described and illustrated. The effectiveness of the systems installed at Tampa, Seattle-Tacoma, Houston, and Dallas/Fort Worth is demonstrated. V.P.

**A73-16593** # **On some aspects of the mathematical theory of airfoils.** S. N. Chaudhuri (Tennessee, University, Tullahoma, Tenn.). *Journal of Mathematical and Physical Sciences,* vol. 6, Sept. 1972, p. 271-295. 11 refs.

The paper discusses a simple and accurate analytical method of predicting the pressure distribution over an arbitrary airfoil placed in inviscid potential flow as well as in real fluid flow. The determination of the velocity increment at the leading edge induced by the changing angle of attack presents some difficulty due to the presence of a logarithmic singularity when the equation of the airfoil contains a linear term in x. A general method of computing this velocity increment is indicated without assuming the absence of the linear term. (Author)

**A73-16600** **Experimental determination of bound vortex lines and flow in the environment of the trailing edge of a slender delta wing (Experimentelle Bestimmung der gebundenen Wirbellinien sowie des Strömungsverlaufs in der Umgebung der Hinterkante eines schlanken Deltaflügels).** D. Hummel and G. Redeker (Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Aerodynamik, Braunschweig, West Germany). *Braunschweigische Wissenschaftliche Gesellschaft, Abhandlungen,* 1972, p. 273-290. 15 refs. In German.

Boundary layer measurements have been carried out on a sharp-edged delta wing with turbulent boundary layers. From the velocities at the outer edge of the boundary layer on the upper and the lower side of the wing the bound vortex lines in the lifting surface were determined. A comparison with former investigations concerning laminar boundary layers shows the influence of the status of the boundary layer on the vortex formation. Investigations of the flow downstream of the wing trailing-edge indicate that the trailing vortex sheet rolls up into a vortex, the rotation of which is opposite to that of the leading-edge vortex. The axis of this so called trailing-edge vortex forms a spiral within the leading-edge vortex.
(Author)

**A73-16618** # **Conflict prediction.** J. G. Wilson (Waterloo, University, Waterloo, Ontario, Canada). *CATCA Journal,* vol. 4, Fall 1972, p. 4-6. Research supported by the National Research Council of Canada.

Conflict search procedure starts at the conflict matrix, picks out a pair of aircraft, and determines if a potential conflict exists, what type of conflict it is, and whether it is, in fact, a conflict. The whole problem was written initially as a linear problem, and after debugging was converted to FORTRAN H. To test the design, it was unrealistically and deliberately loaded with altitude and time conflicts. The very encouraging result was that the complete cycle of route data input, table construction, flight plan data input, data base construction, conflict search, and conflict analysis took only 1.5 sec of CPU time. F.R.L.

**A73-16619** # **What's wrong with the air traffic control system.** P. Hirsch. *CATCA Journal,* vol. 4, Fall 1972, p. 8, 9, 34-36, 6.

The air traffic control automation program is critically evaluated. A study commissioned by the FAA indicates that the entire development of the en route system has begun plagued by technical and management problems. The report states that the quasi-obsolescent hardware, the outdated design of the software, the inadequate production and testing facilities, the ever-increasing use of hardware resources, and the lack of a plan to deploy a quality-assured product, are manifestations of a development without sufficient control. F.R.L.

**A73-16620** # **ATC research - Simulating Arrival/Tower communications.** J. G. Wilson (Waterloo, University, Waterloo, Ontario, Canada). *CATCA Journal,* vol. 4, Fall 1972, p. 12, 13, 16. 5 refs. Research supported by the National Research Council.

**A73-16621** # **The concept of an SST Oceanic Computer Clearance System.** R. N. Harrison (Ferranti, Ltd., Bracknell, Berks., England). *CATCA Journal,* vol. 4, Fall 1972, p. 36-38.

**A73-16623** # **Application of external aerodynamic diffusion to reduce shrouded propeller noise.** R. E. Longhouse (North Carolina State University, Raleigh, N.C.). *Acoustical Society of America, Fall Meeting, Miami, Fla., Nov. 28-Dec. 1, 1972, Paper.* 16 p.

**A73-16626** **Evolution of small turboshaft engines.** M. Bentele and J. Laborde (Avco Corp., Avco Lycoming Div., Stratford, Conn.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720830.* 12 p. 5 refs. Members, $1.25; nonmembers, $2.00. Research supported by the Avco Corp. and DOD.

The historical evolution, present state of the art, and future potential of the small (under 1000 hp) turboshaft engine for aircraft propulsion are reviewed. Its evolution is shown to have been heavily influenced by its use in helicopters in a military environment and by technological advances in large turbine engines used on fixed-wing aircraft. This has resulted not only in lighter weight, higher performance engines, but also in increased engine complexity and costs. Some newer simple engines, where some of the performance has been traded for simplicity and low cost, are shown to emerge at present as a cost-effective alternative to the reciprocating engine for powering smaller fixed-wing aircraft. M.V.E.

**A73-16627** **U.S. Army's 1500-shp demonstrator engine program - Some lessons learned.** N. C. Kailos and P. Chesser (U.S. Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720828.* 8 p. Members, $1.25; nonmembers, $2.00.

Review of some of the technical and nontechnical lessons learned from a program for the development of 1500-shp advanced-technology demonstrator engines, initiated in 1967. Encountered problem areas are analyzed, and a number of important 'hindsight' findings are reflected as 'feedback' for use in future programs of a similar nature. M.V.E.

**A73-16634** **Small turbine advanced gas generator for future propulsion requirements.** E. T. Johnson and M. L. Pedersen (U.S. Army, Air Mobility Research and Development Laboratory, Fort Eustis, Va.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720831.* 12 p. 15 refs. Members, $1.25; nonmembers, $2.00.

Review of the philosophy, background, approach, and anticipated results of the Small-Turbine Advanced Gas Generator (STAGG) program initiated in November 1971. Its chief objectives are to resolve integration and matching problems, reduce specific fuel consumption, and define realistic levels of technology for small aircraft and surface vehicle turboshaft engines at an early date. It is expected that the STAGG program will provide aircraft and systems engineers with demonstrated advanced engine technology to meet future DOD requirements for weapons systems and other applications. M.V.E.

**A73-16639** **System monitoring techniques: Practical applications and experience at Eastern - Jet engines.** J. J. Dziuba (Eastern Air Lines, Inc., New York, N.Y.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720818.* 8 p. Members, $1.25; nonmembers, $2.00.

Practical applications of jet engine monitoring techniques are reviewed including some that have been evaluated and rejected. Techniques that proved effective are X-ray and radioisotope inspection, flexible and rigid borescopes, and engine performance monitoring using manually recorded data. Used in conjunction with each other, these techniques form a powerful condition monitoring system. Techniques evaluated and rejected include sonic analysis and spectrographic oil analysis. M.V.E.

**A73-16640** **Jet engine condition monitoring without aids.** L. C. Ellis (United Air Lines, Inc., Chicago, Ill.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720815.* 9 p. Members, $1.25; nonmembers, $2.00.

Description of the United Air Lines' (UAL) hand-recorded computer-processed flight log monitoring (FLM) system that is used to monitor approximately 1400 engines. Under UAL's operating parameters, it is shown to be more cost-effective than an automatically recorded and computer processed aircraft integrated data system (AIDS). This explains UAL's decision not to replace its FLM by an AIDS system. M.V.E.

**A73-16650 Cost your brakes down.** R. L. Rosback (Bendix Corp., Energy Controls Div., South Bend, Ind.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720867.* 8 p. 5 refs. Members, $1.25; nonmembers, $2.00.

Aircraft wheels and brakes are significant maintenance cost items on transport airplanes. Cost can be minimized by adequate design criteria for original equipment and modernization of existing equipment through the incorporation of new technology. The four parties key to the minimization of operational costs of wheels and brakes are the FAA, the airframe manufacturer, the supplier, and the user. This paper deals with how each of these parties can contribute to this effort. (Author)

**A73-16651 Antiskid and modern aircraft.** E. A. Hirzel (Crane Co., Burbank, Calif.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720868.* 8 p. Members, $1.25; nonmembers, $2.00.

The essence of braking control is to adjust the brake pressure properly at all times to maintain brake torque at the correct level to balance the tire-runway friction force at its peak value, and thus give the aircraft maximum available deceleration. Hydro-Aire has been involved in the development of skid control systems from the days of the old 'tire savers' to today's fully automatic braking controls. This paper presents the technical history and evolution of the modern brake control or 'antiskid' system. (Author)

**A73-16652 Cantilever aircraft tires - More than a break for brakes.** W. R. Woodall (Firestone Tire and Rubber Co., Akron, Ohio). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720870.* 10 p. Members, $1.25; nonmembers, $2.00.

Brief history of the introduction of cantilever aircraft tires, and review of their advantages. The latter include larger rims for larger brakes or increased ventilation, longer tread life through increased tire 'flatness', and better high-speed performance through low aspect ratio design. M.V.E.

**A73-16654 The evolution and development status of the ALF 502 turbofan engine.** T. A. Dickey and E. R. Dobak (Avco Corp., Avco Lycoming Div., Stratford, Conn.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720840.* 13 p. Members, $1.25; nonmembers, $2.00.

**A73-16655 New turbofan engines - F101 and TF34.** J. E. Worsham (General Electric Co., New York, N.Y.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720841.* 6 p. Members, $1.25; nonmembers, $2.00.

The TF34 has been developed for the U.S. Navy's S-3A antisubmarine warfare aircraft; the F101 is being developed for the U.S. Air Force B-1 strategic bomber. Each of the new aircraft programs has the common requirement for subsonic endurance. The S-3A requirement includes subsonic operation only while the B-1 includes supersonic capability as well as subsonic. This basic mission-mix difference combined with major differences in engine/air vehicle installation features and different levels of technology applied due to the relative chronology in the respective development programs leads to contrasts in the design features of the major components of the engines. These major contrasts are presented without delving into the details of the applicable mission analyses and resulting cycle selection. (Author)

**A73-16657 F100/F401 augmented turbofan engines High thrust-to-weight propulsion systems.** J. F. McDermott (United Aircraft Corp., Florida Research and Development Center, West Palm Beach, Fla.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720842.* 6 p. Members, $1.25; nonmembers, $2.00.

**A73-16658 Prototyping in Army air mobility.** W. E. Crouch, Jr. (U.S. Army, Air Mobility Div., Fort Belvoir, Va.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720846.* 8 p. Members, $1.25; nonmembers, $2.00.

Review of the prototyping procedures applied to the development of aircraft capable of satisfying the stringent requirements for personnel and equipment mobility. Prototyping is shown to have made possible early determination of design feasibility and cost minimization of high-performance air transport. M.V.E.

**A73-16659 Choices for the future - An industry viewpoint on prototyping.** H. D. Altis (McDonnell Aircraft Co., St. Louis, Mo.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720848.* 7 p. Members, $1.25; nonmembers, $2.00.

Review of the role of experimental prototyping in aircraft design advances. Special attention is given to such areas as sustained hypersonic and supersonic flight, as well as general purpose VTOL aircraft. For illustration, specific design approaches are presented. M.V.E.

**A73-16660 Suitability of the CL-84 tiltwing aircraft for the sea control ship system.** T. M. Sullivan (General Dynamics Corp., St. Louis, Mo.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720852.* 10 p. Members, $1.25; nonmembers, $2.00.

**A73-16661 Harrier on the Guam A blueprint for the 1970's.** L. A. Smith (McDonnell Aircraft Co., St. Louis, Mo.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720853.* 15 p. Members, $1.25; nonmembers, $2.00.

V/STOL aircraft trials on the Guam have, for the first time, explored the innovative concepts of the Sea Control Ship. An integral part of these trials are the Harrier operations. The Harrier, acquired by the United States Marines and operating frequently as an arm of the prototype Sea Control Ship (Guam), has provided the versatile fixed wing aircraft characteristics that are needed to explore this emerging concept. Derivative aircraft, more optimized for these roles, offer the United States Navy a high confidence, agile weapon system that will have been conceptually evaluated in the initial trials. Integration of the aircraft with the ship has been easily demonstrated, and the Harrier on the Guam provides a blueprint for the 1970's. (Author)

**A73-16662 Combat capabilities and versatility through CCV.** D. H. Bennett (McDonnell Aircraft Co., St. Louis, Mo.) and R. P. Johannes (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720854.* 9 p. Members, $1.25; nonmembers, $2.00.

Advanced design studies indicate that use of control configured vehicle (CCV) concepts can provide improvements in combat

capability and versatility. These benefits will be evidenced by improved performance and survivability, as well as by new maneuvering capabilities not available to pilots of current aircraft. The fly-by-wire (FBW) techniques, utilized to enable CCV, also provide the potential for improved flying qualities. The end result of applying these concepts in the preliminary design stages can be a lighter weight fighter aircraft to do a given job better. (Author)

**A73-16663 * NASA lift fan V/STOL transport technology status.** W. H. Deckert (NASA, Ames Research Center, Advanced VTOL Projects Office, Moffett Field, Calif.) and R. C. Evans (NASA, Lewis Research Center, Fluid System Components Div., Cleveland, Ohio). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720856.* 13 p. 6 refs. Members, $1.25; nonmembers, $2.00.

**A73-16664 Flight simulator development in parallel with aircraft flight test - A case study of the American Airlines DC-10 program.** F. A. Wirth (American Airlines, Inc., New York, N.Y.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720858.* 8 p. Members, $1.25; nonmembers, $2.00.

**A73-16665 Fly off in the wind tunnels.** P. P. Antonatos (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720861.* 19 p. 7 refs. Members, $1.25; nonmembers, $2.00.

With the increased emphasis on technical evolution of flight vehicles during preliminary design, the wind tunnels play an important role in establishing the base for extrapolation to full scale performance. Present day research and development programs are established to improve the correction procedures that are applied to the experimental data and reviews are proceeding to establish the requirements for newer facilities that will better approximate the needed full scale results. Combining the potentially improved accuracy of obtaining data with the sophisticated computerized design and simulation techniques it will then be possible to achieve a fly off in the wind tunnels. (Author)

**A73-16667 Non-steady-state thermal analysis of a rolling aircraft tire.** N. M. Trivisonno (B. F. Goodrich Co., Akron, Ohio). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720871.* 25 p. Members, $1.25; nonmembers, $2.00.

**A73-16671 Optimization of commercial transport airplane stopping systems.** D. B. Meredith and B. C. Hainline (Boeing Co., Commercial Airplane Div., Renton, Wash.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720879.* 11 p. Members, $1.25; nonmembers, $2.00.

The role of the aircraft manufacturer in the design, integration, and optimization of commercial transport airplane stopping systems is discussed. Specific emphasis is placed on: system design considerations, configurations, and features; laboratory and flight testing; typical problems encountered; and future basic data requirements. Advances in stopping system simulation techniques and antiskid control systems in recent years have allowed large improvements in stopping system efficiency. Future improvements are dependent on obtaining basic data on tire and brake dynamic characteristics for use in simulation studies to control and improve the combined brake and tire frequency response phase lag. It is anticipated that new rational landing rules being developed by the FAA must account for and include the effect of the engine thrust reversing system on stopping distances. The design, development, certification, and operation of airplanes with integrated air brake, wheel brake, and thrust reversing systems will further emphasize optimization of the total airplane stopping system. (Author)

**A73-16672 The electrostatic charging tendencies of jet fuel filtration equipment.** K. H. Strauss (Texaco, Inc., New York, N.Y.), W. G. Dukek, and R. E. Langston. *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720866.* 41 p. 8 refs. Members, $1.25; nonmembers, $2.00.

As part of an effort to develop technical information on the electrical charging characteristics of aircraft fuels and ground filtration equipment, an extensive study was made using the filtration equipment of the pipeline supplying J. F. Kennedy Airport, New York. Relative charging tendencies of ten different types and makes of coalescer and separator elements were obtained on the jet fuels being pumped to the airport. Over a 3.5 month period 199 fuel batches totalling 154.2 million gallons were filtered and monitored. The results showed fuel characteristics to have the major effect on filter charging characteristics, as batch-to-batch variations were greater than differences between filters on an absolute basis. However, simultaneous side-by-side tests showed Teflon-coated screen type separators to charge less than pleated paper separators. (Author)

**A73-16673 Charge removal by irradiation.** A. N. de Gaston (Douglas Aircraft Co., Long Beach, Calif.). *Society of Automotive Engineers, National Aerospace Engineering and Manufacturing Meeting, San Diego, Calif., Oct. 2-5, 1972, Paper 720864.* 11 p. 6 refs. Members, $1.25; nonmembers, $2.00.

Jet fuel maintains a static electric charge due to its low conductivity (less than or equal to 10 to the minus 12th mhos/m). The de Gaston decharger is an invention which uses ionizing radiation to increase fuel conductivity (greater than 10 to the minus 9th mhos/m) temporarily. The decharger is able to reduce charge density below any arbitrary level for any flow rates and charge densities by suitable design. The basic theory of the decharger is discussed. Its design and the summarized test data are given. The data indicate that the fuel conductivity is increased to 7.6 x 10 to the minus 9th mhos/m. The average energy per effective ion produced is less than or equal to 147 eV. (Author)

**A73-16684 # Full-scale fire tests on a simulated aircraft carrier flight deck.** E. J. Jablonski, H. B. Peterson, and H. W. Carhart (U.S. Navy, Naval Research Laboratory, Washington, D.C.). *Combustion Institute, Fall Meeting, U.S. Naval Postgraduate School, Monterey, Calif., Oct. 30, 31, 1972, WSCI Paper 72-31.* 5 p.

**A73-16688 # Characterization and suppression of aircraft and fuel fires.** E. L. Capener (Stanford Research Institute, Menlo Park, Calif.) and R. S. Alger (U.S. Navy, Naval Ordnance Laboratory, Washington, D.C.). *Combustion Institute, Fall Meeting, U.S. Naval Postgraduate School, Monterey, Calif., Oct. 30, 31, 1972, WSCI Paper 72-26.* 35 p.

Experimental pool fires of JP-5 were instrumented to measure heat fluxes, burning rates, and suppression characteristics. Test substrates included water, sand, and gravel. The suppressant spray was characterized as to uniformity, average drop size, and kinetics of interaction with the fuel surface. Radiation fluxes at varying distances from the fire were affected by wind velocity, location of the measuring station (view factor), type of substrate, and the water content of the substrate. Fuel burning rates were influenced by wind velocity and substrate characteristics. Suppression with 6% light water solution was influenced primarily by the fire size and secondarily, by the type of substrate. (Author)

**A73-16690 # Emissions from and within an Allison J-33 combustor.** A. M. Mellor, R. D. Anderson, R. A. Altenkirch, and J. H. Tuttle (Purdue University, Lafayette, Ind.). *Combustion Institute, Fall Meeting, U.S. Naval Postgraduate School, Monterey, Calif., Oct. 30, 31, 1972, WSCI Paper 72-22.* 25 p. 11 refs. U.S. Environmental Protection Agency Contract No. 68-04-0001; Grant No. DAAE07-69-C-0756.

Gas temperature, carbon monoxide, and nitric oxide concentration profiles measured as a function of axial and radial position inside an Allison J-33 combustor with unheated inlet air are reported. In addition, the isolated effects of combustor pressure, overall equivalence ratio, and air flow rate on combustor exit plane emissions are investigated. A consistent model of the combustion process in this combustor is presented on the basis of the results. (Author)

**A73-16704 A computer-generated display to isolate essential visual cues in landing.** T. L. Hummel, B. H. Williges, and S. N. Roscoe (Illinois, University, Urbana, Ill.). In: Technology for man 72; Proceedings of the Sixteenth Annual Meeting, Los Angeles, Calif., October 17-19, 1972. Santa Monica, Calif., Human Factors Society, Inc., 1972, p. 98-101. 8 refs. USAF-sponsored research.

**A73-16707 Reorganization of airplane manual flight control dynamics.** E. F. Kraus and S. N. Roscoe (Illinois, University, Urbana, Ill.). In: Technology for man 72; Proceedings of the Sixteenth Annual Meeting, Los Angeles, Calif., October 17-19, 1972. Santa Monica, Calif., Human Factors Society, Inc., 1972, p. 117-126. 11 refs. USAF-sponsored research.

Experiments were conducted in a Link GAT-2 to evaluate the effectiveness of a system providing direct control over aircraft maneuvering performance. Pilots performed complex navigational tasks involving the use of a computer-assisted area navigation system. Changing waypoint storage capacity of the simulated navigation system induced variable task loading on subjects. The experiment was replicated with and without an adaptive side task to determine levels of residual attention associated with the control modifications and the varying workload levels. The flight performance controller yielded greater precision of maneuvering control, fewer procedural blunders, and an increased level of residual pilot attention. (Author)

**A73-16753 From theory to practical use of air cushions for transport of heavy loads in the factory (De la théorie à la pratique des coussins d'air pour les transports en usine de charges lourdes).** F. Croix-Marie (Société Bertin et Cie., Paris, France). *Entropie,* vol. 8, Sept.-Oct. 1972, p. 13-18. In French. Research supported by the Délégation Générale à la Recherche Scientifique et Technique.

The static and dynamic functioning of high pressure air cushions for use in platforms for handling heavy loads on factory floors is analyzed. A 'plenum chamber' device is discussed, which consists of a load support plate, a flexible swivel-joint suspension, an intermediate plate, and an air confinement seal. Each of these elements required a compromise between good static and good dynamic operation. F.R.L.

**A73-16755 Deutsche Gesellschaft für Luft- und Raumfahrt, 1971 Yearbook (Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrbuch 1971).** Edited by H. Blenk and W. Schulz. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1972. 396 p. Members, $9.21; nonmembers, $12.28. In German and English.

The topics discussed include progressive waves investigations concerning unsteady aerodynamic derivatives of the longitudinal motion, the calculation of the natural vibration parameters of a damped system, and problems of aircraft aerodynamics. The technology of composite designs is considered together with trends in the field of electronics concerned with space applications, the disturbance of the environment due to the noise of jet aircraft traffic, and local velocity measurements in atomized spray. The measurement of plasma transport properties in a free-burning electric arc is also reported along with details regarding an inertial navigation system based on two Schuler gyropendulums and one azimuth gyro.

Individual items are announced in this issue. G.R.

**A73-16756 Progressive waves /14th Ludwig Prandtl Memorial Lecture/.** P. Germain (Paris, Université, Faculté des Sciences, Paris, France). In: Deutsche Gesellschaft für Luft- und Raumfahrt, 1971 Yearbook. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1972, p. 11-30. 65 refs.

The concept of a progressive wave is defined with the introduction of the order of magnitudes of rates observed at a point fixed with respect to the reference frame on one hand and at a point traveling with the wave on the other. Progressive waves for a linear system are considered, giving attention to the formal expansion, the properties of the rays, the transport equation, and the conservation of wave action. Nonlinear convective effects are also discussed together with higher order effects. G.R.

**A73-16757 Experimental and theoretical investigations regarding the unsteady aerodynamical derivatives of the longitudinal motion in the case of slender flight bodies at moderate velocity (Experimentelle und theoretische Untersuchungen über die instationären flugmechanischen Derivativa der Längsbewegung an schlanken Flugkörpern bei mässiger Geschwindigkeit).** E. Schmidt (Aerodynamische Versuchsanstalt, Göttingen, West Germany). *(Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 4th, Baden-Baden, West Germany, Oct. 11-13, 1971.)* In: Deutsche Gesellschaft für Luft- und Raumfahrt, 1971 Yearbook. (A73-16755 05-01) Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1972, p. 71-97. 30 refs. In German.

**A73-16759 Technology of composite design (Technologie von Composite-Bauweisen).** U. Hütter (Stuttgart, Universität; Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für Bauweisen- und Konstruktionsforschung, Stuttgart, West Germany). *(Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 4th, Baden-Baden, West Germany, Oct. 11-13, 1971.)* In: Deutsche Gesellschaft für Luft- und Raumfahrt, 1971 Yearbook. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1972, p. 143-161. 23 refs. In German.

Reliable structural materials for aircraft and spacecraft applications can presently be obtained on the basis of a great number of fiber-matrix combinations. It has been found that, in the case of adequate length-diameter ratios for short fibers, composite elements with fibers of finite length have almost the same strength as elements with fibers of infinite length. Elements with fibers of finite length have the advantage that they are better adaptable to specific manufacturing processes. G.R.

**A73-16760 Disturbance of the environment by jet aircraft noise (Lärmbelästigung der Umwelt durch den Strahlflugverkehr).** G. Zimmermann (Max-Planck-Institut für Strömungsforschung, Göttingen, West Germany). *(Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 4th, Baden-Baden, West Germany, Oct. 11-13, 1971.)* In: Deutsche Gesellschaft für Luft- und Raumfahrt, 1971 Yearbook. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1972, p. 176-187. 18 refs. In German.

**A73-16764 The tricuspid hypocycloid as envelope of the force of lift, calculated in a first compressible approximation, in the case of a symmetrical profile in a flow of variable direction and a given Mach number (Die dreispitzige Hypozykloide als Einhüllende der in erster kompressibler Näherung berechneten Auftriebskraft auf ein symmetrisches Profil in einer Strömung gegebener Machzahl und**

**variabler Anströmungsrichtung).** E. Hölder (Mainz, Universität, Mainz, West Germany). In: Deutsche Gesellschaft für Luft- und Raumfahrt, 1971 Yearbook. Cologne, Deutsche Gesellschaft für Luft- und Raumfahrt, 1972, p. 237-243. 8 refs. In German. Research supported by the Deutsche Forschungsgemeinschaft.

**A73-16797 Heat transfer in cooled flow passages of turbines.** S. Z. Kopelev, S. V. Gurov, and M. V. Avilova-Shul'gina. *(Akademiia Nauk SSSR, Izvestiia, Energetika i Transport,* July-Aug. 1971, p. 105-111.) *Heat Transfer - Soviet Research,* vol. 4, Nov.-Dec. 1972, p. 56-63. 9 refs. Translation.

Dimensionless relations for generalizing experimental data on the effectiveness of cooling rotor blades of high-temperature gas-turbine engines are derived. The possibility of extending heat-transfer data obtained in static tests to the operational conditions of turbine blades is demonstrated. Heating data obtained for a representative air-cooled blade are examined. V.P.

**A73-16817 Extending the maximum range of synthetic aperture /hologram/ systems.** W. E. Kock (Bendix Corp., Southfield, Mich.; Cincinnati, University, Cincinnati, Ohio). *IEEE, Proceedings,* vol. 60, Nov. 1972, p. 1459, 1460. 9 refs.

Synthetic-aperture (hologram) radars are finding increasing use, but possess the so-called ambiguity problem, which places a constraint on their usefulness since at least one pulse must be transmitted whenever the aircraft moves a distance D/2, D being the aperture dimension of the airborne antenna. The maximum ambiguity range can be extended by using an additional receive-only antenna placed ahead of the transmit-receive unit. F.R.L.

**A73-16847 Some aspects of instrument flight.** R. J. van der Harten (KLM Noordzee Helikopters, Schiphol Airport, Netherlands). *Vertiflite,* vol. 18, Nov.-Dec. 1972, p. 4-9. 5 refs.

The development and operation of a 24-hr IFR service aimed at supplying oil rigs in the North Sea and transporting harbor pilots to ships, using the Sikorsky S-61N helicopter, is discussed. The first S-61N was equipped with a dual automatic direction finder (ADF), a VHF omnidirectional range/instrument landing system (VOR/ILS), and a single Decca Mk 19 navigation system. The second S-61N was equipped with the Bendix-Air Equipment RDR-1DM weather and approach radar, two ADF's, one VOR/ILS, and one Decca Mk 19. In the third S-61N, the Decca Mk 19 was replaced by a single Decca Doppler 71. The onboard instrumentation, the communication system, and radar system (used to avoid flying into icing conditions) are described. The certification and training of pilots, and the certification of weather limits is described. V.P.

**A73-16851 # A class of airfoils designed for high lift in incompressible flow.** R. H. Liebeck (Douglas Aircraft Co., Long Beach, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-86.* 10 p. 8 refs. Members, $1.50; nonmembers, $2.00. Research supported by the Douglas Aircraft Independent Research and Development Program.

The problem studied is that of designing a single element airfoil which provides the maximum possible lift in an unseparated incompressible flow. First, an airfoil velocity is defined and optimized using boundary-layer theory and the calculus of variations. The resulting velocity distribution is then used as an input for an inverse airfoil design program which provides the corresponding airfoil shape. Since there is no guarantee that an arbitrarily defined velocity distribution will yield a physically possible airfoil shape, some parametric adjustments in the optimized distributions are required in order to obtain realistic and practical airfoil geometries. (Author)

**A73-16852 # Variational approach to the lifting surface problem.** S. F. Shen and S. T. K. Chan (Cornell University, Ithaca, N.Y.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-87.* 10 p. 11 refs. Members, $1.50; nonmembers, $2.00. Contract No. N00014-67-A-0077-0024.

Application of a variational principle to the non-self adjoint lifting surface integral equation, first proposed by Flax, is given a closer look from the finite-element viewpoint. The plan form is divided into elements, and the unknown pressure loading is expressed as the sum of shape functions, each of which gives a local approximation within an element but vanishes elsewhere. The quadrature difficulty in the numerical solution can thus be effectively reduced. Because of the difference kernel in the integral equation, if both the plan form and the finite-element mesh pattern obey polar symmetry, the resulting algebraic problem is shown to have a symmetric coefficient matrix, in fact identical to that which follows from a straight Galerkin procedure using the same basis of approximating functions. For arbitrary plan form and mesh pattern, symmetrization can be achieved by an imbedding technique. Numerical examples are worked out for the classical two-dimensional flat plate and a number of lifting surfaces in steady incompressible flow, mainly to demonstrate the feasibility of the approach. (Author)

**A73-16853 * # The effects of leading-edge serrations on reducing flow unsteadiness about airfoils.** R. G. Schwind (Nielsen Engineering and Research, Inc., Mountain View, Calif.) and H. J. Allen. *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-89.* 12 p. 11 refs. Members, $1.50; nonmembers, $2.00. Contract No. NAS2-6010.

High frequency surface pressure measurements were obtained from wind-tunnel tests over the Reynolds number range 1.2 x 1,000,000 to 6.2 x 1,000,000 on a rectangular wing of NACA 63-009 airfoil section. A wide selection of leading-edge serrations were also added to the basic airfoil. Under a two-dimensional laminar bubble very close to the leading edge of the basic airfoil there is a large peak in rms pressure, which is interpreted as an oscillation in size and position of the bubble. The serrations divide the bubble into segments and reduce the peak rms pressures. A low Reynolds number flow visualization test on a hydrofoil in water was also conducted. A von Karman vortex street was found trailing from the rear of the foil. Its frequency is at a much lower Strouhal number than in the high Reynolds number experiment, and is related mathematically to the airfoil trailing-edge and boundary-layer thicknesses. (Author)

**A73-16854 # Unsteady wing in curved flight.** E. C. James (U.S. Navy, Naval Ship Research and Development Center, Bethesda, Md.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-90.* 7 p. Members, $1.50; nonmembers, $2.00.

A linearized theory which treats small amplitude unsteady motions of a wing in curved flight at variable rotational speeds in an inviscid incompressible fluid is developed. The problem is considered where the wing geometry, motions and flight path are specified and the time-dependent force, moment, power required to sustain the motion, pressure and velocity fields, and strength of the shed vorticity and circulation about the wing are readily obtained. The theory is expected to provide useful estimates provided the wing does not cross its own wake. The effect of path curvature present in the calculated physical quantities of particular interest in this investigation and the results are readily compared with known results for a wing in straight-line flight to contrast this effect. (Author)

**A73-16855 * # Finite element analysis of unsteady incompressible flow around an oscillating obstacle of arbitrary shape.** T. Bratanow, A. Ecer, and M. Kobiske (Wisconsin, University, Milwaukee, Wis.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-91.* 11 p. 7 refs. Members, $1.50; non-

members, $2.00. Grant No. NGR-50-007-001.

An analytical procedure based on Navier-Stokes equations was developed for representing unsteady flow patterns around oscillating obstacles. A variational formulation of the Helmholtz vorticity equation was discretized in finite element form and integrated numerically. At each step of the numerical integration the velocity field around the obstacle was determined from the finite element solution of Poisson's equation. The time-dependent boundary conditions around the oscillating obstacle were introduced as external constraints at each time step of the numerical integration. The obtained results for a cylinder and an airfoil were illustrated in the form of streamlines and vorticity and pressure distributions. (Author)

**A73-16859** # **Turbojet exhaust reactions in stratospheric flight.** L. B. Anderson, J. W. Meyer (Lockheed Research Laboratories, Palo Alto, Calif.), and W. J. McLean (Cornell University, Ithaca, N.Y.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-99.* 10 p. 15 refs. Members, $1.50; nonmembers, $2.00. Research supported by the U.S. Department of Transportation.

This paper summarizes computations of chemical reactions in turbojet engine exhausts and aircraft wakes. Interest is in potential stratospheric pollutants. The chemical kinetics model shows that oxidation and reduction rates of carbon, nitrogen, and sulfur species are controlled by H, O, and OH radicals. These radicals are present in super-equilibrium concentrations - in contrast to the usual equilibrium radical concentrations in engine exhausts at low altitudes. Where high levels of unburned hydrocarbons are also present, termination reactions greatly reduce the inorganic radical concentrations. Significant conversion of nitrogen oxides to nitric acid in the wake appears unlikely for most operating conditions. (Author)

**A73-16860** # **Atmospheric dispersion of aircraft exhaust.** R. J. Conti, H. Hoshizaki, K. O. Redler, and P. E. Cassady (Lockheed Research Laboratories, Palo Alto, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-100.* 10 p. 26 refs. Members, $1.50; nonmembers, $2.00. Research supported by the U.S. Department of Transportation.

A model for the dispersal of exhaust from high-flying aircraft is proposed. This model was developed as part of a study to predict stratospheric pollution from supersonic transports and other aircraft that may be operating by 1990. The model addresses the exhaust trail from the engines to the point at which aircraft-induced effects become negligible compared with natural atmospheric transport. This may involve lengths of trail on the order of 100 km. The model was developed from simple theoretical arguments and a study of condensation trails from jet aircraft. (Author)

**A73-16867** * # **Aircraft wake dissipation by sinusoidal instability and vortex breakdown.** A. J. Bilanin and S. E. Widnall (MIT, Cambridge, Mass.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-107.* 12 p. 15 refs. Members, $1.50; nonmembers, $2.00. Grant No. NGR-22-009-605.

Sinusoidal instability of aircraft trailing vortices was induced by differentially oscillating inboard and outboard flaps on a model wing in a ship towing tank. Measured amplification rates qualitatively agree with theoretical predictions. Axial velocities in the vortex core were directed towards the wing and measured to be approximately 25% of the tow speed. Vortex breakdown was observed to occur along trailers undergoing sinusoidal instability near but ahead (towards the wing) of positions of maximum trailer separation. It is shown that axisymmetric pressure gradients are imposed along the vortex core by the other sinusoidally deformed trailer and are responsible for the observed changes in core diameter. A theoretical model predicts the short-time behavior of the vortex core and shows that the response of the vortex depends crucially on the axial velocity in the vortex. (Author)

**A73-16869** # **Observations of atmospheric effects on the transport and decay of trailing vortex wakes.** I. Tombach (AeroVironment, Inc., Pasadena, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-110.* 9 p. 20 refs. Members, $1.50; nonmembers, $2.00. Research supported by the U.S. Department of Transportation and U.S. Air Force.

Smoke-marked trailing vortices were generated by a light aircraft under a hierarchy of measured atmospheric stability and turbulence levels, and their motion and decay was recorded photographically. Decay from both sinuous core interaction and core bursting type instabilities occurred, with bursting being the dominant mode. Turbulence had a strong effect on wake life. Observed lifetimes ranged from 6 seconds in light-to-moderate turbulence to more than 80 seconds in calm, stable air. Atmospheric stratification had a weak influence on wake life and its effect on wake descent could not be determined, since descent was often stopped by a rolling of the plane of the vortices. (Author)

**A73-16878** * # **Unsteady transonic flow analysis for low aspect ratio, pointed wings.** K. R. Kimble, S. Y. Ruo, J. M. Wu (Tennessee, University, Tullahoma, Tenn.), and D. Y. Liu (Southampton, University, Southampton, England). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-122.* 10 p. 19 refs. Members, $1.50; nonmembers, $2.00. Grant No. NGR-43-001-102.

Oswatitsch and Keune's parabolic method for steady transonic flow is applied and extended to thin slender wings oscillating in the sonic flow field. The parabolic constant for the wing was determined from the equivalent body of revolution. Laplace transform methods were used to derive the asymptotic equations for pressure coefficient, and the Adams-Sears iterative procedure was employed to solve the equations. A computer program was developed to find the pressure distributions, generalized force coefficients, and stability derivatives for delta, convex, and concave wing planforms. (Author)

**A73-16880** * # **Analysis of high aspect ratio jet flap wings of arbitrary geometry.** P. B. S. Lissaman (AeroVironment, Inc., Pasadena, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-125.* 9 p. 11 refs. Members, $1.50; nonmembers, $2.00. Contract No. NAS1-10627.

Paper presents a design technique for rapidly computing lift, induced drag, and spanwise loading of unswept jet flap wings of arbitrary thickness, chord, twist, blowing, and jet angle, including discontinuities. Linear theory is used, extending Spence's method for elliptically loaded jet flap wings. Curves for uniformly blown rectangular wings are presented for direct performance estimation. Arbitrary planforms require a simple computer program. Method of reducing wing to equivalent stretched, twisted, unblown planform for hand calculation is also given. Results correlate with limited existing data, and show lifting line theory is reasonable down to aspect ratios of 5. (Author)

**A73-16888** * # **Flight and wind tunnel investigation of the effects of Reynolds number on installed boattail drag at subsonic speeds.** R. Chamberlin and B. J. Blaha (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-139.* 11 p. 10 refs. Members, $1.50; nonmembers, $2.00.

A flight and wind tunnel investigation was conducted to determine the effects of Reynolds number on the installed boattail drag of an underwing nacelle. Tests were run on a modified F-106B aircraft and 0.05 and 0.22 scale wind tunnel models. Tests were conducted at Mach numbers of 0.6 and 0.9 and over a 16 to 1 range of Reynolds numbers. Highest drag was obtained at intermediate Reynolds numbers corresponding to about the lowest flight values and that of the 0.22 scale model. Significantly lower drag was obtained at both higher and lower Reynolds numbers. (Author)

**A73-16889** # **Three dimensional dynamic characteristics of solid particles suspended by polluted air flow in a turbine stage.** M. F. Hussein and W. Tabakoff (Cincinnati, University, Cincinnati, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-140.* 15 p. 13 refs. Members, $1.50; nonmembers, $2.00. Grant No. DAHC04-60-C-0016.

The equations that govern the three dimensional motion of solid particles suspended by a compressible gas flow through a rotating cascade of a turbomachine are formulated. These equations are solved for the case of flow through a turbine stage. The solution takes into account the loss in particle momentum due to their collision with the turbine blades or casing. The dynamic characteristics of the solid particles; namely, their absolute trajectories, paths relative to the turbine rotor, velocity distributions, and the combined stage velocity diagrams, are calculated. The effects of changing the particles mean diameter, material density, and initial particle and gas velocities at the stator inlet on the dynamic characteristics of the solid particles are investigated. The results obtained from this study indicate the locations on the turbine blades subjected to severe erosion damage. (Author)

**A73-16901** # **B-1 airplane model support and jet plume effects on aerodynamic characteristics.** H. August (North American Rockwell Corp., Los Angeles, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-153.* 6 p. 5 refs. Members, $1.50; nonmembers, $2.00.

Wind tunnel test programs designed to provide more representative flow field simulation have been performed. Influence of afterbody closure and jet plume interference on lift, drag, longitudinal and directional static stability, and control surface effectiveness has been determined. These incremental data were measured by a force and moment balance installed in the aft fuselage of a strut-supported, complete configuration model. These data are applied to force model test results of a typical sting-supported, ducted nacelle configuration. In this manner, representative B-1 airplane aerodynamic characteristics at trimmed flight conditions have been determined. (Author)

**A73-16902** # **Measured axial and normal force coefficients for 9-deg cones in rarefied, hypersonic flow.** D. Bharathan and S. S. Fisher (Virginia, University, Charlottesville, Va.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-154.* 7 p. 18 refs. Members, $1.50; nonmembers, $2.00. Grant No. AF-AFOSR-69-1798.

Axial and normal force coefficients for slender cones in the transitional regime of low-density, hypersonic flow have been measured. The flow fields are freely expanding jets emerging from sharp-edged orifices. Models are supported in a three-dimensional electromagnetic suspension system in which the aerodynamic forces are measured by monitoring the currents in various electromagnetic coils. In the experiments, the following conditions are fixed: models of 9-deg semivertex angle, free-stream Mach number 8.2 at model mid-chord point, nitrogen test gas, ratio of model wall temperature to gas stagnation temperature unity. Angle of attack is varied from 0 to 18 deg. Model Reynolds number, based on free-stream density, free-stream velocity, model length, and viscosity at the model wall temperature, varies from 4 to 60. (Author)

**A73-16906** # **Practical optimal flight control for aircraft with large flight envelopes.** A. J. VanDierendonck (Honeywell, Inc., Minneapolis, Minn.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-159.* 7 p. 8 refs. Members, $1.50; nonmembers, $2.00. Contract No. F33615-71-C-1058.

A practical controller design procedure for the control of aircraft with large flight envelopes has been developed. The procedure is based on quadratic optimal control theory with limited measurement feedback. The feedback gains are fixed, although some may be allowed to vary with the flight conditions. The system is represented linearly at discrete points in the flight envelope (flight conditions). A performance index is defined as a weighted sum of quadratic performance indices at these points. The index is minimized with a gradient scheme - the 'Incremental Gradient' - that ensures fast convergence to a global minimum. It is applied to aircraft flight control examples. (Author)

**A73-16907** # **Combat control versatility with CCV.** R. A. Strahota (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) and D. R. McGovern (McDonnell Aircraft Co., St. Louis, Mo.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-160.* 8 p. Members, $1.50; nonmembers, $2.00.

The Control Configured Vehicles (CCV) F-4 Program is an R and D program dedicated to control technology development to enhance fighter aircraft performance. Basic CCV concepts are examined, taking into account static stability compensation control, maneuver load control, precision flight path control and maneuver enhancement, control system design, and Canard technology. Advantages obtainable with the aid of CCV include smaller, lighter weight, and lower cost fighters. G.R.

**A73-16908** # **Modeling of aircraft position errors with independent surveillance.** D. E. Stepner (Systems Control, Inc., Palo Alto, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-162.* 9 p. 12 refs. Members, $1.50; nonmembers, $2.00. U.S. Department of Transportation Contract No. TSC-260.

In order to reduce present air traffic separation standards, a means of quantitatively measuring the safety level of a particular air route structure must be established. The most important factor in determining route safety is the distribution of aircraft position errors about their intended tracks. This paper presents a modeling technique which can compute the distribution of position errors as the aircraft proceed along the route. The technique takes into account not only the time dependence, but also all the factors influencing an aircraft's position errors, e.g., surveillance and navigation errors, surveillance fix rate, and Air Traffic Control procedures. (Author)

**A73-16909** * # **Interactive real time simulation for scheduling and monitoring of STOL aircraft in the terminal area.** J. D. McLean and L. Tobias (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-163.* 9 p. 6 refs. Members, $1.50; nonmembers, $2.00.

**A73-16921** # **Analysis of flight vehicle response to nonstationary atmospheric turbulence including wing bending flexibility.** Y. Fujimori and Y. K. Lin (Illinois, University, Urbana, Ill.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-181.* 13 p. 8 refs. Members, $1.50; nonmembers, $2.00. NSF Grant No. GK-34136X.

**A73-16922** # **A statistical analysis of pilot control during a simulation of STOL landing approaches.** D. J. Moorhouse (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) and M. W. M. Jenkins (Lockheed-Georgia Co., Marietta, Ga.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-182.* 7 p. Members, $1.50; nonmembers, $2.00.

**A73-16926** # **Analytical and experimental supersonic jet noise research.** P. R. Knott and M. J. Benzakein (General Electric Co., Cincinnati, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-188.* 10 p. 29 refs. Members, $1.50; nonmembers, $2.00. Contract No. F33615-71-C-1662.

**A73-16927** * # **Flyover and static tests to investigate external flow effect on jet noise for nonsuppressor and suppressor exhaust nozzles.** R. R. Burley and R. J. Karabinus (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-190.* 10 p. 12 refs. Members, $1.50; nonmembers, $2.00.

**A73-16929** * # **Aeroelastic instabilities of hingeless helicopter blades.** P. Friedmann (MIT, Cambridge, Mass.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-193.* 11 p. 16 refs. Members, $1.50; nonmembers, $2.00. Contract No. NAS2-6175.

In this study the stability boundaries of a hingeless helicopter blade are studied using a system of coupled flap-lag-pitch equations of motion. Divergence and flutter boundaries for the linearized system of equations are presented. Flap-lag, flap-pitch and coupled flap-lag-pitch instabilities in hovering flight are studied. The effect of the torsional degree of freedom on the flap-lag type of instability is investigated. Similarly the effect of lag on the flap pitch type of instability is also considered. Results illustrating these effects, together with the effect of various important blade parameters on blade stability are presented. (Author)

**A73-16930** # **Active flutter control - An adaptable application to wing/store flutter.** W. E. Triplett, H.-P. F. Kappus, and R. J. Landy (McDonnel Aircraft Co., St. Louis, Mo.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-194.* 12 p. 5 refs. Members, $1.50; nonmembers, $2.00. Contract No. F33615-71-C-1481.

An active flutter suppression system using an electronically compensated feedback signal can be adapted to stabilize widely differing wing/store flutter mechanisms. A generalized compensation network in the feedback loop modifying the signal of a single wing motion sensor is shown to provide sizable stability margins out to the aircraft performance limits for several airplane/store configurations. Flutter control can be maintained even though aileron actuators are rate saturated during flutter suppression. Usual levels of hydraulic system deadspace and freeplay do not impair the supression system operation. Necessary hardware improvements include: increasing component reliabilities, increasing hydraulic flow rate, and improving actuator bandwidths. (Author)

**A73-16937** # **Similarity relationship for wing-like bodies at high Mach numbers.** K. F. Stetson and N. E. Scaggs (USAF, Fluid Dynamics Facilities Research Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-203.* 12 p. 14 refs. Members, $1.50; nonmembers, $2.00.

Hypersonic wind tunnel experiments, with delta wing configurations, have been performed to evaluate similarity relationships for wing-like bodies. Order of magnitude estimates of shock layer thickness were found to be in good agreement with experimental results, thus substantiating the order of magnitude estimations of the various flow variables in the similitude analyses for wing-like bodies. Experimental values of shock wave detachment from the leading edge of small aspect ratio delta wings agreed well with predictions from similitude analyses. A one parameter correlation of experimental data is presented which demonstrates the existence of similarity relationships that provide a correction term to the Newtonian normal force coefficient. (Author)

**A73-16940** # **A general solution for lift interference in rectangular ventilated wind tunnels.** E. M. Kraft and C. F. Lo (ARO, Inc., Arnold Air Force Station, Tenn.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-209.* 10 p. 18 refs. Members, $1.50; nonmembers, $2.00. Contract No. F40600-73-C-0004.

**A73-16946** # **Photochemical ignition and combustion enhancement in high speed flows of fuel-air mixtures.** A. E. Cerkanowicz and R. F. McAlevy, III (Photochem Industries, Inc., Fairfield, N.J.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-216.* 7 p. 7 refs. Members, $1.50; nonmembers, $2.00. Contract No. F44620-70-C-0051.

Ignition of unadulterated (no added sensitizers, e.g., NO2, Cl2, SO2), unheated (room temperature), flowing (subsonic), fuel (atomized liquid and gaseous) and air mixtures was achieved by exposure to minute energy pulses (10 microjoules) of vacuum ultraviolet radiation. Experimental and analytical results indicated that ignition energies were essentially constant for mixture velocities below some critical value and then increased linearly with increasing mixture velocity. Further, it has been shown possible to hold a flame photochemically in a flowing mixture by operating the radiant source in a repetitively pulsed mode. (Author)

**A73-16950** * # **Noise generated by a thin wing in a turbulent jet.** S. S. Davis (NASA, Ames Research Center, Moffett Field, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-223.* 7 p. 12 refs. Members, $1.50; nonmembers, $2.00.

Linearized equations of motion describing a compressible, unsteady, viscous gas under the influence of an externally applied fluctuating force field are examined. The response of the medium is split into a near-field viscous wake mode and a far-field acoustic wave mode. The resulting modal equations are then used to predict both the undulating viscous wake and the far-field acoustic wave emitted by a thin wing (modeled by a dipole force field) in a cylindrical slug jet. The directivity pattern of the acoustic wave which propagates into the quiescent region beyond the jet is compared with available experiments. The peak frequency of the broad-band noise generated by upstream turbulence is also calculated and compared to published data. (Author)

**A73-16953** # **Aircraft energy management.** N. R. Zagalsky (Honeywell, Inc., Systems and Research Div., Minneapolis, Minn.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-228.* 8 p. 6 refs. Members, $1.50; nonmembers, $2.00.

Aircraft performance can be significantly improved through implementation of those flight paths which optimally apply to aircraft's limited kinetic, potential, and chemical energy resources towards the space time objectives of its mission. This paper describes some recent efforts directed at providing instruments or systems that would enable such implementation at the operational level. These

range from development of a new instrument aid, the energy/energy rate meter, to synthesis of a flight path optimization algorithm which promises real-time, on-board implementation. (Author)

**A73-16954** * # **Long-range energy-state maneuvers for minimum time to specified terminal conditions.** M. G. Parsons (Michigan, University, Ann Arbor, Mich.), A. E. Bryson, Jr. (Stanford University, Stanford, Calif.; Aerospace Systems, Inc., Burlington, Mass.), and W. C. Hoffman (Aerospace Systems, Inc., Burlington, Mass.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-229.* 8 p. 6 refs. Members, $1.50; nonmembers, $2.00. Contracts No. N00014-67-A-0112-0063; No. F44620-72-C-0001; Grant No. NGR-05-020-007.

**A73-16956** # **Energy management rules for turning flight.** A. J. Czuchry and A. J. Calise (Dynamics Research Corp., Wilmington, Mass.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-231.* 9 p. 8 refs. Members, $1.50; nonmembers, $2.00. Contract No. F08635-72-C-0191.

The fundamental objective in this paper is to present a procedure for (1) developing improved analytical bases for evaluating aerial combat weapons systems and for (2) developing improved maneuvering and delivery tactics. The method is illustrated by computing approximate optimal feedback control laws (rules) for minimum time trajectories of a supersonic aircraft from an initial energy and heading to a final energy and heading. Placard limit, maximum normal load factor, and maximum and minimum thrust level constraints are considered. Numerical results are presented to demonstrate that these rules provide an improved basis for fighter performance evaluation with respect to tactical needs. Finally, the method is applied to a problem which we view as a simple turning game. It is shown that these results can be employed to generate diagrams that reveal how turning advantage evolves with time (Dynamic Maximum-Maneuver Diagrams). (Author)

**A73-16957** # **Application of reachable sets techniques to air combat analysis.** M. D. Ciletti, L. Meier, and D. M. Salmon (Systems Control, Inc., Palo Alto, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-232.* 8 p. Members, $1.50; nonmembers, $2.00.

The problem of identifying air combat roles from knowledge of potential aircraft and weapon capabilities will be addressed by means of a reachable sets technique. This technique first determines the set of positions which can be reached from an initial aircraft state and, second, the set of positions to which ordnance can be delivered from an initial state. The first set describes the aircraft capability, and the second set describes the joint capability of the aircraft and the weapon system. Aircraft and aircraft/weapon sets of reachable positions are combined to identify capture regions for each combatant. (Author)

**A73-16958** # **Strategy synthesis in aerial dogfight game models.** M. Falco and V. Cohen (Grumman Aerospace Corp., Research Dept., Bethpage, N.Y.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-233.* 47 p. 7 refs. Members, $1.50; nonmembers, $2.00. Contract No. F44620-72-C-0032.

The main problem of interest in this paper is the role-definition problem arising in one-on-one dogfight game models. The computational approach is aimed at providing a decomposition of the space of game initial conditions into sets of unilateral capture capability for each of the players, and at outlining the draw and sacrifice sets in accordance with the players' individual preferences for game outcomes. The procedure develops the feedback policy (in terms of the observable data) that attains the above decomposition. Two highly simplified one-on-one games are considered. (Author)

**A73-16961** # **Shock impingement caused by boundary layer separation ahead of blunt fins.** L. G. Kaufman, II (Grumman Aerospace Corp., Research Dept., Bethpage, N.Y.), R. H. Korkegi, and L. C. Morton (USAF, Hypersonic Research Laboratory, Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-236.* 10 p. 15 refs. Members, $1.50; nonmembers, $2.00.

**A73-16965** * # **Gudunov-method computation of the flow field associated with a sonic-boom focus.** L. W. Parker and R. G. Zalosh (Mount Auburn Research Associates, Inc., Newton, Mass.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-240.* 12 p. 12 refs. Members, $1.50; nonmembers, $2.00. Contract No. NAS1-10276.

**A73-16966** # **Atmospheric attenuation of noise measured in a range of climatic conditions.** C. M. Smith (Hawker Siddeley Aviation, Ltd., Hatfield, Herts., England). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-242.* 7 p. 19 refs. Members, $1.50; nonmembers, $2.00.

Standard values of atmospheric attenuation determined from SAE ARP 866 are used in correcting aircraft noise measurements from test day to reference day conditions but errors are often introduced when there is a large difference between test and reference conditions. This paper describes a systematic investigation into atmospheric attenuation by simultaneous measurement of meteorological data and aircraft noise under more than twenty different conditions of temperature and humidity. Measured attenuation values are presented which show better agreement with SAE ARP 866 predictions when conditions representing the whole noise path are used rather than surface conditions. Continuing analysis will provide a direct comparison with SAE ARP 866 and consider the problems of predicting attenuation where only limited meteorological data is available. (Author)

**A73-16969** * # **Externally blown flap trailing edge noise reduction by slot blowing - A preliminary study.** D. J. McKinzie, Jr. and R. J. Burns (NASA, Lewis Research Center, Cleveland, Ohio). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-245.* 12 p. 11 refs. Members, $1.50; nonmembers, $2.00.

**A73-17024** # **Simulation of turbine-stage operation using other than the actual working media (Modelirovanie raboty turbinnoi stupeni na rabochikh telakh, otlichaiushchikhsia ot naturnykh).** G. E. Kalinin. *Energomashinostroenie,* vol. 18, Aug. 1972, p. 25-27. 6 refs. In Russian.

Dimensional relations are derived for simulating the modes of operation of a single-stage turbine at sub- and supercritical flow conditions in the air-gas flow area. Correction coefficients required for determining the performance indices of an actual turbine from data obtained with air, or similar media, are proposed. The selection of parameters for model tests is examined. V.P.

**A73-17089** # **High-frequency vibrations of a circular wing in the flow of an ideal fluid (Vysokochastotnye kolebaniia kruglogo kryla v potoke ideal'noi zhidkosti).** V. I. Borisenko (Akademiia Nauk Ukrainskoi SSR, Institut Mekhaniki, Kiev, Ukrainian SSR). *Prikladnaia Mekhanika,* vol. 8, Sept. 1972, p. 97-102. In Russian.

The vibrations of a slightly cambered wing of circular planform in ideal fluid flow are analyzed for the case of large Strouhal numbers. An analytical solution to the vibration problem is obtained by using an asymptotic formula for the Fourier integral. It is shown that the analytical expressions for the lifting force are practically the same for large and small Strouhal numbers. V.P.

**A73-17099 Thunder at Trollhattan - The Volvo Flygmotor RM8.** H. Field and M. Wilson. *Flight International,* vol. 102, Dec. 14, 1972, p. 871-874.

The Volvo RM8 turbofan powerplant provides 26,000 lb thrust, and is the most powerful European military engine. The design is based on that of the Pratt and Whitney JT8D-1 commercial turbofan. The two fan stages are of titanium. A major structural change was a strengthening of the low-pressure shaft to withstand a flameout in the afterburner. In order to optimize the intake conditions the bypass ratio has been lowered from 1.05 to 0.97. F.R.L.

**A73-17104 # Inverse method of designing two-dimensional transonic airfoil sections.** J. Sato (National Aerospace Laboratory, Tokyo, Japan). *AIAA Journal,* vol. 11, Jan. 1973, p. 58-63. 29 refs.

The approximate compressible theory of two-dimensional airfoil sections at transonic speeds is obtained by means of the method of integral relations and quasi-linearization. The theory is an inverse method in which airfoil sections are obtained from prescribed velocity distributions which are assumed to be shock free at design Mach numbers. In order to decrease the number of strips necessary to keep the accuracy of results, the singularity of equations at stagnation points is removed analytically and the remaining regular parts of equations are transformed into a two-point boundary value problem of a system of nonlinear ordinary differential equations by means of the method of integral relations; and these equations are integrated through using quasi-linearization and the Runge-Kutta-Gill numerical method. Application of quasi-linearization admits the use of as many strips as one wishes and the accuracy of results can be improved without limit. An iterative cycle is set up to make the resulting profiles close when the pressure distributions are arbitrarily prescribed. Examples of airfoil sections designed with a four strip method and an experimental pressure distribution are presented. The rate of convergence of quasi-linearization is shown to be high. (Author)

**A73-17105 # A method for transonic wind-tunnel corrections.** A. Ferri (Advanced Technology Laboratories, Inc., Jericho; New York, University, New York, N.Y.) and P. Baronti (Advanced Technology Laboratories, Inc., Jericho, N.Y.). *AIAA Journal,* vol. 11, Jan. 1973, p. 63-66. Contract No. N00014-72-C-0201.

A method for the determination of wind-tunnel corrections at transonic speed is described. The method consists of measuring pressure and streamline deflection at the walls of the tunnel and analytically determining the streamline deflection corresponding to the measured pressure and the pressure corresponding to the measured streamline deflection for external uniform freestream conditions at the same Mach number as the test. The comparison between measured and computed pressures and measured and computed streamline deflections is then utilized to determine the wall porosity characteristics which eliminate wall interference or to calculate the wall corrections to be applied to the experimental results. (Author)

**A73-17121 # Computing meteorological effects on aircraft noise.** R. J. Thompson (Sandia Laboratories, Albuquerque, N. Mex.). *AIAA Journal,* vol. 11, Jan. 1973, p. 121-123. 6 refs. AEC-supported research.

A method is presented for studying the effects of winds and sound speed variations on sound propagation from a subsonic aircraft flying in the vicinity of the ground. The method is based on ray acoustics and is implementable on a digital computer. The computation of three-dimensional ray paths is described, and the concept and structure of 'the ray pattern on the ground' are discussed. M.V.E.

**A73-17190 Olympus on Concorde (L'Olympus sur le Concorde).** J. Devriese (SNECMA, Paris, France) and P. H. Young (Rolls-Royce, Ltd., Bristol Engine Div., Bristol, England). *(Association Aéronautique et Astronautique de France and Royal Aeronautical Society, Journée Louis Blériot, 25th, Paris, France, Apr. 21, 1972.) L'Aéronautique et l'Astronautique,* no. 37, 1972, p. 5-22. 8 refs. In French.

It has been demonstrated during flight tests that the Olympus engine cycle, eight years after it was designed, is perfectly suited to supersonic operation. Engineering improvements such as: intake casing assembly, annular combustion chamber, modern means of soundness monitoring, etc., were introduced to maintain the engine in the lead of advanced technology while satisfying pollution requirements. Noise reduction is being subjected to extensive research, with continuous improvements being introduced. The use of reheat - with a ratio increased to 18 per cent - was extended to transonic flight operation. Increased payload is ensured by the new type of secondary nozzle, which also contributes to noise abatment. Further engine developments are being considered. (Author)

**A73-17200 Fatigue of aircraft structures.** W. E. Anderson (Battelle Pacific Northwest Laboratories, Richland, Wash.). *International Metallurgical Reviews,* vol. 17, Dec. 1972, p. 240-263. 326 refs.

The basic factors contributing to crack development in airplane structures are discussed with particular reference to the subsonic jet airframe. Airframe loads, aircraft operating environments, and load paths in conventional structures are examined, together with the influence of environmental effects, flight time, and altitude on aircraft fatigue. It is shown that typical pin-fastened airframes experience alternating moisture conditions in the crevices of joints, and that load transfer in the joint occurs at many microscopic contact sites through various degrees of friction and fretting. Airframe fatigue is mainly the result of local stresses in real joints, but these are not related to the well-described general loads, because of structural redundancy and geometrically inexact assembly as viewed on the active microscopical scale. Consequently, service experience does not correlate with uniform-environmental laboratory tests, except in terms of some peculiar 'variable constant' or scatter factor. Current trends and likely directions to be taken by designers and manufacturers of future airframes are outlined. V.P.

**A73-17213 * # Leading-edge force features of the aerodynamic finite element method.** C.-T. Lan and J. Roskam (Kansas, University, Lawrence, Kan.). *Journal of Aircraft,* vol. 9, Dec. 1972, p. 864-867. 13 refs. Grant No. NGR-17-002-071.

Description of a practical procedure for computing the wing leading-edge thrust distribution by the finite element method. When incorporated into a wing-body aerodynamic computer program, the technique is capable of predicting (at subsonic and supersonic speeds) the leading-edge thrust distribution (and therefore, the lateral-directional stability derivatives due to roll) and the nonlinear aerodynamic characteristics of low aspect-ratio wings with leading edge separation due to the application of suction technology. T.M.

**A73-17214 # Load-time dependent relaxation of residual stresses.** D. Simpkins, R. L. Neulier, and D. J. Golden (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio). *Journal of Aircraft,* vol. 9, Dec. 1972, p. 867, 868. 6 refs.

Tests with aluminum specimens of aircraft structural elements commonly show that lifetime is enhanced due to compressive residual stresses which occur as a result of plastic tensile deformation at a stress concentration. The present study describes cyclic tests which were conducted with 7075-T651 bare aluminum center-hole specimens in order to determine how these residual-stress benefits may be affected by a procedure of applying compressive loads, holding these loads for specified time periods, and then cycling to

failure. Results indicate that all benefits due to residual stresses observed in aluminum specimen tests of a few days duration may not be observed in actual aircraft lower wing surface structures which sustain compressive loads of 24 hr and longer when parked. T.M.

**A73-17215** # **Comment on 'interpolation using surface splines.'** W. P. Rodden (Virginia Polytechnic Institute and State University, Blacksburg, Va.), J. A. McGrew, and T. P. Kalman (Douglas Aircraft Co., Long Beach, Calif.). *Journal of Aircraft,* vol. 9, Dec. 1972, p. 869-871. 11 refs.

The development of two-dimensional interpolation methods in aeroelastic analysis is reviewed to provide a historical background to the surface-spline interpolation technique described by Harder and Desmarais (1972). Harder and Desmarais demonstrated the superiority of surface splines over 21-term two-dimensional polynomials in the solution of the multiply supported infinite plate problem. It is argued that this comparison involved the least accurate of the alternative methods proposed in the past, and numerical data are given to illustrate a comparison with the more reasonable alternative of interpolation-in-the-small. T.M.

**A73-17249** **Digital control mounts on jet engine.** K. J. Stein. *Aviation Week and Space Technology,* vol. 98, Jan. 1, 1973, p. 48-51.

Discussion of a new electronic supervisory control system developed by United Aircraft and used on F100/F401 engines. The system furnishes vernier trim signals to the unified control for precision control of high compressor rotor speed, engine airflow, fan turbine inlet temperature, and compressor discharge flow. A new USAF F-15 electronic system is also described. V.Z.

**A73-17272** **Recent progress in the field of aircraft noise technology (Progressi recenti nel campo della tecnologia dei rumori aeronautici).** L. G. Napolitano and G. D'Elia (Napoli, Università, Naples, Italy). *L'Aerotecnica - Missili e Spazio,* vol. 51, Aug. 1972, p. 289-297. 30 refs. In Italian.

**A73-17369** * **The acoustic response of rooms with open windows to airborne sounds.** P. G. Vaidya (Tufts University, Medford, Mass.). *Journal of Sound and Vibration,* vol. 25, Dec. 22, 1972, p. 505-532. 23 refs. NASA-supported research.

The objective of the work described in this and the companion paper was to establish a theory for predicting the sound field generated in a room by a sonic boom incident on an open window. In this paper, some basic theoretical results are presented. First, the case of a normally incident harmonic wave was considered. Expressions for the pressure field were obtained by viewing the room as a terminated duct and by using a Green function method. The concept of mode excitation distribution functions was formulated and used to match the boundary conditions. This concept has been extended for oblique incidence. A modified form of Laplace transform technique was used to obtain expressions in the time domain for transient signals. (Author)

**A73-17370** * **The transmission of sonic boom signals into rooms through open windows.** P. G. Vaidya (Tufts University, Medford, Mass.). *Journal of Sound and Vibration,* vol. 25, Dec. 22, 1972, p. 533-559. 15 refs. Research supported by the Royal Aircraft Establishment and NASA.

This paper is the second of two companion papers. In the first paper, expressions for the acoustic field generated inside a room with an open window due to incoming transient or periodic signals have been presented. In this paper, the technique has been applied to the specific example of an N-wave type signal. Detailed mathematical analysis is followed by its approximate version and numerical computation. Results of controlled experiments, using simulated sonic booms, have been compared with theoretical predictions. (Author)

**A73-17374** **Distortion of near-sonic shocks by layers with weak thermal fluctuations.** L. S. Taylor (U.S. Navy, Naval Ordnance Laboratory, Silver Spring; Maryland, University, College Park, Md.) and R. E. Phinney (U.S. Navy, Naval Ordnance Laboratory, Silver Spring, Md.). *Journal of Sound and Vibration,* vol. 25, Dec. 22, 1972, p. 623-631. 6 refs. U.S. Department of Transportation Contract No. FA70WAI-174.

**A73-17565** **The effects of various parameters on an aeroelastic optimization problem.** R. H. Plaut (Brown University, Providence, R.I.). *Journal of Optimization Theory and Applications,* vol. 10, Nov. 1972, p. 321-330. 8 refs. Army-supported research; Contract No. N00014-67-A-0191-0009.

The optimal design of a panel flutter problem is investigated in this paper. A semi-infinite flat panel with either a homogeneous or sandwich cross section is considered. The thickness distribution of the panel is allowed to vary while the total weight is held fixed, and the distribution which maximizes the critical flutter parameter for stability is chosen as the optimal design. This design is calculated here by means of a generalized Ritz procedure, with the panel thickness assumed to have a certain form. Variations in the following parameters are then considered: a minimum allowable thickness, aerodynamic damping, in-plane loading, and nonstructural stiffness and mass for the case of a sandwich panel. It is shown that the optimal design may be significantly affected by changes in these parameters. (Author)

**A73-17571** * # **A Quiet Engine for stilling complaints.** N. D. Sanders (NASA, Lewis Research Center, Cleveland, Ohio). *Astronautics and Aeronautics,* vol. 11, Jan. 1973, p. 40-48.

Two experimental Quiet Engines using derated CF6 cores are discussed. One engine has a low-speed fan running at a tip speed of 1160 fps; the other engine has a fan running at the high speed of 1550 fps. The two engines are expected to show the relative advantages of fans operating at low tip speeds with high lift coefficients in comparison with fans operating at high tip speeds with low lift coefficients. Test results obtained with full-scale (6-ft diameter) fans are examined. V.P.

**A73-17572** # **DAIS - A major crossroad in the development of avionic systems.** B. List (USAF, Avionics Laboratory, Wright-Patterson AFB, Ohio). *Astronautics and Aeronautics,* vol. 11, Jan. 1973, p. 55-61.

The Digital Avionics Information System (DAIS) is discussed as a new approach to meet the requirements of modern military supersonic all-weather precision weapon delivery systems operable by small crews. The approach described provides ability to modify an avionic system by means of software rather than hardware changes, and to use modular or common equipment design in different types of aircraft. Further it gives a significantly greater total system mean time between failures (MTFB) through the planned use of redundancy at subsystem, equipment, and component levels, and a greater flexibility of adding new sensors and capabilities to the system without rewiring the aircraft. V.P.

**A73-17600** # **Problems related to the measurement and evaluation of ATC/CAS interaction.** G. D. Jolitz (U.S. Department of Transportation, National Aviation Facilities Experimental Center, Atlantic City, N.J.). *Operations Research Society of America, National Meeting, 42nd, Atlantic City, N.J., Nov. 8-10, 1972, Paper.* 16 p.

A real-time closed loop simulation was conducted for the purpose of finding order-of-magnitude interaction effects between the air traffic control (ATC) system and an airborne collision avoidance system (CAS). The simulated environment was a high-density terminal area with provisions for simultaneous parallel approaches. The CAS was modeled after a threat evaluation and avoidance logic. The simulation was conducted on a newly developed digital simulation facility which permitted software modeling of the threat detection, threat evaluation, and pilot response functions of the CAS. Since the amount and nature of the ATC/CAS interaction would be directly related to the behavior of aircraft, relative to each other, while under ATC, it became of paramount importance to capture the kinematic characteristics of the several experimental conditions. (Author)

**A73-17601** # **Aircraft environmental problems.** V. L. Blumenthal, J. M. Streckenbach, and R. B. Tate (Boeing Co., Commercial Airplane Group, Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-5.* 13 p. 5 refs. Members, $1.50; nonmembers, $2.00.

Some of the key problems confronting the aircraft industry are discussed, citing present examples of recent noise research, with suggestion of a few areas needing a major increase in effort and national resolve in order to provide a basis for future solutions to aircraft noise. In the field of noise technology, trained personnel are in very short supply, and first-class acoustic laboratories are still in the developmental stages. In the area of design and test techniques one of the most frustrating aspects of current aircraft noise reduction efforts is the recurring need to prove out solutions through full-scale tests. Various test techniques, and improvements in noise reduction resulting, are discussed. Aerodynamic noise, operating procedures, and exhaust emissions are considered. F.R.L.

**A73-17602** # **Air transportation systems problems - The airport operators' view.** N. R. Montanus (Port Authority of New York and New Jersey, New York, N.Y.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-6.* 4 p. Members, $1.50; nonmembers, $2.00.

This paper discusses how metropolitan airports are attempting to improve service despite the operational and environmental constraints imposed on air transportation by an increasingly urbanized society. Technology has dramatically expanded the air-side capacity of our airports, but growth in ground-site capacity has not kept pace. New approaches to problems of highway and terminal congestion, excessive aircraft noise, air and water pollution, conflicting land use requirements, and airport security are discussed in context of the overall needs of a viable air transportation system. Particular emphasis is placed on how these problems are being faced in the metropolitan New York region. (Author)

**A73-17603** # **Current Pratt & Whitney engine noise reduction programs.** J. D. Kester (United Aircraft Corp., Pratt and Whitney Aircraft Div., East Hartford, Conn.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-8.* 9 p. Members, $1.50; nonmembers, $2.00.

The objectives of the programs range from studies of fundamental noise generation processes to the development of noise reduction hardware for specifica aircraft applications. Both jet and fan noise were of concern in the design and development of the JT9D. Specific features incorporated to minimize noise generation were elimination of inlet guide vanes, low fan blade tip speed, determining the correct number of fan exit vanes, use of a sound absorbing liner, optimum axial spacing, and low jet velocity. Quiet nacelle programs and JT3D/JT8D refan programs are discussed. Because the current fleet of older, noisier airplanes still have a significant useful life; programs are underway to establish how best to approach the problem of reducing the noise. F.R.L.

**A73-17604** # **Recent advances in aerodynamics for transport aircraft.** L. T. Goodmanson and L. B. Gratzer (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-9.* 22 p. 32 refs. Members, $1.50; nonmembers, $2.00.

Some of the promising new developments in aerodynamics state of the art that offer potential improvements in the performance, economics, and/or noise characteristics of transport aircraft are described. Improved aerodynamic technology items such as advanced transonic airfoils, low-drag/high-lift systems, and new stability augmentation concepts are discussed as they apply to aircraft from STOL to intercontinental transports. The implications of advanced aerodynamics applied to future air transport vehicles covering the subsonic, transonic, supersonic, and hypersonic speed ranges are touched on. The roles of improved analytical and test techniques are referred to as they relate to incorporation of advanced aerodynamic concepts into viable configurations. (Author)

**A73-17607** # **Expanding horizons for long-haul air transportation.** R. E. Black and J. A. Stern (Douglas Aircraft Co., Long Beach, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-14.* 25 p. Members, $1.50; nonmembers, $2.00.

It is considered that the market for long-range airplanes will continue to expand due to the overall growth of air travel as well as the trend for long-haul transportation to become an increasingly important proportion of the total air transportation market. For advanced long-range aircraft, technological emphasis will be placed on advanced airfoils, noise reduction, composite structures, and active controls. For second-generation SSTs, design objectives are speeds of Mach 2.0 to 3.5, range 4800 mi, capacity 200-350 passengers, operating economies approximating DC-10 Series 30, and reduction of the sonic boom. Advanced SST development areas include use of composite and superalloy structures, active control systems, and variable cycle engines. Aspects of hypersonic aircraft, expected to be available by 2000, are discussed. F.R.L.

**A73-17608** * # **Toward a second-generation supersonic transport.** L. K. Loftin, Jr. (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-15.* 11 p. Members, $1.50; nonmembers, $2.00.

A number of promising avenues of research and development are considered in relation to an advanced supersonic transport which has improved range/payload characteristics and lower airport noise and sonic boom than current-generation supersonic transports. The prospects for advanced technology suggest that a high lift-to-drag-ratio configuration incorporating advanced materials and control concepts and utilizing a variable-cycle engine or perhaps an advanced dry turbojet, will yield an advanced supersonic transport which is economically viable and socially acceptable. Hydrogen fuel offers great promise for future supersonic aircraft, however, the formidable problems associated with the use of such fuel probably precludes its use on any near term second-generation supersonic transport. The state of technology in some of the areas discussed is not very far advanced and, consequently, a major effort will be required to bring these technologies to a state of readiness on a timely basis. (Author)

**A73-17609** # **Concorde inaugurates the supersonic era.** E. H. Burgess (British Aircraft Corp., Ltd., Filton, Bristol, England). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-16.* 10 p. Members, $1.50; nonmembers, $2.00.

It is shown that there is going to be a 'supersonic era' and that

this revolution in air transport will be spearheaded by the Concorde. The SST's speed advantage is so great that it becomes virtually a different type of vehicle, complementing rather than supplementing the large subsonic transports. The present status of the Concorde project is outlined, and its development history is given. Market prospects are that 200 to 250 Concordes will be sold. Environmental factors, such as high altitude effects, noise, air pollution, and depletion of resources are considered. F.R.L.

**A73-17610 * # Structural technologies - Systems challenges and NASA thrusts.** G. W. Brooks (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-17.* 12 p. 11 refs. Members, $1.50; nonmembers, $2.00.

Some significant areas of emphasis in the NASA airframes structures program are highlighted. The topics treated include automated analysis and design processes, building confidence in advanced composites, improving the technology base for future supersonic and hypersonic vehicles, validation of concepts for active control systems, development of predictive methods for aircraft loads and aeroelasticity, and generation of methodology to assure structural integrity as a part of the design process. An integrated long-range program for fatigue and fracture is recommended. F.R.L.

**A73-17611 # The USAF aircraft structural integrity program /ASIP/.** G. P. Haviland and C. Tiffany (USAF, Aeronautical Systems Div., Wright-Patterson AFB, Ohio). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-18.* 9 p.

MIL-STD-1530 is in its final form, and four very basic requirements are discussed. The first and second are to establish, evaluate, and utilize operational usage date to provide a continued service life of airplane systems, and to provide a continued record of the in-service integrity. The third and fourth requirements are to provide a basis for determining logistics and force planning requirements, and a basis to improve structural criteria and methods of design, evaluation, and substantiation for future systems. A complete description of the B-1 structural integrity program is presented in order to indicate how the new requirements are being implemented by an ongoing program. F.R.L.

**A73-17612 # Commercial aircraft outlook for structural engineers.** D. S. Warren (Douglas Aircraft Co., Long Beach, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-19.* 9 p. 13 refs. Members, $1.50; nonmembers, $2.00.

An attempt is made to provide a realistic perspective of the future for aircraft structural engineers. Wide-body designs will be the mainstay of production, and competition for this market of 4000 aircraft will be keen. Numerous derivatives of the current designs will be invented to avoid the high investment risk of a completely new design. STOL and SST designs will involve major engineering and development activities, and will benefit significantly from government programs. Emphasis is on technology escalation which is reviewed in terms of analysis/design methods, fracture control, advanced composites, active controls, and time-compressed fatigue testing. F.R.L.

**A73-17613 # Structural design of future commercial transports.** P. L. Sandoz (Boeing Co., Everett, Wash.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-20.* 13 p. Members, $1.50; nonmembers, $2.00.

This paper explores potential applications of structural research and development to the design of future commercial transports. Advanced structural systems are evaluated relative to cost and value for use in commercial transports. The levels of structural fail-safeness and durability available in current transports will be maintained as requirements for future designs. The value of durability is low structural maintenance cost and airplane availability for high daily utilization rates. Airline acceptance of new structural systems will be influenced by these factors through assessments of return on investment and the effect on direct operating cost. (Author)

**A73-17614 # Review of New York Airways helicopter operations.** W. A. Fucigna (New York Airways, Inc., La Guardia Airport, Flushing, N.Y.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-25.* 4 p. Members, $1.50; nonmembers, $2.00.

The major technical problems of scheduled helicopter operation are considered to have been for the most part resolved, and the problem now is one of economics rather than technical capability. To achieve a record of 99.4% mechanical performance factor a maintenance program was developed in which 100% of all maintenance actions were scheduled. The aircraft improvements required to ensure the success of the helicopter as a mode of transportation are not difficult to outline and are within the industry capability. F.R.L.

**A73-17615 # Washington Airlines - The short haul /STOL/ experiment.** R. A. Richardson (Helicopter Association of America, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-26.* 14 p. Members, $1.50; nonmembers, $2.00.

The Washington Airlines operation for a period of over a year, using Dornier Do-28 STOL aircraft between Baltimore and the two Washington airports is analyzed. Applications for helicopter operation of the service had previously been denied by the CAB, and a helicopter air taxi operation between Baltimore and Washington had failed. The STOL project was also unsuccessful because of interline delays, the reversal of the CAB position with respect to the Washington-Baltimore helicopter operating certificate, equipment problems, interline opposition, aircraft acceptance, city-center landing facilities, head-to-head competition, and capitalization/cash flow. F.R.L.

**A73-17616 * # Research on future short-haul aircraft at the NASA Langley Research Center.** J. M. Riebe and R. E. Kuhn (NASA, Langley Research Center, Low-Speed Aircraft Div., Hampton, Va.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-27.* 14 p. 20 refs. Members, $1.50; nonmembers, $2.00.

Some of the current research for improving our short-haul air-transportation system is reviewed. Promising aircraft range from helicopters, turbofan-powered STOL, through mechanical flap reduced take-off and landing (RTOL) concepts. Advanced rotorcraft technology can provide improved passenger, community, operational, and economic acceptability of civil transport helicopters. From wind-tunnel and design studies, techniques are available for achieving low-noise fixed-wing STOL and RTOL through proper engine and airframe design. Agreeable ride qualities, crosswind landing capability, and all-weather terminal operation are also goals of present effort. (Author)

**A73-17617 # The trend toward increasing avionics complexity.** R. C. Collins (United Air Lines, Inc., San Francisco, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-28.* 4 p. Members, $1.50; nonmembers, $2.00.

'Avionics' is defined as those areas of application of electronics to aircraft where an impact on the operational safety or reliability is

present. Aspects of redundancy are discussed which lead to the conclusion that excessive redundancy may complicate matters unnecessarily. Increasing complexity is the price that must be paid for increasing operational versatility. It is suggested that avionics components could be designed with a guaranteed operational life rather than a guaranteed mean time between failure. F.R.L.

**A73-17618 # Flight control techniques for advanced commercial transports.** J. Doniger and D. Beckman (Bendix Corp., Navigation and Control Div., Teterboro, N.J.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-30.* 14 p. 14 refs. Members, $1.50; nonmembers, $2.00.

The basic design goals of commercial aircraft are to provide lower structural weight and/or longer fatigue life, smoother pilot handling and passenger ride qualities, lower drag at the same or higher cruise speeds, and improved efficiency in the cockpit and in the traffic control environment. Among the most significant aircraft design features that can be used to accomplish the design goals are reduced free airframe stability margins, the use of active controls to provide structural fatigue alleviation and to improve ride qualities, and the use of integrated navigation, air data, and flight guidance controls and displays. The architecture and organization of an integrated control and guidance systems that provides these features is described. F.R.L.

**A73-17627 # Arrested landing studies for STOL aircraft.** C.-C. Hsin (Virginia, University, Charlottesville, Va.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-51.* 11 p. 9 refs. Members, $1.50; nonmembers, $2.00. FAA-supported research.

This is a computer simulation study of the motion of a STOL aircraft after touchdown, when it is restrained by an arresting gear. After touchdown, the runout of the aircraft is shortened by engaging the extendable arresting cable, and the chance of going over the side is reduced. A set of second order nonlinear differential equations, which is solved numerically, has been developed to simulate such aircraft motion. The entire time history of the motion has been calculated and studied. The results show that the arresting gear is a very promising containment device for elevated STOL ports. (Author)

**A73-17629 # Preliminary design of the man-powered aircraft, Icarus.** D. L. Hall (TRW Systems Group, Redondo Beach, Calif.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-53.* 10 p. 16 refs. Members, $1.50; nonmembers, $2.00.

**A73-17630 # Computer aided shrouded propeller design.** T. W. Sheehy (Wichita State University, Wichita, Kan.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-54.* 7 p. 10 refs. Members, $1.50; nonmembers, $2.00.

A method of designing shrouded propellers using a computer algorithm was developed which enables the designer to investigate designs quickly and efficiently. An outline of the resultant design procedure is included along with an appropriate discussion of the method. Results of a specific design are compared to an experimental model. The comparison shows satisfactory agreement. (Author)

**A73-17631 * # Key technology for airbreathing hypersonic aircraft.** A. L. Nagel and J. V. Becker (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-58.* 12 p. 9 refs. Members, $1.50; nonmembers, $2.00.

This paper reviews recent progress in the key hypersonic technologies, which has been good despite a relatively low priority. Successful hypersonic research engine tests have been made. Active cooling system analyses have shown potential for weight savings, alleviation of structural design problems, and long airframe life. Maturing computerized flow field theories permit optimizing engine-airframe performance. Adequate progress in the future requires an expanded technology program emphasizing hydrogen usage. A hydrogen fueled hypersonic research airplane is essential, providing critical flight data and operational experience. (Author)

**A73-17635 # Military contributions to civil aviation.** T. C. Muse (U.S. Department of Defense, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Annual Meeting and Technical Display, 9th, Washington, D.C., Jan. 8-10, 1973, Paper 73-67.* 8 p. Members, $1.50; nonmembers, $2.00.

A study was conducted to identify the significant technological advances that have been made in U.S. aviation since 1925 and to assess the relevance of current and planned military aeronautical research and development to the research and development needs of civil aviation. The advances considered include the radial air-cooled engine, supercharging, controllable-pitch propellors, high octane fuels, the turbojet, the thrust reverser, on-board power generation, the turbofan engine, and the high bypass ratio turbofan. It was seen that in most cases advances were sponsored by the military and found their first use on military aircraft. G.R.

**A73-17642 # Equivalence rule and transonic flows involving lift.** H. K. Cheng and M. M. Hafez (Southern California, University, Los Angeles, Calif.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-88.* 23 p. 81 refs. Members, $1.50; nonmembers, $2.00. Contract No. N00016-67-A-0269-0021.

The transonic flow around a smooth configuration with swept leading edges is shown to possess a nonlinear structure determined principally by a line doublet and a line source. Recent works on this and other classes of three-dimensional flow structure are reviewed. Relaxation methods based on second-order difference schemes are developed to solve the reduced lifting problem in the thickness-controlled domain, employing a number of analytical features of the theory. Shock-free (slightly) supercritical solutions for two equivalent lift and area distributions are presented; the data confirm that departures from the (axisymmetric) area rule in the nonlinear region and in the far field are significant. Extensions to studies of wall effects, sonic boom, unsteady flow, as well as a lifting-line formulation of the critical wing problem are discussed. (Author)

**A73-17643 # Engine exhaust emission levels.** A. K. Forney (FAA, Washington, D.C.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-98.* 10 p. 9 refs. Members, $1.50; nonmembers, $2.00.

As a part of the U.S. Department of Transportation's Climatic Impact Assessment Program the exhaust emission products from a YJ93-GE-3 afterburning turbojet engine were measured under simulated flight conditions. These measurements were made by means of on-line instruments, spectroscopy and laboratory analysis of exhaust gas samples. The results show that the emission index for nitric oxide formation increases with increasing Mach number and that the emission indexes for the formation of carbon monoxide and total unburned hydrocarbons increase with increasing altitude. (Author)

**A73-17645 * # Aerodynamic influence coefficient method using singularity splines.** J. E. Mercer, J. A. Weber (Boeing Co., Seattle, Wash.), and E. P. Lesferd (Boeing Computer Services, Inc., Seattle, Wash.). *American Institute of Aeronautics and Astronautics,*

*Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-123.* 8 p. 8 refs. Members, $1.50; nonmembers, $2.00. NASA-supported research.

A new numerical formulation with computed results, is presented. This formulation combines the adaptability to complex shapes offered by paneling schemes with the smoothness and accuracy of the loading function methods. The formulation employs a continuous distribution of singularity strength over a set of panels on a paneled wing. The basic distributions are independent, and each satisfies all of the continuity conditions required of the final solution. These distributions are overlapped both spanwise and chordwise (termed 'spline'). Boundary conditions are satisfied in a least square error sense over the surface using a finite summing technique to approximate the integral. (Author)

**A73-17654 * #** **An analysis of jet noise directivity.** S. P. Pao (Alabama, University, Huntsville, Ala.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-185.* 10 p. 18 refs. Members, $1.50; nonmembers, $2.00. NASA-supported research.

This paper is intended for pointing out several factors which may be important to the calculation of directivity patterns of jet noise. In a hot, high speed jet the directional pattern can be divided into a maximum of four zones. The convection law and the correspondence between the sound field and turbulence are different in each zone. The convection law for high and low frequencies is also different. Numerical examples are presented in parallel to the discussions. (Author)

**A73-17656 * #** **An automated method for determining the flutter velocity and the matched point.** K. G. Bhatia (NASA, Langley Research Center, Hampton, Va.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-195.* 10 p. 9 refs. Members, $1.50; nonmembers, $2.00.

**A73-17664 * #** **Results of an experimental program for the development of sonic inlets for turbofan engines.** F. Klujber (Boeing Co., Seattle, Wash.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-222.* 9 p. 21 refs. Members, $1.50; nonmembers, $2.00. Contract No. NAS3-15574.

Results of a current program for sonic inlet technology development are presented. This program includes configuration and mechanical design selection of concepts, aerodynamic design description of the models, and results of test evaluation. In the test program several sonic inlet concepts were tested and compared for aerodynamic and acoustic performance. Results of these comparative evaluations are presented. Near-field measurements were taken inside the sonic inlet on several inlet models. Results of these tests are discussed with respect to the effect of Mach number gradients on noise attenuation and rotor shock wave attenuation, and boundary layer effects on noise propagation. The test facilities and experimental techniques employed are described briefly. (Author)

**A73-17666 * #** **Sonic boom reduction through aircraft design and operation.** A. R. Seebass and A. R. George (Cornell University, Ithaca, N.Y.). *American Institute of Aeronautics and Astronautics, Aerospace Sciences Meeting, 11th, Washington, D.C., Jan. 10-12, 1973, Paper 73-241.* 11 p. 36 refs. Members, $1.50; nonmembers, $2.00. Grant No. NGR-33-010-054.

Means of reducing or eliminating the sonic boom through aerodynamic design or aircraft operation are discussed. These include designing aircraft to minimize or eliminate certain features of the overpressure signature, operating aircraft at slightly supersonic speeds so that the sonic boom does not reach the ground, and seeking reductions through the high altitude-high speed flight conditions of hypersonic transports. (Author)

**A73-17675 Technical and economical analysis of various QSTOL concepts (Technische und wirtschaftliche Analyse verschiedener QSTOL-Konzepte).** D. Reich, W. Sardanowsky, and E. Rutzen (Messerschmitt-Bölkow-Blohm GmbH, Ottobrunn, West Germany). *Deutsche Gesellschaft für Luft- und Raumfahrt, Jahrestagung, 5th, Berlin, West Germany, Oct. 4-6, 1972, Paper 72-055.* 33 p. In German.

A limited number of QSTOL concepts was parametrically varied, taking into account wing loading, the thrust-weight ratio, runway length, and the number of passengers. It was the aim of the investigation to determine the technical and operational conditions for an economical employment of quiet aircraft in air traffic. An internal German route network was considered. Payload restrictions were imposed for the aircraft at various points of the network because of noise considerations. Questions of the economy of aircraft operations were explored on the basis of investment and amortization calculations. G.R.

**A73-17721 #** **An all-regime optimal speed control for a single-shaft jet engine (Celorezimova optimalni regulace otacek jednohrideloveho proudoveho motoru).** J. Muller (Jihoceske Strojirny, Velesin, Czechoslovakia). *Zpravodaj VZLU,* no. 6, 1972, p. 15-27. In Czech.

Consideration of the structure of a time-optimal controller for an all-regime speed control of a single-shaft jet engine with an integral fuel valve. The problem is first analyzed qualitatively on a linearized model of the engine. Then the switching trajectories are determined on an all-regime nonlinear model of the engine, and the controller structure is established. The shape of the switching trajectories thus found is approximated by a simple analytic expression. On a numerical model of the optimal control loop the shapes of the transient trajectories during a change in regime are shown and are compared with the trajectories obtained if the engine is controlled by a linear proportional plus integral controller with limiting. Good agreement is found between linear proportional plus integral control with limiting and time-optimal speed control. A.B.K.

**A73-17722 #** **Control of jet engines with an afterburner (Regulace proudovych motoru s pridavnym spalovanim).** V. George (Ministerstvo Prumyslu, Bucharest, Rumania). *Zpravodaj VZLU,* no. 6, 1972, p. 29-38. In Czech.

Consideration of problems of controlling engines with an afterburner, and description of the control laws used and of the special features of the operation of such engines. The characteristics of the process of afterburning are reviewed, and the flight and operational conditions are described. Possible controller schemes and the corresponding structures are presented. The use of the afterburner regime in high-compression engines is considered, as well as problems concerning the stability and control of the regime. An analysis is made of the possibility of improving the flight and tactical parameters of supersonic aircraft for operation at low altitudes. A.B.K.

**A73-17726 Emissions from continuous combustion systems; Proceedings of the Fifteenth Symposium, Warren, Mich., September 27, 28, 1971.** Symposium sponsored by the General Motors Corp. Edited by W. Cornelius and W. G. Agnew (GM Research Laboratories, Warren, Mich.). New York, Plenum Press, 1972. 474 p. $25.

Topics discussed include models of continuous combustion, modeling continuous-flow combustors, flows described by coupled mixing and kinetics, nitric oxide formation in diffusion flames, the formation kinetics of nitric oxide in combustion processes, emission of nitric oxide and carbon monoxide from gas-turbine combustors,

particulate emissions from gas-turbine engines, emission of nitric oxide from a multifueled gas-turbine combustor, fuel injection in a gas-turbine combustor, and the reduction of exhaust emissions from jet aircraft engines.

A.B.K.

**A73-17733** **Effect of fuel composition on particulate emissions from gas turbine engines.** R. M. Schirmer (Phillips Petroleum Co., Bartlesville, Okla.). In: Emissions from continuous combustion systems; Proceedings of the Fifteenth Symposium, Warren, Mich., September 27, 28, 1971. New York, Plenum Press, 1972, p. 189-208; Discussion, 209, 210. 33 refs. Navy-supported research.

**A73-17734** **Measurement of nitric oxide formation within a multifueled turbine combustor.** C. W. LaPointe and W. L. Schultz (Ford Motor Co., Dearborn, Mich.). In: Emissions from continuous combustion systems; Proceedings of the Fifteenth Symposium, Warren, Mich., September 27, 28, 1971. New York, Plenum Press, 1972, p. 211-240; Discussion, p. 240-242. 13 refs.

**A73-17735** **Effects of fuel injection method on gas turbine combustor emissions.** E. R. Norster and A. H. Lefebvre (Cranfield Institute of Technology, Cranfield, Beds., England). In: Emissions from continuous combustion systems; Proceedings of the Fifteenth Symposium, Warren, Mich., September 27, 28, 1971. (A73-17726 06-33) New York, Plenum Press, 1972, p. 255-278. 10 refs.

**A73-17736 *** **Effect of operating variables on pollutant emissions from aircraft turbine engine combustors.** J. S. Grobman (NASA, Lewis Research Center, Cleveland, Ohio). In: Emissions from continuous combustion systems; Proceedings of the Fifteenth Symposium, Warren, Mich., September 27, 28, 1971. (A73-17726 06-33) New York, Plenum Press, 1972, p. 279-303. 29 refs.

**A73-17737** **Control and reduction of aircraft turbine engine exhaust emissions.** D. W. Bahr (General Electric Co., Lynn, Mass.). In: Emissions from continuous combustion systems; Proceedings of the Fifteenth Symposium, Warren, Mich., September 27, 28, 1971. New York, Plenum Press, 1972, p. 345-372; Discussion, p. 372, 373.

**A73-17738** **The method of parabolic substitution for high subsonic flow.** K. Oswatitsch (Wien, Technische Hochschule, Vienna, Austria; Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt, Institut für theoretische Gasdynamik, Aachen, West Germany) and R. E. Singleton (Lockheed-Georgia Co., Marietta, Ga.). *Zeitschrift für Flugwissenschaften,* vol. 20, Nov. 1972, p. 401-406. 7 refs.

A new relaxation method is formulated by substituting artificial time dependence for true time dependence in the Euler equations of fluid mechanics. The initially hyperbolic equations are thereby converted into parabolic form, and the convergence question is studied analytically within the framework of linearized small-disturbance theory. The fully nonlinear equations are solved numerically using this new relaxation technique for the cases of symmetry flow past a Joukowsky airfoil, flow past an 8.57% cambered Karman-Trefftz airfoil, and a NACA 0012 airfoil at 2 degree angle of attack. The method is seen to work quite well and warrants further extension into the transonic range. (Author)

**A73-17767** # **New thermosensitive materials and prospects for their application in astronautics (Nowe materialy termoczule i perspektywy ich uzycie w astronautyce).** A. Szymanski (Lodz, Politechnika, Lodz, Poland). *Postepy Astronautyki,* vol. 5, no. 2, 1972, p. 27-39. 15 refs. In Polish.

The structure and optical properties of cholesteric liquid crystals are reviewed to illustrate possible applications in aerospace sciences and engineering. Attention is given to measurements of temperature and temperature distribution, thermal radiant flux measurements, defectoscopy based on measurement of differences in heat conduction, and in-flight measurements of heat transfer between the ambient airstream and aircraft surfaces. T.M.

**A73-17844** # **Turbine blade radiation pyrometer system.** K. R. Curwen (Kollsman Instrument, Ltd., Southampton, England). *Aircraft Engineering,* vol. 44, Dec. 1972, p. 16-21.

The temperature of rotor blades can be determined by measuring the radiation emitted by the blades, the radiation being a function of temperature. This method has the advantage of being contactless and of being able to measure, with a single instrument, the temperature of each blade or the mean temperature of all blades, depending on the readout electronics. Radiation methods, moreover, do not have the inherent thermal inertia of thermocouple techniques and thus can have very rapid response. In combination with modern electronic circuitry, a temperature measuring system of great sensitivity, accuracy, and speed can be located optimally in a gas turbine engine in an airborne environment. The pyrometer head, amplifier, and indicator are described. Factors affecting the accuracy of a radiation pyrometer system are individually considered. F.R.L.

**A73-17862** **The international rules of route rentals. I (Le régime international des redevances de route. I).** R. Goy (Rouen, Université, Rouen, France). *Revue Générale de l'Air et de l'Espace,* vol. 35, no. 3, 1972, p. 257-278. 151 refs. In French.

The concept of route rental is the payment for the use by aircraft in flight of route installations and services such as navigation aids, air traffic control, flight information and warnings, meteorology, and search and rescue. However, the application of route rentals has for long been opposed by operators, while rental charges at airports have been considered normal. Because of the rising costs of complex equipment, the financing of route services cannot always be assumed by the state alone. Many states already collect route rentals. It is considered that, in establishing and collecting rentals, universal rules should be set up, based on various national and international conventions and agreements. F.R.L.

**A73-17870** **Aviation law: Cases and materials.** A. F. Lowenfeld (New York University, New York, N.Y.). New York, Matthew Bender and Co., Inc., 1972. 978 p. 1035 refs. $19.50.

The economic regulation of domestic aviation is discussed, giving attention to the functions of the CAB in domestic route awards, domestic rate making, and airline mergers. A substantial portion of the book deals with international law: the drafting and interpretation of international agreements, the settlement of international disputes, the workings of international organizations, and the conduct of states. The legal aspects of aircraft noise are considered, and extensive attention is given to the question of accident compensation. There is some inquiry into the role and effect of treaties. A chapter on hijacking brings together problems of international law, juridsdiction, extradition, and the conflict in criminal law and procedure between civil liberties and public safety. F.R.L.

**A73-17888** # **Economics - The quality controller.** K. J. Anderson (British Caledonian Airways, Ltd., Horley, Surrey, England). *Tech Air,* vol. 29, Jan. 1973, p. 4-7.

Improved economic performance is noted as the key ingredient of air transport maintenance and engineering quality control against a context of recent selling price trends in world air transport. Cost problems of some representative maintenance operations are

reviewed to emphasize the importance of economy in air transport maintenance and engineering. V.Z.

**A73-17995** # **Hydraulic systems of modern aircraft (Uklady hydrauliczne wspolczesnych samolotow).** J. Filip. *Technika Lotnicza i Astronautyczna,* vol. 27, Nov. 1972, p. 23-28. In Polish.

The applications and advantages of hydraulic systems in aircraft are discussed, and measures employed to enhance the reliability of such systems are outlined, with particular attention devoted to prevention of fluid loss from pipelines and components. Structural design aspects of electrohydraulic servos used for lift-surface control are explained together with applications of fluidic control elements. T.M.

**A73-17996** # **Development trends in design methods for aircraft engine compressors. II - Centrifugal-flow compressors (Kierunki rozwoju metod projektowania sprezarek silnikow lotniczych. II - Sprezarki odsrodkowe).** J. Filip. *Technika Lotnicza i Astronautyczna,* vol. 27, Nov. 1972, p. 29-32, 41. In Polish.

**A73-17997** **Aircraft radome design (Die Konstruktion von Flugzeug-Radomen).** P. Brüchmann. *Flug Revue/Flugwelt International,* Jan. 1973, p. 23-26, 31, 32. In German.

The housing for aircraft radar must combine extraordinary mechanical-physical properties with suitable electrical characteristics. The shape of the external radome surface is determined by the aerodynamical expert who frequently employs an electronic computer for his design studies. The radome design has to take into account the configuration of the space in the aircraft assigned to the radar by the aircraft designer. Questions regarding the determination of the mechanical strength requirements are discussed together with approaches for satisfying the electrical specifications. Methods for solving problems connected with lightning hazards, electrostatic surface charges, and form changes of plastic components are also considered. G.R.

**A73-17998** **Aircraft for business trips - Yes or no. II (Geschäftsreiseflugzeug - Ja oder nein. II).** H. G. Wellmann. *Flug Revue/Flugwelt International,* Jan. 1973, p. 33, 34. In German.

An evaluation of the costs of aircraft operation is discussed, giving attention to maintenance and repair work. In order to reduce expenses it is recommended to select firms for motor repair work needed on an international basis. Details regarding the determination of the operational condition of the aircraft are discussed together with questions of the depreciation of the aircraft. G.R.

**A73-17999** **AM-C111 - The new concept of 'Air-Metal' (AM-C111 - Das neue Konzept der Air-Metal).** *Flug Revue/Flugwelt International,* Jan. 1973, p. 36-39. In German.

A German aerospace company has designed a STOL multiple-purpose aircraft for 20 passengers or two tons of cargo. It is planned to build two prototypes and between 10 and 14 model aircraft for companies which are to manufacture the aircraft under a license arrangement. The manufacture of various structural components of the aircraft is being undertaken by German and French aerospace companies. The technical design of the aircraft is discussed together with the wing structure, the fuselage, the tail unit, the propulsion system, and instruments for flight control and navigation. G.R.

**A73-18067** # **Univalent solvability of the inverse problem of hydromechanics (Ob odnolistnoi razreshimosti obratnoi zadachi gidromekhaniki).** L. A. Aksent'ev and Iu. A. Reshetnikov. *Seminar po Kraevym Zadacham, Trudy,* no. 8, 1971, p. 12-21. 7 refs. In Russian.

Derivation of the conditions of simplicity (i.e., the conditions of absence of self-intersections) of the unknown profile in the inverse problem of hydromechanics. Three alternative formulations of the problem are considered. The solvability of three problems in the first formulation is investigated, as well as problems concerning the univalence of the functions obtained. Sufficient conditions of univalent solvability of the second and third formulations of the inverse problem are obtained. A.B.K.

**A73-18075** **Aircraft Instruments: Principles and applications.** E. H. J. Pallett. London, Sir Isaac Pitman and Sons, Ltd., 1972. 378 p. $11.07.

Emphasis is placed on fundamental principles and their application to flight, navigation, and engine-performance monitoring instruments. Requirements and standards are outlined, and instrument elements and mechanisms, displays, panels and layouts, and pitot-static instruments and systems are discussed. Attention is given to attitude indicating and primary heading indicating instruments, remote-indicating compasses, and aircraft magnetism and its effect on compasses. Accelerometers, fatigue meters, and synchronous data-transmission systems are considered. Measurements of engine speed, temperature, pressure, fuel quantity and fuel flow are treated. Engine power and control instruments, and integrated instrument and flight director systems are described. F.R.L.

**A73-18093** **ECM of gas turbine components.** J. A. Cross (General Electric Co., New York, N.Y.). *Society of Manufacturing Engineers, Paper MR 72-536,* 1972. 22 p. 5 refs. Members, $1.50; nonmembers, $2.00.

Discussion of the merits and requirements of electrochemical machining (ECM) in application to the manufacture of aircraft engine components. It is shown to offer the advantages of high removal rate, accuracy and surface finish capability, ability to produce multiple three-dimensional configurations in a single operation, and applicability to all electrically conductive materials regardless of hardness. Achieved work precision depends upon tooling accuracy and exercised process controls. Quality control aspects include geometric considerations, surface integrity, and mechanical properties of the finished component. ECM can help reduce manufacturing costs, but success in the use of ECM depends primarily upon the thorough competence of manufacturing engineers, tool designers, and operating personnel. M.V.E.

**A73-18094** **Manufacturing developments for producing advanced metallic structures.** D. M. Hermanson (Vought Aeronautics Co., Dallas, Tex.). *Society of Manufacturing Engineers, Paper MF 72-513,* 1972. 18 p. Members, $1.50; nonmembers, $2.00.

The development of techniques for fabricating complex airframe structure components by adhesive bonding of sheet metal details is reviewed. Some of the fabrication methods used for aluminum and titanium materials are described, along with the component design considerations prerequisite to fabricability. A program to advance further the development of adhesively bonded multilayer airframe components currently in progress is aimed at fabricating and testing titanium laminated structures and comparing them with existing monolithic structures. The key to successful application of adhesively bonded multilayer components to critical airframe structure areas is shown to lie in proper coordination of design and fabrication. M.V.E.

**A73-18148** # **Birds and airplanes.** J. Grey. *AIAA Student Journal,* vol. 10, Dec. 1972, p. 3-7.

Bird and airplane flight is compared and contrasted. A bird's wings change the flight-path-directed momentum of the air through which it flies by exactly the force needed to keep it moving. Soaring birds and sailplane pilots have learned to detect the conditions that produce thermals and wind-induced updrafts, and use them to best

advantage. An airplane's range is proportional to its lift-drag ratio divided by its specific fuel consumption, multiplied by the logarithm of its initial to final mass. However, some birds can fly thousands of miles with only small changes in their body mass. The high level aerodynamic efficiency of birds brings substantial maneuverability benefits, particularly during the critical takeoff and landing. F.R.L.

**A73-18149 # The aircraft wake turbulence problem.** A. S. Carten, Jr. (USAF, Cambridge Research Laboratories, Bedford, Mass.). *AIAA Student Journal*, vol. 10, Dec. 1972, p. 8-13. 5 refs.

Wing-tip vortices are the primary constituent of aircraft wake turbulence, hence the problem is basically one of vortex avoidance, arising from the fact that the trailing vortices remain after the departure of generating aircraft. At cruise altitudes, small jet aircraft should stay above the long-lived vortices of larger jet aircraft. The principle constituent of the wake turbulence is the trailing vortex pair. The vortices owe their existence to lift generated by wing surfaces and are not a direct product of power plant operation. A vortex model which features a thin vortex 'sheet' flowing from the trailing edge of the wing is described. The failure of conventional theory to describe the vortex filament illustrates the need for continual theoretical investigation of the vortex phenomenon. F.R.L.

**A73-18150 # VTOL aircraft and short-haul transportation.** W. Z. Stepniewski (Boeing Co., Vertol Div., Philadelphia, Pa.). *AIAA Student Journal*, vol. 10, Dec. 1972, p. 33-39. 11 refs.

The advantages of VTOL aircraft are reduction of door-to-door travel time, lower cost of development of the whole system as compared to ground transportation, flexibility in route and schedule structures, easing the pressure for the need of developing new airports, and reduction of highway congestion and air pollution. At present, the classical helicopter is the only operational VTOL configuration of the transport size. It appears that the tilt-rotor should be better suited for short-haul operations. Problems of noise are discussed in some detail, and attention is given to ecological aspects. F.R.L.

**A73-18156 # Aerial photograph distortions due to internal refraction (Iskazheniia aerosnimkov iz-za vnytrennei refraktsii).** V. M. Pozdniakov and Iu. S. Timofeev. *Geodeziia i Aerofotos'emka*, no. 3, 1972, p. 85-93. In Russian.

Assessment of the influence of temperature-and-pressure conditions in sealed aerial-photography compartments of aircraft. The influence is determined in terms of the magnitude of the aerial photograph distortions due to internal refraction. Procedures are considered for reducing and preventing these photograph distortions. M.V.E.

**A73-18254 Northwest Airlines' in-house maintenance.** L. M. Raverty (Northwest Airlines, Inc., St. Paul International Airport, St. Paul, Minn.). *Shell Aviation News*, no. 414, 1972, p. 16-19.

Northwest Airlines maintains, overhauls, and repairs most of its equipment, including sophisticated electronic gear. The engine, machine, and plating shops are located so that parts movement is kept to a bare minimum. Balancing of rotating parts is done with a strobe-type light connected to meters and programmed to a master blade. The airline attempts to keep the latest test equipment available. The continuous maintenance system provides the capability of taking advantage of each hour that a unit is approved to operate, since each unit is controlled on an individual basis without regard to the total aircraft time. F.R.L.

**A73-18377 Optimal 3-dimensional minimum time turns for an aircraft.** R. P. Humphreys (USAF, Air University, Maxwell AFB, Ala.), G. R. Hennig (USAF, Frank J. Seiler Research Laboratory, Colorado Springs, Colo.), W. A. Bolding, and L. A. Helgeson. *Journal of the Astronautical Sciences*, vol. 20, Sept.-Oct. 1972, p. 88-112. 10 refs. USAF-sponsored research.

Using a 3-dimensional formulation for an aircraft's dynamics, the required controls for minimum time-to-turn are calculated. Three controls are used: (1) angle of attack, (2) bank angle, and (3) thrust. The minimum time-to-turn solutions are subject to varying terminal conditions on both flight path angle and heading angle. In general, the time for the turns are not greatly changed by varying thrust/weight ratios or the final flight path angle. Significant effects on the change in total energy, final altitude, final velocity, and control histories are noted for variations of the above parameters. Solutions to the above problem are accomplished through the use of Miele's sequential gradient-restoration algorithm. (Author)

**A73-18402 ASTM manual for rating motor, diesel, and aviation fuels.** Philadelphia, American Society for Testing and Materials, 1972. 585 p. $17.75.

Standard and Tentative Methods of Test for determining the knocking or detonation characteristics of motor, diesel, and aviation fuels are outlined. The following nine methods are considered: D 2699, Test for Knock Characteristics of Motor Fuels by the Research Methods; D 2700, Test for Knock Characteristics for Motor and Aviation-Type fuels by the Motor Method; D 2623, Test for Knock Characteristics of Liquid Petroleum (LP) Gas by the Motor (LP) Method; D 2722, Test for Knock Characteristics of Motor Fuels Using the Compression Ratio Technique for Research Method Ratings; D 2723, Test for Knock Characteristics of Motor Fuels Using the Compression Ratio Technique for Motor Method Ratings; D 2885, Test for Research and Motor Method Octane Ratings Using On-Line Analyzers; D 2886, Test for Knock Characteristics of Motor Fuels by the Distribution Octane Number Method; D 613, Test for Ignition Quality of Diesel Fuels by the Cetane Method; and D 909, Test for Knock Characteristics of Aviation Fuels by the Supercharge Method. The methods of test for each fuel type are followed by the appropriate set of annexes. V.P.

**A73-18436 Contribution to the protection of flight vehicles against lightning effects (Ein Beitrag zum Schutz von Flugkörpern gegenüber Blitzeinwirkungen).** W. Heise. *AEG-Telefunken, Technische Mitteilungen*, vol. 62, no. 7, 1972, p. 319-323. In German.

**A73-18482 Method of analysis and prediction for variable amplitude fatigue crack growth.** T. R. Porter (Boeing Co., Research and Engineering Div., Seattle, Wash.). *(Symposium on Fracture and Fatigue, George Washington University, Washington, D.C., May 3-5, 1972.) Engineering Fracture Mechanics*, vol. 4, Dec. 1972, p. 717-736.

In this analysis method, the crack growth rate is evaluated for each load cycle using a modification of the fracture mechanics correlation technique. The crack growth for each cycle was evaluated as a function of the stress intensity factor excursion with a correction factor for the maximum and minimum peak stress levels in the test spectrum. The fatigue crack growth correction for the peak stresses in the spectrum is given as a growth rate correction factor r. The relationship for r, is termed the 'fatigue crack growth rate interaction model.' For verification, the interaction model was applied to test data from spectrum loading tests. The correlation obtained for the example, indicated that the model properly predicts the interaction effects and its use could significantly improve the accuracy of crack growth life calculations for programmed spectrum tests. (Author)

**A73-18494 Fracture control for composite structures.** J. R. Eisenmann and B. E. Kaminski (General Dynamics Corp., Convair Aerospace Div., Fort Worth, Tex.). *(Symposium on Fracture and Fatigue, George Washington University, Washington, D.C., May 3-5, 1972.) Engineering Fracture Mechanics*, vol. 4, Dec. 1972, p. 907-913.

A fracture control technique for composite structures is presented which takes advantage of the unique capability of composite materials to be tailored in stiffness and fracture toughness. Crack arrestment is achieved through the use of integral 'buffer' strips in the primary load-carrying laminate. Experimental uniaxial tension data obtained from damaged laminates containing such buffer strips indicate residual strength capacity in excess of the limit design stress for the selected laminate. (Author)

**A73-18509** **Advances in helicopter avionics.** J. E. Nethaway (Royal Aircraft Establishment, Farnborough, Hants., England). *Aeronautical Journal,* vol. 76, Nov. 1972, p. 641-646.

The primary roles of the military helicopter are considered, giving attention to the reconnaissance operations of the army helicopter, the general support helicopter of the air force, and the antisubmarine warfare role of the navy. Helicopter radio communication systems are discussed together with surveillance systems, navigation approach systems, flight control systems, power/torque management systems, and navigation/attack systems. G.R.

**A73-18510** **Pressure airships - A review.** K. Hecks (Hawker Siddeley Dynamics, Ltd., Stevenage, Herts., England). *Aeronautical Journal,* vol. 76, Nov. 1972, p. 647-656. 11 refs.

The principles of operation for airships are examined, giving attention to engine power requirements and lift force in relation to airship size. For an airship, the need to minimize drag makes it necessary to provide a more streamlined shape than presented by the spherical form of a balloon. Aspects of aerodynamic control are discussed together with the location of the crew and passenger/cargo compartments, dynamic lift, performance, and trim. Problems of handling the airship are also considered, taking into account take-off, cruise, turning, landing, mooring, and operational procedures conducted to cope with weather effects. G.R.

**A73-18511** **SI units applied to aircraft performance calculations.** P. J. Wingham (Bath University of Technology, Bath, England). *Aeronautical Journal,* vol. 76, Nov. 1972, p. 657, 658.

In the field of aircraft performance, which embraces many of the activities of both the airframe and the engine manufacturers, it appears possible to choose advantageous multiples or submultiples of SI units for the quantities regarding force, pressure, and specific fuel consumption, which are all fundamental to aircraft design and testing. A case is made for the adoption of the kilonewton as the unit of aerodynamic force, thrust and weight, and the kilonewton per square meter as the unit of pressure wing loading. G.R.

**A73-18512** **Applications of shock expansion theory to the flow over non-conical delta wings.** L. C. Squire (Cambridge University, Cambridge, England). *Aeronautical Journal,* vol. 76, Nov. 1972, p. 659-662. 12 refs.

**A73-18514** **The use of model building in a production environment.** D. Fleming and R. M. Laing. *Aeronautical Journal,* vol. 76, Nov. 1972, p. 675-681.

Decision making problems regarding production tend to fall into two categories which are called strategic and operating. Three problems of the operating type and one of the strategic variety are discussed together with a particular problem of economic purchasing. The model developed makes use of a comprehensive production data processing system. Batching routines are considered together with risk horizons, price breaks, and the implementation of a pilot scheme. It is estimated that the new approach will result in a reduction in inventory of somewhat less than 15%. G.R.

**A73-18529** **The excess noise field of subsonic jets.** D. G. Crighton (Imperial College of Science and Technology, London, England). *Journal of Fluid Mechanics,* vol. 56, Dec. 28, 1972, p. 683-694. 13 refs. Research supported by the National Gas Turbine Establishment.

The sound field generated by the interaction of spatial instabilities on the shear layer shed from a duct with the nozzle lip is studied. It is shown that the intensity varies with direction theta from the exhaust and with the subsonic exhaust speed U according to I approximately equal to U to the 6th power(1 - cos theta)squared and I approximately equal to U to the 6th power sin squared theta for the axisymmetric and first azimuthal (sinuous) modes respectively. The first of these results is interpreted in terms of monopole and dipole sources at the exit plane, representing the acoustic effect of fluctuating mass flow and axial thrust across the exit plane, and the second in terms of a transverse dipole at the exit plane, corresponding to fluctuations in cross-stream thrust. A correlated thrust fluctuation of 1% is shown to overwhelm the jet mixing noise in the forward arc, theta greater than 90 deg, while the acoustic efficiency of the interaction process is never less than 10 to the minus 6th power times M cubed even under the cleanest possible exit conditions. It is suggested that much of the discrepancy between the noise fields of real engines and the predictions of Lighthill's theory of jet mixing noise - the so-called 'excess noise' problem - can be explained in terms of this interaction mechanism. (Author)

**A73-18538** **Description of the transfer of heat by natural convection in a horizontal porous layer with the help of a solid-fluid transfer coefficient (Description du transfert de chaleur par convection naturelle dans une couche poreuse horizontale à l'aide d'un coefficient de transfert solide-fluide).** M. Combarnous (Toulouse, Université, Toulouse, France). *Académie des Sciences (Paris), Comptes Rendus, Série A - Sciences Mathématiques,* vol. 275, no. 25, Dec. 18, 1972, p. 1375-1378. 7 refs. In French.

The concept of transfer coefficient is used for the modeling of thermoconvective motions in a porous medium. The information acquired, largely typical of experimental reality, demonstrates the influence on mean heat transfer of the degree of division of the medium and the thermal characteristics of the phases constituting it. It is noted, however, that the numerical values are sometimes distinctly lower than the experimental values. F.R.L.

**A73-18692** **Assembling by welding and bonding - Introductory report on assemblies (Les assemblages par soudage et collage Exposé introductif sur les assemblages).** R. Puydebois (Société Nationale Industrielle Aérospatiale, Paris, France). *(Société Française des Mécaniciens, Conférence d'Etude et d'Information, Paris, France, Mar. 21, 22, 1972.) Revue Française de Mécanique,* 2nd Quarter, 1972, p. 5-17. In French.

**A73-18710** # **Acoustic sounding of meteorological phenomena in the planetary boundary layer.** W. T. Cronenwett, G. B. Walker, and R. L. Inman (Oklahoma, University, Norman, Okla.). *Journal of Applied Meteorology,* vol. 11, Dec. 1972, p. 1351-1358. 16 refs.

Review of the potential of acoustic radar for indirect probing of meteorological phenomena in the planetary boundary layer, and summary of the relevant acoustical theory for sound scattering by regions of temperature fluctuations and reflection by airborne particulate matter. It is shown that the high sensitivity of acoustic radar to temperature and velocity fluctuations in comparison with radar or lidar and its low cost of construction and operation relative to alternative sounding methods make the technique attractive as a remote probe for boundary layer studies. M.V.E.

**A73-18720** **Polyimide composites development for aircraft structures.** R. Kollmansberger and E. Birchfield (McDonnell Aircraft Co., St. Louis, Mo.). *SAMPE Quarterly,* vol. 4, Jan. 1973, p. 28-39. Contract No. F33615-70-C-1546.

A program is described in which boron/PI and graphite/PI

structural parts were successfully fabricated on a production basis. The fabrication cycles for the polyimide composites were shortened to approach epoxy times. Low void contents were produced as evidence by the good matrix dependent properties. Potential problem areas are discussed, including prepreg manufacturing variables and the need for consistent quality control testing by the user. (Author)

**A73-18819 * Application of pole-placement theory to helicopter stabilization systems.** B. Sridhar and D. P. Lindorff (Connecticut, University, Storrs, Conn.). In: Hawaii International Conference on System Sciences, 6th, Honolulu, Hawaii, January 9-11, 1973, Proceedings. North Hollywood, Calif., Western Periodicals Co., 1973, p. 405-407. Grant No. NGL-07-002-002.

This paper is concerned with the problem of designing a controller for a complex dynamical system using output feedback. The system selected for the study is the Boeing-Vertol CH-46 tandem rotor helicopter. Feedback gains are obtained by a least square solution of the nonlinear equations derived from pole-placement theory. (Author)

**A73-18837 The use of aerosols for the visualization of flow phenomena.** O. M. Griffin and C. W. Votaw (U.S. Navy, Naval Research Laboratory, Washington, D.C.). *International Journal of Heat and Mass Transfer,* vol. 16, Jan. 1973, p. 217-219. 11 refs. Navy-supported research.

The effectiveness of a polydisperse liquid aerosol of DOP (di(2-ethylhexyl)-phtalate) as an indicator in the visualization of oscillatory and turbulent flows is demonstrated by photographs of the Karman vortex streets formed in the wakes of vibrating cables. The DOP aerosol is nontoxic and noncorrosive, and has a high flash point and chemical inertness. The aerosol generation and injection systems are described which in addition to simplicity and economy have the advantage of no moving parts, no need for ignition, combustion, and cooling of the tracer, and controllable particle size and mass. V.P.

# STAR ENTRIES

**N73-14000#** Advisory Group for Aerospace Research and Development, Paris (France).
**UNSTEADY AERODYNAMICS OF HELICOPTER ROTORS**
Oct. 1972 50 p refs Partly in ENGLISH; partly in FRENCH Presented at 34th AGARD Struct. and Mater. Panel Meeting, Lynbgy, Denmark, 11 Apr. 1972
(AGARD-R-595) Avail: NTIS HC $4.50

The proceedings of a conference on the unsteady aerodynamics of helicopter rotors are presented. Methods for improving the analytical prediction methods for assessing loads, loads, both static and dynamic, exerted on rotor blades are discussed. Test data to evaluate the effectiveness of current analytical design procedures are correlated with analytical methods. Modifications of design procedures for design of future aircraft are examined.

**N73-14001** Texas A&M Univ., College Station. Dept. of Aerospace Engineering Dept.
**UNSTEADY AERODYNAMICS OF HELICOPTER ROTORS**
W. P. Jones *In* AGARD Unsteady Aerodyn. of Helicopter Rotors Oct. 1972 23 p refs
(Grant DA-ARO(D)-31-124-71-G153)

Developments in the field of research on unsteady aerodynamics of helicopter rotors are presented. Advances in such problem areas as stall flutter of a retreating rotor blade, flutter of the advancing blade, transient effects due to the interaction of the tip-vortex of one blade with a following blade and wake induced instabilities in hovering and low speed flight are discussed. Attention is also drawn to aspects requiring additional research and, where possible, suggestions are made for new studies which could lead to further advancement of knowledge and understanding of the unsteady problems of helicopter rotor blades. Author

**N73-14002** Army Air Mobility Research and Development Lab., Moffett Field, Calif.
**DYNAMIC STALL OF AIRFOILS AND HELICOPTER ROTORS**
W. J. McCroskey *In* AGARD Unsteady Aerodyn. of Helicopter Rotors Oct. 1972 7 p refs

Model helicopter rotor tests to determine the characteristics of retreating blade stall are described. It is shown that the phenomenon may be modeled by the dynamic stall on an oscillating wing. The dynamic overshoot of the static stall conditions to show the shedding of a vortex-like disturbance from the leading edge is discussed. Application of classical static airfoil section data for predicting aerodynamic loads is explained. Author

**N73-14003** Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
**COMPUTATION OF UNSTEADY AERODYNAMIC FORCES ON HELICOPTER ROTOR BLADES**
Jean-Joel Costes *In* AGARD Unsteady Aerodyn. of the Helicopter Rotors Oct. 1972 16 p refs In FRENCH, ENGLISH summary

Numerical methods for determining the unsteady aerodynamic forces on helicopter rotor blades are presented. The calculation of the velocity potential induced by a lifting surface element when its position, orientation, and lift are known is developed as a function of time. The collocation method makes it possible to express the lift distribution as a function of the velocity component normal to the blades on a network of collocation points distributed on the rotor disc. A comparison between theory and experiment in the case of forward flight is provided. Author

**N73-14006*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**A PERTINENT SOLUTION OF HELICOPTER ROTOR FLAPPING STABILITY**
Wayne Johnson (Army Air Mobility R&D Lab., Moffett Field, Calif.) Jul. 1972 123 p refs
(NASA-TM-X-62165) Avail: NTIS HC $8.25 CSCL 01A

The stability of the flapping motion of a single blade of a helicopter rotor is examined using the techniques of perturbation theory. The equation of motion studied is linear, with periodic aerodynamic coefficients due to the forward speed of the rotor. Solutions are found for four cases: small and large advance ratio and small and large Lock number. The perturbation techniques appropriate to each case are discussed and illustrated in the course of the analysis. The application of perturbation techniques to other problems in rotor dynamics is discussed. It is concluded that perturbation theory is a powerful mathematical technique which should prove very useful in analyzing some of the problems of helicopter dynamics. Author

**N73-14007#** Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.
**THEORETICAL USE OF VARIABLE POROSITY IN SLOTTED TUNNELS FOR MINIMIZING WALL INTERFERENCE ON DYNAMIC MEASUREMENTS**
H. C. Garner London Aeron. Res. Council 1972 51 p refs Supersedes RAE-TR-71017; ARC-33053
(ARC-R/M-3706; RAE-TR-71017; ARC-33053) Avail: NTIS HC $4.75; HMSO £1.90; PHI $7.65

A theory for small frequency and subsonic compressible flow is extended to include a tunnel roof and floor with arbitrary slot and porosity parameters. With some allowance for wing span the wall-interference corrections to oscillatory lift and pitching moment are formulated and evaluated iteratively for two wings in pitching oscillation. The optimum wall porosity for low interference is found to be similar in theory and experiment for both wings over a range of Mach number. A recommended practical procedure for achieving this is extended to give residual corrections, but the span of a half-model should not exceed 40% of the tunnel breadth, nor should the planform area exceed 1t% of the working cross section. Author (ESRO)

**N73-14008#** Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.
**HEAT TRANSFER AND SURFACE PRESSURE MEASUREMENTS ON TWO CONICAL WINGS IN FREE FLIGHT UP TO M INFINITY = 4.5**
G. H. Greenwood London ARC 1972 59 p refs Supersedes RAE-TR-71087; ARC-33376
(ARC-CP-1212; RAE-TR-71087; ARC-33376) Avail: NTIS HC $5.00; HMSO 95p; PHI $3.90

Measurements in free flight at zero angle-of-attack have been made up to M infinity = 4.5 of the heat transfer rates and surface pressures for two conical wings having sharp leading edges, diamond cross-sections and aspect ratios of 1.0 and 2.3 respectively. The heating rates are shown to be generally in good agreement with theoretical values using the intermediate enthalpy method and the surface pressures are generally in good agreement with linearized theory. Author (ESRO)

**N73-14009#** Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.
**THE LONGITUDINAL STABILITY CHARACTERISTICS OF AN OGEE WING OF SLENDERNESS RATIO EQUALS 0.35**
A. G. Hepworth London Aeron. Res. Council 1972 21 p refs Supersedes RAE-TR-71103; ARC-33206
(ARC-CP-1227; RAE-TR-71103; ARC-33206) Avail: NTTIS HC $3.25; HMSO 35p; PHI $1.55

The lift, drag and pitching moment characteristics of an ogee wing of slenderness ratio = 0.35 have been measured in the 4 ft x 3 ft wind tunnel and the results and analysis are presented. The analysis extends the results already obtained on a previous generalized series of planforms. Author (ESRO)

**N73-14010#** Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.
**A RESULT CONCERNING THE SUPERSONIC FLOW BELOW A PLANE DELTA WINGS**
P. L. Roe London Aeron. Res. Council 1972 18 p refs Supersedes RAE-TR-72077; ARC-33828
(ARC-CP-1228; RAE-TR-72077; ARC-33828) Avail: NTIS HC $3.00; HMSO 35p; PHI $1.55

If a plane wing in inviscid supersonic flow supports an attached shockwave, the surface pressure distribution is uniform near the leading edges and nonuniform near the centerline. An expression is derived for the spanwise pressure gradient on the wing surface on the inboard side of the boundary between the uniform and nonuniform flows. The results supplement existing numerical solutions. Author (ESRO)

**N73-14011#** National Aerospace Lab., Amsterdam (Netherlands).
**UNSTEADY AERODYNAMICS AND ITS INTEGRATION IN AEROELASTIC ANALYSIS**
R. J. Zwaan 9 Nov. 1971 20 p refs Presented at the Colloq. on Aeroelasticity, Berlin, 1-2 Jul. 1971
(NLR-MP-71013-U) Avail: NTIS HC $3.00

For use in aeroelastic analysis various theoretical and experimental methods have become available to determine unsteady aerodynamic forces and pressure distributions specially on harmonic oscillating wings. Such methods are described to determine the unsteady pressure distribution and to estimate the empirical pressure distribution for required vibration modes. Methods are also described with examples of inttegration of experimental results in aeroelastic analysis. ESRO

**N73-14014#** Federal Aviation Administration, Washington, D.C. Office of Aviation Economics.
**MILITARY AIR TRAFFIC FORECAST, 1972 - 1983**
Nov. 1971 50 p
Avail: NTIS HC $4.50

Forecasts of military air traffic activity and of resulting Federal Aviation Administration workload for the period fiscal years 1972 through 1983 are presented. The report is based on the most reliable information currently available and is required for planning to meet the demands which the military services will place on the National Aviation System. On the basis of the trends evident in these key elements relating to Federal airways activity, the projections were developed showing expected military workload for the Federal Aviation Administration in terms of aircraft operations, aircraft contacted, and IFR aircraft handled. Author

**N73-14015*#** Serendipity, Inc., Arlington, Va. Eastern Operations Div.
**THE DEVELOPMENT OF HUMAN FACTORS RESEARCH OBJECTIVES FOR CIVIL AVIATION**
Theodore J. Post 30 Jun. 1970 122 p refs
(Contract NASw-1825)
Avail: NTIS HC $8.25 CSCL 01B

Human factors research programs which would support civil aviation and be suitable for accomplishment by NASA research centers are identified. Aviation problems formed the basis for the research program recommendations and, accordingly, problems were identified, ranked and briefly defined in an informal report to the project monitor and other cognizant NASA personnel. The sources for this problem foundation were literature reviews and extensive interviews with NASA and non-NASA personnel. An overview of these findings is presented. Author

**N73-14016#** National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
**AIR TAXI SAFETY STUDY**
27 Sep. 1972 72 p refs
(NTSB-AAS-72-9) Avail: NTIS HC $5.75

A special accident prevention study to determine the level of safety in air taxi/commuter operations; to identify the safety factors involved; and to make any necessary recommendations to enhance safety in air taxi/commuter operations is presented. A historical review of the air taxi industry, accident data, government regulation, results of a field investigation of a select number of representative air taxi/commuter operations, pertinent findings of a public hearing, and recommendations for accident prevention action are included. Author

**N73-14017#** National Transportation Safety Board, Washington, D.C.
**AIRCRAFT ACCIDENT REPORT: ALASKA AIRLINES INCORPORATED, BOEING 727, N2969G, NEAR JUNEAU, ALASKA, 4 SEPTEMBER 1971**
13 Oct. 1972 82 p refs
(NTSB-AAR-72-28) Avail: NTIS HC $6.25

A Boeing 727 crashed while attempting a nonprecision instrument approach to the Juneau Municipal Airport, Juneau, Alaska, on September 4, 1971. The flight had been cleared for a Localizer Directional Aid (LDA) approach to Runway 8 and had reported passing the final approach fix inbound to the airport. The aircraft struck a slope in the Chilkat Mountain range at about the 2,500-foot level on the approximate localizer course at a position 18.5 miles west of the airport. All 104 passengers and seven crewmembers were injured fatally. The aircraft was destroyed. The probable cause of this accident was a display of misleading navigational information concerning the flight's progress along the localizer course which resulted in a premature descent below obstacle clearance altitude. The origin of the erroneous navigational information could not be determined. The Board further concludes that the crew did not use all available navigational aids to check the flight's progress along the localizer nor were these aids required to be used. The crew also did not perform the required audio identification of the pertinent navigational facilities. Author

**N73-14018#** National Transportation Safety Board, Washington, D.C.
**SPECIAL STUDY, GENERAL AVIATION STALL/SPIN ACCIDENTS, 1967 - 1969**
13 Sep. 1972 115 p refs
(NTSB-AAS-72-8) Avail: NTIS HC $7.75

A discussion of stall/spin accidents and related statistics, and a series of statistical tables containing aircraft accident analysis data relative to a selected group of 991 stall/spin accidents which occurred during the period 1967 to 1969 inclusive are presented. The study is based on 37 small, fixed-wing, U.S. general aviation aircraft. The data tabulated include the numbers of injuries, kind of flying, phase of operation, detailed accident causes, pilot certificate, experience, etc., and a summary of significant, statistical findings is presented. Selected Briefs of Accidents are included, and an evaluation is made of the relative frequency of occurrence of stall/spins involving each airplane. Other types of accidents which preceded or were associated with a stall/spin, are also considered in connection with their broad and detailed causes and related factors. Author

**N73-14019#** National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
**BRIEFS OF AIRCRAFT ACCIDENTS INVOLVING TURBINE POWERED AIRCRAFT, US GENERAL AVIATION, CALENDAR YEAR 1970**
Dec. 1972 65 p
(NTSB-AMM-72-6) Avail: NTIS HC $5.25

Statistical, cause/factor and injury tables, accident rates and the briefs of accidents involving turbine powered aircraft in 1970 are presented. Author

**N73-14020*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**LONGITUDINAL AERODYNAMIC AND PROPULSION**

**CHARACTERISTICS OF A PROPULSIVE-WING V/STOL MODEL AT HIGH SUBSONIC SPEEDS**
Leland B. Salters, Jr. and James W. Schmeer Washington Jan. 1973 76 p refs
(NASA-TM-X-2693; L-8500) Avail: NTIS HC $3.00 CSCL 01B

The aerodynamic and propulsion characteristics of a 1/6-scale propulsive-wing V/STOL air-powered model was investigated over the Mach number range from 0.40 to 0.96 and at angles of attack from -5 deg to 15 deg for several fan rotational speeds. Three fanduct-exit configurations were tested, including two exit areas. The model with 25-percent-thick wing had a drag-rise Mach number of 0.85, which is typical of aircraft with thinner, conventional, unswept wings. Author

**N73-14021#** Deutsche Gesellschaft fuer Luft- und Raumfahrt, Cologne (West Germany).
**FLIGHT MECHANICS OF ROTOR AIRCRAFT [FLUGMECHANIK DER DREHFLUEGELFLUGZEUGE]**
Aug. 1971 127 p refs In GERMAN; ENGLISH summary
Proc. of the DGLR Symp. held at Stuttgart, 6 Nov. 1969
(DLR-Mitt-71-15) Avail: NTIS HC $8.50; ZLDI Munich: 26.70 DM

A theoretical investigation comparing the yaw maneuverability of various types of helicopters is reported. Calculation of the behavior of helicopters in autorotation is described. The simulation of a tied down helicopter by means of a hybrid computer is treated. Two exact theories for rotor wake calculations are compared. ESRO

**N73-14022** Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany).
**COMPARATIVE STUDY OF THE YAW MANEUVERABILITY OF HELICOPTERS IN GLIDING FLIGHT [VERGLEICHENDE BETRACHTUNGEN UEBER DIE HOCHACHSENSTEUERUNG VON HUBSCHRAUBERN IM SCHWEBEFLUG]**
P. Oelker and H. E. Schmidt *In* DGLR Flight Mech. of Rotor Aircraft Aug. 1971 p 7-38 refs In GERMAN

A theoretical investigation of the yaw maneuverability of several helicopters in gliding flight is presented. Shaft driven and reaction driven helicopters are compared as regards flight specifications about the vertical axis. Yaw control of shaft driven helicopters with the tail rotor is calculated according to rough formulas as well as with a digital computer program to determine the motion behavior. For reaction driven helicopters similar calculations were done with certain assumptions concerning torque production. The digital computation of the motion control about the vertical axis was carried out using an analytical pilot function in the system of motion equations. ESRO

**N73-14023** Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany).
**DETERMINATION OF THE AUTOROTATION BEHAVIOR OF HELICOPTERS USING THE BO 105 AS AN EXAMPLE [ERMITTLUNG DES AUTOROTATIONSVERHALTENS VON HUBSCHRAUBERN AM BEISPIEL DER BO-105]**
H. Huber *In* DGLR Flight Mech. of Rotor Aircraft Aug. 1971 p 39-71 refs In GERMAN

Motion calculations were carried out for helicopters in the autorotation phase. The motions of helicopter and rotor are described with six translational and rotational degrees of freedom, flapping rotor blades, and variable speeds of revolution. Non-linear air loads with breakaway, rear incident flow, and Mach number effects in rotor aerodynamics, and in wing and tailplane aerodynamics, are considered. The general autorotation properties of the BO-105, predicted from known criteria (Katzenberg factor), are discussed in connection with the calculations. The feasibility of the program and the obtainable results are demonstrated by sample calculations. The properties of the changeover behavior, the approach, and the autorotation landing are discussed in detail. ESRO

**N73-14024** Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).
**HYBRID SIMULATION OF A TIED DOWN HELICOPTER [HYBRIDSIMULATION EINES GEFESSELTEN HUBSCHRAUBERS]**
W. Dusold *In* DGLR Flight Mech. of Rotor Aircraft Aug. 1971 p 75-88 In GERMAN

The real time simulation of a tied down helicopter on a hybrid computer to investigate the optimal stability control settings for all three axes is described. The stability controller is mounted on a three axis table, and reacts to its motion with electric signals to the servomotors of the cyclic blade adjustment in pitch and roll. The influence of yaw motion can be neglected as a result of the lack of flight mechanical coupling. The servomotor displacements are measured electrically, digitized and fed to the digital part of a hybrid computer. The computer determines in real time the magnitudes of motion of the mathematical model of rotor, airframe and cable, and transfers them to the three axis table through a digital-to-analog converter. This closes the control loop. ESRO

**N73-14025** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Stuttgart (West Germany). Inst. fuer Drehfluegelflugzeuge.
**RESULTS OF THE MILLER AND SCULLY THEORIES OF ROTOR DOWNWASH [ERGEBNISSE DER THEORIE DER ROTORDURCHSTROEMUNG NACH MILLER AND SCULLY]**
J. W. Fuhr *In* DGLR Flight Mech. of Rotor Aircraft Aug. 1971 p 91-122 refs In GERMAN

Several methods of helicopter rotor wake calculation are considered and their results are compared, based on the uniform distribution of induced velocity over the circular surface of the rotor according to the momentum theory. The methods discussed are: (1) simplified theories such as the momentum theory with constant flow rate, (2) the Glauert-Payne theory, (3) the cylindrical wake theory; and (4) exact theories based on vortex models such as the Miller theory and the Scully theory. The calculations based on the last two theories were plotted graphically, and it is shown that both theories produce similar results. The Miller method is found to be simpler, and is 15-20 times shorter in computing time than the Scully method, which is more exact. ESRO

**N73-14026#** Royal Aircraft Establishment, Farnborough (England).
**MULTIVARIATE ANALYSIS APPLIED TO AIRCRAFT OPTIMISATION. SOME EFFECTS OF RESEARCH ADVANCES ON THE DESIGN OF FUTURE SUBSONIC TRANSPORT AIRCRAFT**
D. L. I. Kirkpatrick and D. H. Peckham Sep. 1972 28 p refs Presented at the DGLR Conf., Berlin, 4-6 Oct. 1972
(RAE-TM-AERO-1448; DGLR-Paper-72-93) Avail: NTIS HC $3.50

The development of a computer program is described which can find the optimum design of a subsonic swept-wing jet transport aircraft and can be used to assess rapidly the effect on this design of changes in the specified performance and of advances in aeronautical science. The effects of advances in aerodynamic, structural, and propulsion technology on the design and performance of the optimum aircraft are presented and discussed. Author (ESRO)

**N73-14027#** Royal Aircraft Establishment, Farnborough (England). Structures Dept.
**AERODYNAMIC DATA FOR THE BAC 221 UP TO A MACH NUMBER OF 0.955 AS MEASURED IN WIND-TUNNEL TESTS**
Dorothy M. Holford London Aeron. Res. Council 1972 69 p refs Supersedes RAE-TR-70252; ARC-33464
(ARC-CP-1230; RAE-TR-70252; ARC-33464) Avail: NTIS HC $5.50; HMSO £1.10; PHI $4.30

The results of various wind-tunnel tests have been used to produce a set of aerodynamic data (longitudinal and lateral data, lateral oscillary derivatives and aileson and rudder powers) for

the BAC 221 at Mach numbers from 0.2 to 0.955. The data have been reduced to the reference condition used by BAC, viz. S = 448 sq ft and a CG position 154 in forward of the datum, on the body datum. Data for both clean and approach configurations are presented. Author (ESRO)

**N73-14028#** Kaman Aerospace Corp., Bloomfield, Conn.
**DESIGN STUDY OF REPAIRABLE MAIN ROTOR BLADES Final Report**
Paul F. Maloney and Carrol R. Akeley Jul. 1972 262 p refs
(Contract DAAJ02-70-C-0070; DA Proj. 1F1-62203-A-119)
(AD-749283; R-928; USAAMRDL-TR-72-12) Avail: NTIS CSCL 01/3

The report presents the results of a design study of repairable main rotor blades. The designs studied are applicable to the Army's UH-1H helicopter with semirigid teetering rotor system. The program included development of analysis methodology, including a model for rotor blade life cycle costs, establishment of design concepts, analysis of these concepts from both a technical and cost viewpoint, and selection of a final recommended configuration for future development. As partial support for the concept of field repairability of rotor blades, an experimental evaluation of a major repair was conducted under simulated field conditions. GRA

**N73-14029#** United Aircraft Corp., Stratford, Conn. Sikorsky Aircraft Div.
**S-67 AIRCRAFT FEEL AUGMENTATION SYSTEM FLIGHT EVALUATION Final Report**
Sean J. OConnor and Donald W. Fowler Aug. 1972 68 p
(Contract DAAJ02-71-C-0034; DA Proj. 1F1-63204-D-157)
(AD-749284; SER-67009; USAAMRDL-TR-72-41) Avail: NTIS CSCL 01/3

A flight test program has been conducted to evaluate improvements in handling qualities of the S-67 resulting from the addition of a Feel Augmentation System (FAS). The pitch channel of FAS applies to the cyclic stick, a force proportional to the load factor resulting from aircraft pitch rate. Roll FAS provides control harmony, and the collective stick shaker warns of high rotor control loads. Subjective reactions of contractor test pilots, combined with flight test results, indicated that a satisfactory load factor force gradient was 18-25 pounds per g. Furthermore, this nearly constant force gradient was insensitive to changes in airspeeds, collective setting, or attitude during maneuvers. Author (GRA)

**N73-14030#** Northrop Corp., Hawthorne, Calif. Aircraft Div.
**PREDICTION AND EVALUATION OF FLYING QUALITIES IN TURBULENCE Final Report, 4 Dec. 1970 - 4 Oct. 1971**
Edward D. Onstott, Ernest P. Salmon, and Ralph L. McCormick Feb. 1972 386 p refs
(Contract F33615-71-C-1076; AF Proj. 8219)
(AD-749480; NOR-71-139; AFFDL-TR-71-162) Avail: NTIS CSCL 01/3

A method for predicting tracking performance of Class 4 airplanes in turbulence has been validated through a moving-base simulation of 16 F-5 and A-7 configurations on the Northrop Large Amplitude Flight Simulator. The method is based on pilot model theory and predicts root mean square tracking errors for piloted tasks in turbulence. Both lateral and longitudinal dynamics are considered, and the accuracy of the method is assessed. Specification design criteria are evolved from the simulation data for bank angle and pitch angle attitude hold tasks in turbulence. Digital programs that perform the prediction calculations accept arbitrary equations of motion and are available on request from the United States Air Force; a user's guide is included in the report, along with complete tracking error, gust level, and pilot rating data from the simulation. Author (GRA)

**N73-14031#** Space and Missile Systems Organization, Detachment 2, Houston, Tex.
**A SELF-GENERATING OVERHEAT DETECTION SYSTEM FOR USE ON USAF AIRCRAFT Final Report, 16 Feb. 1970 - 30 Sep. 1972**
Otto Riemer Sep. 1972 135 p refs
(Contract F33615-70-C-1271; AF Proj. 3048)
(AD-749474; AFAPL-TR-72-73) Avail: NTIS

The report describes the development, design, fabrication and testing of a self-generating overheat detection system for USAF aircraft. The system consists of a loop sensor cable connected by way of a junction box and thermocouple type extension wires to a control unit. The developed sensor consists of a continuous coaxial cable which changes its electrical properties as cable temperature is changed. Here, cable thermoelectric voltage as well as impedance is utilized in establishing alarm signal levels. Theoretical work involving such factors as thermocouple signal transmission and detection, together with an investigation of cable materials and electronic componentry available for aircraft use is described. Author (GRA)

**N73-14032#** Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
**FLIGHT CONTROL PRINCIPLES FOR CONTROL CONFIGURATION VEHICLES Final Report**
Edmund G. Rynaski Jan. 1972 99 p refs
(Contract F33615-71-C-1238; AF Proj. 8226)
(AD-749479; CAL-TB-3052-F-1; AFFDL-TR-71-154) Avail: NTIS CSCL 01/3

The compatibility between maneuver load control, relaxed static stability, and flying qualities requirements is investigated in the report. Three steps were involved in the investigation: an analysis was made of control surface combinations and their effectiveness for maneuver load control when used with an airplane having shortened tail length and reduced tail surface area, control system configurations were synthesized that minimize a weighted measure of change in drag, wing root bending moment, control surface activity and response error between a Level 1 flying qualities model and the actual T-33 airplane; and a direct optimization of the tail length, tail area and control surface deflections required to obtain a compatible compromise of the CCV objectives was performed. Author (GRA)

**N73-14033#** Army Engineer Topographic Labs., Fort Belvoir, Va.
**STUDIES OF THE ARMY AVIATION (V/STOL) ENVIRONMENT. REPORT NO. 1: POTENTIAL SAND AND DUST SOURCE AREAS Final Report**
Howard L. Ohman, John Viletto, Jr., Kenneth T. Anderson, and L. LeForest Miller Aug. 1972 37 p refs
(AD-749462; ETL-SR-72-1) Avail: NTIS CSCL 01/3

The report delineates world patterns of various soil types that have a potential for the generation of atmospheric sand and dust either through natural causes or man-induced mechanical agitation. This is done by three maps: one showing soil types as determined by classes of particle size; a second showing seasonal durations of wet, moist, and dry soil conditions; and a third portraying the distribution of siliceous, vitreous, saline, and acidic soils, soils with high percentages of iron and aluminum, and soils consisting largely of montmorillonitic clays. The maps provide the basis for a realistic assessment of Army aircraft design problems which can be attributed to sand and dust. Additionally, they contribute to the total store of environmental information needed to determine the environmental criteria to be adopted for the design and testing of Army V/STOL aircraft systems. Author (GRA)

**N73-14034#** Army Engineer Topographic Labs., Fort Belvoir, Va. 01/3
**STUDIES OF THE ARMY AVIATION (V/STOL) ENVIRONMENT. REPORT NO. 2: PARTICULATE MATTER CONSIDERATIONS IN THE DESIGN OF V/STOL AIRCRAFT Final Report**
John Viletto, Jr. and Howard L. Ohman Aug. 1972 43 p
(AD-749463; ETL-SR-72-2) Avail: NTIS

Existing criteria reflected in military specifications and standards and design guides are inadequate for V/STOL aircraft. The present criteria for helicopter design and testing are those which evolved and have been used over several years for U. S.

Air Force fixed-wing aircraft. The helicopter takeoff and landing environment, particularly airborne particle concentration, is markedly more severe than that for fixed-wing aircraft. This report presents data and conclusions which can be used to establish design and testing criteria for future V/STOL aircraft.
Author (GRA)

N73-14035# Lockheed-Georgia Co., Marietta.
**THE GENERATION AND RADIATION OF SUPERSONIC JET NOISE. VOLUME 1: SUMMARY OF SUPERSONIC JET NOISE STUDIES Final Technical Report, 1 May 1971 - 31 May 1972**
Harry E. Plumblee and Philip E. Doak Jul. 1972 47 p
(Contract F33615-71-C-1663; AF Proj. 3066)
(AD-749428; AFAPL-TR-72-53-Vol-1) Avail: NTIS CSCL 20/1

This is a summary report of the results of a 13-month research program on the generation and reduction of supersonic jet noise. This program was planned as the first phase of a four-phase effort. Tasks compromising this Phase 1 program were as follows: reviews and evaluation of existing theoretical models for supersonic jet noise generation and radiation; development of the framework of a new, unified theory of aerodynamic noise; development of a new theoretical model of turbulent mixing region noise; development of a new theoretical model for calculating progagation and radiation of upstream noise; a preliminary review of combustion noise; tests on turbulent mixing region noise and shock-associated noise; review of the problems of jet flow measurement and analysis; development of new instrumentation for jet flow measurement; establishment of full facilities for the total program; formulation of the program for future studies. Author (GRA)

N73-14036# Lockheed-Georgia Co., Marietta.
**THE GENERATION AND RADIATION OF SUPERSONIC JET NOISE. VOLUME 2: FUTURE STUDIES FOR DEFINITION OF SUPERSONIC JET NOISE GENERATION AND REDUCTION MECHANISMS Final Technical Report, 1 May 1971 - 31 May 1972**
Harry E. Plumblee and Robert H. Burrin Jul. 1972 47 p refs
(Contract F33615-71-C-1663; AF Proj. 3066)
(AD-749137; AFAPL-TR-72-53-Vol-2) Avail: NTIS CSCL 20/1

The report contains a detailed list of proposed recommendations for work necessary to attain the goal of developing technology for significantly reducing supersonic aircraft propulsion system noise. The recommendations and proposed work task are based on the research findings reported in Volume 1 and Volumes 3-6 of this report. Recommendations for experimental and theoretical studies of turbulent-mixing jet noise, shock-associated noise and upstream noise are detailed in the technical plan. Also recommendations for improvements in instrumentation and noise suppression studies are listed. Author (GRA)

N73-14037# Lockheed-Georgia Co., Marietta.
**THE GENERATION AND RADIATION OF SUPERSONIC JET NOISE. VOLUME 3: PROGRESS TOWARD A UNIFIED THEORY OF JET ENGINE NOISE Final Technical Report, 1 May 1971 - 31 May 1972**
Philip E. Doak Jul. 1972 152 p refs
(Contract F33615-71-C-1663; AF Proj. 3066)
(AD-749138; AFAPL-TR-72-53-Vol-3) Avail: NTIS CSCL 20/1

Existing theories of aerodynamic noise generation are critically reviewed with special emphasis on conceptual adequacy and physical scope with special reference to supersonic jet noise. In this review the basic work of Stokes, Kirchoff and Rayleigh on fluctuating motions in fluids is recalled and developed to provide a firm basis for the critique. The advantages and disadvantages of acoustic analogy theories such as Lighthill's are thoroughly discussed in Section 11.3. A contribution is made towards removing the criticisms made by Lighthill of Ribner's isotropic source tensor theory. New developments such as those by Crow, Lilley and Doak are emphasized. On the basis of the evidence provided by the critical review, a new unified theory for jet noise has been devised. Author (GRA)

N73-14038# Lockheed-Georgia Co., Marietta.
**THE GENERATION AND RADIATION OF SUPERSONIC JET NOISE. VOLUME 4: THEORY OF TURBULENCE GENERATED JET NOISE, NOISE RADIATION FROM UPSTREAM SOURCES, AND COMBUSTION NOISE Final Technical Report, 1 May 1971 - 31 May 1972**
Geoffrey M. Lilley, Harry E. Plumblee, Warren C. Strahle, Song-Yeong Ruo, and Philip E. Doak Jul. 1972 189 p refs
(Contract F33615-71-C-1663; AF Proj. 3066)
(AD-749139; AFAPL-TR-72-53-Vol-4) Avail: NTIS CSCL 20/1

The report presents a series of specific theoretical studies directed toward the solution of jet noise generation and radiation, upstream noise radiation and combustion noise generation. Three theories are presented. Lilley's work is a new theory of jet noise generation, based on identification of acoustic and source generation terms. The acoustic converted wave equation derived includes the Pridmore-Brown/Mungur shear refraction term. Plumblee presents a theoretical analysis and numerical solution techniques for solving for the radiation field from a source within a jet flow and specifically deals with radiation from an acoustic distribution initally specified at the end of a circular exhaust duct termination through the jet flow to the surrounding medium. Finally, Strahle presents a theory on afterburner type combustion noise generation and radiation. Order of magnitude analyses are made in an attempt to estimate acoustic power levels and refraction effects are also investigated. Author (GRA)

N73-14039# Lockheed-Georgia Co., Marietta.
**THE GENERATION AND RADIATION OF SUPERSONIC JET NOISE. VOLUME 5, APPENDIX 1: TURBULENCE MIXING REGION NOISE DATA Final Technical Report, 1 May 1971 - 31 May 1972**
Robert H. Burrin, Peter A. Lush, and George A. Wynne Jul. 1972 578 p
(Contract F33615-71-C-1663; AF Proj. 3066)
(AD-749141; AFAPL-TR-72-53-Vol-5-App-1) Avail: NTIS CSCL 20/1

A series of experiments was conducted for the purpose of clearly isolating and quantifying the noise sources associated with supersonic jet noise and for establishing the effect of refraction on the radiated field of these sources, as well as establishing the range of validity of available theoretical formulas for predicting the radiation field characteristics of these sources. Turbulent mixing region noise from a fully expanded supersonic flow exhausting from a well designed convergent-divergent nozzle was measured over a very wide range of operational parameters. This Appendix contains computer printouts obtained from a jet noise data analysis program for turbulent mixing region noise.
Author (GRA)

N73-14040# Lockheed-Georgia Co., Marietta.
**THE GENERATION AND RADIATION OF SUPERSONIC JET NOISE. VOLUME 5, APPENDIX 2: SHOCK ASSOCIATED NOISE DATA Final Technical Report, 1 May 1971 - 31 May 1972**
Peter A. Lush and Robert H. Burrin Jul. 1972 244 p
(Contract F33615-71-C-1663; AF Proj. 3066)
(AD-749142; AFAPL-TR-72-53-Vol-5-App-2) Avail: NTIS CSCL 20/1

A series of experiments was conducted for the purpose of clearly isolating and quantifying the noise sources associated with supersonic jet noise and for establishing the effect of refraction on the radiated field of these sources, as well as establishing the range of validity of available theoretical formulas for predicting the radiation field characteristics of these sources. Shock-associated noise, both discrete and broadband, was investigated thoroughly. This Appendix contains sequences of data in the form of narrow band spectra illustrating the existence of these types of shock associated noise in the jet flows investigated. Author (GRA)

N73-14041# Lockheed-Georgia Co., Marietta.
**THE GENERATION AND RADIATION OF SUPERSONIC JET NOISE. VOLUME 6: JET FLOW MEASUREMENT AND ANALYSIS WITH SPECIAL EMPHASIS ON REMOTE SENSING DEVICES. CROSSED BEAM SCHLIEREN, LASER DOPPLER VELOCIMETER, PULSED LASER INTERFEROMETER Final Technical Report, 1 May 1971 - 31 May 1972**
Michael J. Fisher, William T. Mayo, Donald M. Meadows, Robert H. Burrin, and George E. Beisel Jul. 1972 320 p refs
(Contract F33615-71-C-1663; AF Proj. 3066)
(AD-749143; AFAPL-TR-72-53-Vol-6) Avail: NTIS CSCL 20/1

The report describes three remote sensing devices developed to measure jet exhaust fluctuating density gradients, mean and turbulent velocity and mean temperature are described. These instruments are a crossed-beam schlieren, a laser Doppler velocimeter, and a pulsed laser interferometer. A jet turbulence facility was developed, along with five 2 inch diameter jet nozzles (one convergent and four con-div, up to Mach 2.0), for the purpose of providing laboratory controlled conditions, in order to properly evaluate the remote sensing instruments.
Author (GRA)

N73-14042# General Dynamics/Fort Worth, Tex. Aerospace Div.
**DEVELOPMENT OF THEORETICAL METHOD FOR TWO-DIMENSIONAL MULTI-ELEMENT AIRFOIL ANALYSIS AND DESIGN. PART 1: VISCOUS-FLOW ANALYSIS METHOD Final Report, 24 May 1971 - 12 Jun. 1972**
Ishwar C. Bhateley and Jack W. McWhirter Aug. 1972 379 p refs
(Contract F33615-71-C-1597; AF Proj. 1366)
(AD-749484; AFFDL-TR-72-96-Pt-1) Avail: NTIS CSCL 01/3

A method has been developed for the analysis of arbitrary multi-element airfoils in viscous flow. The viscous solution is obtained through an inviscid analysis of an equivalent system defined from viscous considerations. An iterative procedure has been formulated to implement this analysis. The inviscid solution is obtained through a distributed singularity method. A finite-difference method is used to determine boundary-layer characteristics. Methods are included to predict laminar-flow bubbles and separation and transition points. The equivalent airfoil is defined for airfoils with attached flow as well as for airfoils with flow separation. The validity of the method is established through comparison of the predicted results with experimental data for several single- and multi-element airfoils. The comparisons show good agreement for lift coefficient and maximum lift coefficient and fair agreement for drag and pitching moment coefficients. Details of the computer program developed to implement this method are described, including input and output details, FORTRAN source deck listing, and a sample problem.
Author (GRA)

N73-14043# General Dynamics/Fort Worth, Tex. Aerospace Div.
**DEVELOPMENT OF THEORETICAL METHOD FOR TWO-DIMENSIONAL MULTI-ELEMENT AIRFOIL ANALYSIS AND DESIGN. PART 2: LEADING-EDGE SLAT DESIGN METHOD Final Report, 24 May 1971 - 12 Jun. 1972**
O. Wayne McGregor and Jack W. McWhirter Aug. 1972 86 p refs
(Contract F33615-71-C-1597; AF Proj. 1366)
(AD-749485; AFFDL-TR-72-96-Pt-2) Avail: NTIS CSCL 01/3

A method has been developed for the design of leading-edge slats that produce a specified pressure distribution on the main airfoil. The method of distributed singularities is applied in a unique manner. The airfoil is represented in the conventional manner by a vortex sheet having the same shape as the airfoil. The slat is represented by a vortex sheet and a source line. The source line provides the slat thickness; the vortex sheet provides the camber. A closed slat shape is guaranteed by requiring that the net mass added to the system be zero and that the stream function at the slat leading-edge stagnation point have the same value as at the trailing edge. It was found that valid solutions are possible only when the source line at least approximates a streamline generated by the airfoil without the slat. The slat shape is computed by locating the body streamline of the slat. A constrained least-square analysis provides this definition. Several sample designs are discussed. Detailed instructions for application of the method are provided. Details regarding the associated computer program are included.
Author (GRA)

N73-14044# Beta Industries, Inc., Dayton, Ohio.
**A STATISTICAL INVESTIGATION INTO THE DEVELOPMENT OF ENERGY ABSORBER DESIGN CRITERIA Final Report**
Norman S. Phillips, Richard W. Carr, and Richard S. Scranton 30 Dec. 1971 82 p refs
(Contract N00156-71-C-0669)
(AD-749333; BII-217-5; NADC-CS-7122) Avail: NTIS CSCL 01/3

A Statistical technique for evaluating the injury reduction capability of energy absorbers was developed. Existing statistical data on crash accelerations and man-weight distributions were used as inputs to a MIMIC computer program. A Dynamic Response Index (D.R.I) and stroke length were computed for each acceleration man-weight combination. The joint probability for each acceleration, man-weight, DRI combination was figured. The summation of all such combinations produced a cumulative probability of injury for the specific energy absorber. The waveform of the force deflection curve of the energy absorber was varied to determine the effect on cumulative probability of injury and required stroke length. The results of the program can be used as a guideline in selecting candidate energy absorbers and the technique developed is appropriate for evaluating the absorbers so selected.
Author (GRA)

N73-14045# Aerospace Medical Research Labs., Wright-Patterson AFB, Ohio.
**LONG-LINE LOITER PERSONNEL RETRIEVAL SYSTEM: TRIAXIAL ACCELERATION TESTS Final Report, Nov. 1969 - Jun. 1970**
Edward A. Behling, Richard B. Pilmer, and Eric J. Jumper May 1972 50 p refs
(AF Proj. 7184)
(AD-749518; AMRL-TR-70-104) Avail: NTIS CSCL 01/3

The report describes the feasibility of using a fixed-wing aircraft, employing free-fall and circling-line techniques, to rescue personnel or retrieve equipment from the ground. The technique involves deploying a line from the aircraft while a controlled turn is maintained, causing the line to describe a diminishing spiral earthward. As a continuation of the efforts described in AMRL-TR-69-140, this report describes measurements of launch g forces and of line tensions in recovering 185 to 231-pound dummies. For 7 launches, the mean total g was 01.7 plus or minus .19 g/sec. Line tension at the aircraft was 360-645 pounds at launch and from 245-410 pounds when the dummy was in trail behind the aircraft. Results suggest that this method of retrieval is feasible for human subjects or equipment with regard to stability and g load at launch.
Author (GRA)

N73-14046# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
**JET BLAST HAZARDS**
6 Jul. 1972 30 p
(PB-211593; NTSB-AAS-72-7) Avail: NTIS HC $3.00 CSCL 01B

The report encompasses a broad review of hazards directly related to inadvertent use of jet thrust power and its adverse effects on other aircraft, airport-ramp personnel, passengers and airport equipment. These jet-blast hazards are illustrated by a representative number of accidents and incidents. The report also includes photographs of damaged aircraft, airport properties and equipment. Attached to the report is a computer readout of all accidents reported to the National Transportation Safety Board, with jet blast as a probable cause. For more specific information on jet blast vs. distance, there are two graphic drawings of three-and-four-engine wide-body jet blast profiles. Jet blast ready-reference 'tear out' cards also are attached for the convenience of the reader.
Author (GRA)

N73-14047# National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
**AIRCRAFT ACCIDENT REPORTS: BRIEF FORMAT, US CIVIL AVIATION. ISSUE NUMBER 5: 1970 ACCIDENTS**
27 Mar. 1972 379 p
(PB-211158; NTSB-BA-72-2) Avail: NTIS HC $6.00 CSCL 01B

The publication contains selected aircraft accident reports, in brief format, occurring in U.S. Civil Aviation operations during calendar year 1970. The 1000 General Aviation accidents contained in the publication represent a random selection. The brief format presents the facts, conditions, circumstances, and probable cause(s) for each accident. Additional statistical information is tabulated by type of accident, phase of operation, kind of flying, injury index, aircraft damage, conditions of light, pilot certificate, injuries, and causal factors. Author (GRA)

N73-14048# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**INDUCED VELOCITIES OF FREE WING VORTICES WITH A CURVED AXIS IN A PLANE**
K. I. Kondrat 4 Aug. 1972 11 p refs Transl. into ENGLISH from Tr. Leningrad. Vysshee Aviationnoe Uchilishche Grazhdanskoi Aviatsii (Leningrad), no. 24, 1965 p 82-86
(AD-749843; FTD-MT-24-182-72) Avail: NTIS CSCL 01/3

The report calculates induced velocities of a wing with a curved axis not perpendicular to the velocity of the incoming flow. The velocity produced at each point of the surrounding space by the wing vortex system will consist of two parts: the velocity created by the vortex sheet and the velocity created by the lifting vortex line. The calculation of the velocity created by the wing vortices is the content of this article. Author (GRA)

N73-14049# Transportation Systems Center, Cambridge, Mass.
**THE NOISE EXPOSURE MODEL MOD-5, VOLUME 1**
J. Taub, T. Foreman, and B. Brownfield Jun. 1972 93 p refs 2 Vol.
(PB-211979; DOT-TSC-OST-72-5-Vol-1) Avail: NTIS HC $3.00 CSCL 13B

The report contains three sections. The first two sections are contained in Volume 1. It contains an airport analysis which describes the noise exposure model MOD-5 from the perspective of analysing an airport in order to develop the program input model, and a user's manual which describes the process of developing the input model for the noise exposure model. GRA

N73-14050# Transportation Systems Center, Cambridge, Mass.
**THE NOISE EXPOSURE MODEL MOD-5, VOLUME 2**
J. Taub, T. Foreman, and B. Brownfield Jun. 1972 173 p 2 Vol.
(PB-211976; DOT-TSC-OST-72-5-Vol-2) Avail: NTIS HC $3.00 CSCL 13B

The volume is a programmer's manual describing the noise exposure model MOD-5 computer program. Volume 2 has been revised in 1972 to correct inconsistencies in the initial version. The NEM-5 computer program is written in FORTRAN 4 for the IBM 360/75 computer. The program uses some special subroutines, which are not included. GRA

N73-14051# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**APPLICATION OF THE WING IMPULSE THEORY TO THE DETERMINATION OF PROPELLER SLIP STREAM INFLUENCE ON WING AERODYNAMIC CHARACTERISTICS**
G. N. Kopylov 4 Aug. 1972 36 p refs Transl. into ENGLISH from Tr. Vysshee Aviationnoe Uchilishche Grazhdanskoi Aviatsii (USSR), no. 24, 1965 p 24-43
(AD-749726; FTD-HT-23-181-72) Avail: NTIS CSCL 01/3

The report analyzes the influence of propeller slip-stream on the aerodynamic characteristics of a wing while the propeller operates in place and under conditions of external incoming flow is determined by the impulse theory of an airfoil of finite span. The results are compared to both those obtained by the Possio experiment and those obtained by a specially conducted experiment with high relative loads on the propeller-disk area. The results of this work can be used when calculating the influence of flow from a propeller at any subsonic flight speeds under draft design conditions. Author (GRA)

N73-14052# Winzen Research, Inc., Minneapolis, Minn.
**DESIGN AND FABRICATION OF A BALLOON FOR POWDERED FLIGHT IN THE MINIMUM WIND FIELD Final Report, 19 Apr. - 31 Aug. 1972**
Jean R. Nelson and Peter J. Osborne 12 Oct. 1972 9 p
(Contract F19628-72-C-0318)
(AD-750542; AFCRL-72-0487) Avail: NTIS CSCL 01/3

The project was concerned with the design and fabrication of a balloon capable of carrying a 3500 lb. payload at an altitude of 60,000 feet to demonstrate the feasibility of powering a free balloon near the minimum wind field. For this purpose five balloons were fabricated based on a design in accordance with the specifications of Section F of The Schedule. The balloon, which has a diameter of 118.66 feet and a gore length of 174.87 feet, has a double-wall construction consisting of 83 integrally sealed gores of 1.5 mil film material. In order to provide a smoother surface to the air flow, the bottom half of the balloon was tailored to a natural shape in place of the usual tapered tangent construction. Author (GRA)

N73-14053# Aerophysics Co., Washington, D.C.
**A THEORETICAL ANALYSIS OF THE TIP RELIEF EFFECT ON HELICOPTER ROTOR PERFORMANCE Final Report, Oct. 1970 - Oct. 1971**
John M. Lenard Aug. 1972 84 p refs
(Contract DAAJ02-71-C-0006; DA Proj. 1F1-62204-A-A42)
(AD-750179; AR-53; USAAMRDL-TR-72-7) Avail: NTIS CSCL 01/3

A theoretical method is derived whereby the effect of the compressible three-dimensional relief on the torque required for a helicopter rotor may be calculated. The complementary wing approach is used to represent the relief effect. The effect of the wing which complements a finite wing to make it an infinite wing may be found as a reduction in the free-stream velocity. This approach was applied to fixed wings by Anderson and is extended here for application to helicopter rotors. By using a simplified blade element analysis, the magnitude of the change in torque due to tip relief has been calculated and compares well with test results. The method to use the tip relief calculation in more complex blade element computer programs is described. Author (GRA)

N73-14054# Advisory Group for Aerospace Research and Development, Paris (France).
**FLIGHT TEST INSTRUMENTATION**
W. D. Mace 1972 77 p In ENGLISH and FRENCH
(AD-749890; AGARD-LS-50) Avail: NTIS CSCL 01/3

New technology in recent years has provided significant improvements in the operating characteristics of flight test data systems. These improvements, from the instrument engineer's point of view, can be measured in such terms as increased data accuracy, system capacity, flexibility, etc., while to the flight test engineer they can be interpreted in terms of broader objectives for each flight, more precise examination of the variables at test conditions, or more comprehensive post-flight data analysis. The intent of the report is to provide for the non-instrument engineer, particularly those involved in flight testing, an overview of new data acquisition/processing systems and capabilities, a look at new mathematical techniques for extracting data from recorded information, and illustrate how these new developments have influenced the design of flight test programmes. Author (GRA)

N73-14161 Kiruna Geophysical Observatory (Sweden).
**ON THE GENERATION AND DETECTION OF ARTIFICIAL ATMOSPHERIC WAVES**
Ludwik Liszka and Sixten Olsson *In* AGARD Effects of Atmospheric Acoustic Gravity Waves on Electromagnetic Wave Propagation Oct. 1972 11 p refs

Preliminary results of detection of atmospheric waves produced by focussing of shocks generated by supersonic aircraft are presented. The flight trajectories were chosen so that the acoustic gravity waves following the shock front were focussed on the ground after reflection from the stratosphere, or in the E layer. Infra-acoustic waves were detected on the ground using a 2 Hz infra-acoustic correlator. At the E layer, the waves were detected using a modified vertical sounding technique. Results obtained during 11 test flights have shown that the ray tracing technique may be successfully used for predicting the propagation of atmospheric waves following shock fronts. Author

**N73-14251#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany).
**CONTROL THEORY RESEARCH Final Scientific Report, 1 Mar. 1970 - 29 Feb. 1972**
Jurgen E. Ackermann and Gerhard Kreisselmeier May 1972 150 p refs
(Contract F61052-70-C-0020; AF Proj. 9749)
(AD-746296; DFVLR-IB-2/72; AFOSR-72-1332TR) Avail: NTIS CSCL 12/1

The report contains a summary of research performed by the control systems department at the Institute for Dynamics of Flight Systems of DFVLR during the period from March 1, 1970 until February 29, 1972. Author (GRA)

**N73-14266#** Kaisers Engineers, Los Angeles, Calif.
**HIGH SPEED GROUND TRANSPORTATION. DOCUMENTATION OF PRELIMINARY ENGINEERING, LOS ANGELES INTERNATIONAL AIRPORT AND THE SAN FERNANDO VALLEY**
Apr. 1972 175 p refs
(Contract DOT-UT-312)
(PB-211833; UMTA-CA-09-0010-72-2; Rept-72-1-RE) Avail: NTIS HC $3.00 CSCL 13F

Work completed under Phase 3 of a project to construct a high speed ground rapid transit access facility between Los Angeles International Airport and the San Fernando Valley is discussed. Service in this corridor will be provided by tracked air-cushion vehicles running on a special guideway. Phase 3 of the project included preliminary engineering studies and continued development of the route and structures. GRA

**N73-14267#** Mitre Corp., Bedford, Mass.
**THE TRACKED AIR CUSHION RESEARCH VEHICLE (TACRV)**
May 1972 212 p refs
(Contract DOT-7-35248)
(PB-211216; FRA-RT-72-41) Avail: NTIS HC $3.00 CSCL 13F

The Department of Transportation's (DOT) Tracked Air Cushion Research Vehicle (TACRV) System is described using descriptive material and data provided by the design contractors and the Federal Railroad Administration Office of Research, Development, and Demonstrations. The TACRV is an experimental vehicle that will carry out research pertinent to evaluating the technical feasibility of the tracked air cushion vehicle (TACV) concept for commercial high-speed ground transportation. The report includes background information, detailed design descriptions, and vehicle performance estimates. Author (GRA)

**N73-14269#** Mitre Corp., McLean, Va.
**THE TRACKED AIR CUSHION RESEARCH VEHICLE (TACRV) SYSTEM**
May 1972 208 p refs
(Contract DOT-FR-7-35248)
(PB-211992; FRA-RT-72-41) Avail: NTIS HC $3.00 CSCL 13F

The Department of Transporation's tracked air cushion research vehicle system is described using descriptive material and data provided by the design contractors and the Federal Railroad Administration, Office of Research, Development, and Demonstrations. The TACRV is an experimental vehicle that will carry out research pertinent to evaluating the technical feasibility of the tracked air cushion vehicle concept for commercial high speed ground transportation. The report includes background information, detailed design descriptions, and vehicle performance estimates. Author (GRA)

**N73-14276*#** Pratt and Whitney Aircraft, West Palm Beach, Fla. Research and Development Center.
**EVALUATION OF CIRCUMFERENTIAL AIRFLOW UNIFORMITY ENTERING COMBUSTORS FROM COMPRESSORS. VOLUME 1: DISCUSSION OF DATA AND RESULTS**
J. H. Shadowen and W. J. Egan, Jr. Nov. 1972 122 p 2 Vol.
(Contract NAS3-15693)
(NASA-CR-121009; PWA-FR-5183-Vol-1) Avail: NTIS HC $8.25 CSCL 20D

The compressor discharge airflow uniformity of two compressors from advanced engines, the J58 and F100/F401, was studied. Compressor discharge pressures and temperatures at up to 33 circumferential rake locations allowed the airflow distribution to be ascertained and computer plotted. Several flight conditions and compressor variables, i.e., inlet distortion, modified seals, etc., were analyzed. An unexpectedly high nonuniform airflow was found for both compressors. Circumferential airflow deviation differences of up to 52% from maximum to minimum were found for the J58, and up to 40% for the F100/F401. The effects of aerodynamic and thermal distortion were found to be additive. The data were analyzed for influence of exit guide vane wakes and found free of any effect. Data system errors were small in relation to the measured pressure and temperature variations. Author

**N73-14277*#** Pratt and Whitney Aircraft, West Palm Beach, Fla. Research and Development Center.
**EVALUATION OF CIRCUMFERENTIAL AIRFLOW UNIFORMITY ENTERING COMBUSTORS FROM COMPRESSORS. VOLUME 2: DATA SUPPLEMENT**
J. H. Shadowen and W. J. Egan, Jr. Nov. 1972 103 p 2 Vol.
(Contract NAS3-15693)
(NASA-CR-121010; PWA-FR-5183-Vol-2) Avail: NTIS HC $7.25 CSCL 20D

A study of the airflow uniformity leaving compressors and entering combustors was made using compressors from two advanced engines, the J58 and F100/F401. The data used in the analysis of each case is presented in tabular form and computer-generated profile plots. A plot of the square root of the dynamic pressure ratio, which is similar to airflow deviation, is also presented. Author

**N73-14287#** Central Electricity Generating Board, Southampton (England). Marchwood Engineering Lab.
**CALCULATION OF BLADE-TO-BLADE FLOW IN A TURBOMACHINE BY STREAMLINE CURVATURE**
D. H. Wilkinson London Aeron. Res. Council 1972 50 p refs Supersedes ARC-32878
(ARC-R/M-3704; ARC-32878) Avail: NTIS HC $4.50; HMSO £1.80; PHI $7.20

A blade-to-blade method for compressible flow is given. This is a streamline curvature method with iterative determination of stagnation streamlines for tangential periodicity. The outlet angle is also found for fixed and moving blades with change of radius and annulus area. Good agreement with other theories and experiment is shown. A new prescribed velocity distribution design method is also proposed. Author (ESRO)

**N73-14300#** Naval Postgraduate School, Monterey, Calif.
**AN INVESTIGATION OF SECONDARY-FLOW PHENOMENA AND ASSOCIATED LOSSES IN A HIGH DEFLECTION TURBINE CASCADE Ph.D. Thesis**
James Raney Wood, Jr. Sep. 1972 126 p refs
(AD-750183) Avail: NTIS CSCL 10/2

The report presents precise quantitative data established for the overall flow losses in a high-deflection turbine rotor cascade for a range of aspect ratios h/c from 1.480 to 0.592. The magnitude of the losses due to secondary-flow effects was also determined. From these measurements it was possible to obtain an improved physical description of the complex secondary-flow phenomena. Author (GRA)

**N73-14472#** Laboratorio de Acustica e Sonica, Sao Paulo (Brazil).
**ULTRASONIC INSPECTION OF WING SPAR ATTACHMENT JOINTS AND LUGS**
L. X. Nepomuceno 7 Jul. 1972 15 p
(TR-7207.591) Avail: NTIS HC $3.00

The results obtained with ultrasonic inspection of wing spar joints and lugs of Viscount Aircraft operated by PLUNA are presented. The procedures and the results are in accordance with directives issued by the British Aircraft Corporation.
Author

**N73-14692*** National Aeronautics and Space Administration, Washington, D.C.
**HEAD-UP ATTITUDE DISPLAY** Patent
William J. OKeeke, inventor (to NASA) Issued 19 Dec. 1972 7 p Filed 12 May 1970 Supersedes N70-35429 (08-19, p 3586)
(NASA-Case-ERC-10392; US-Patent-3,706,970; US-Patent-Appl-SN-36534; US-Patent-Class-340-27AT) Avail: US Patent Office CSCL 17G

An aircraft instrument is described which provides a head-up attitude display. The instrument provides a pitch and roll attitude reference coincident with the true horizon in a pilot's actual field of view through a cockpit windscreen. The principal indicator is a movable, horizontal baton which is driven from a standard gyroscopic attitude reference. The baton has two degrees of freedom, one up and down in the vertical plane for pitch attitude changes and a tilting movement for roll attitude changes. With the two degrees of freedom and the baton positioned immediately adjacent the windscreen, an artificial horizon is provided in the direct field of view of the pilot with all the advantages of peripheral vision inherent in a head-up system. The batons are illuminated to accentuate the image of the batons in the peripheral vision of the pilot.
Official Gazette of the U.S. Patent Office

**N73-14693#** Joint Publications Research Service, Arlington, Va.
**SPACECRAFT AND AIRCRAFT GUIDANCE SYSTEMS**
7 Dec. 1972 15 p Transl. into ENGLISH from Aviats i Kosmonavt. (Moscow), no. 6, 1972 p 36-37 and 42-43
(JPRS-57704) Avail: NTIS HC $3.00

Information is presented on astro-orientation of a spaceship and instrument errors on supersonic aircraft.

**N73-14695** Joint Publications Research Service, Arlington, Va.
**INSTRUMENT PANEL FOR ERRORS READING ON SUPERSONIC AIRCRAFT**
M. Kozlov and G. Krylov *In its* Spacecraft and Aircraft Guidance Systems 7 Dec. 1972 p 6-12

Instrument errors on supersonic aircraft are analyzed for the airspeed and altitude indicators. The methods for converting indicated readings to the true values are discussed including automatic compensation of the instrument correction which is fed into the instrument. Aerodynamic compensation is also discussed. F.O.S.

**N73-14696#** Federal Aviation Administration, Washington, D.C. Flight Services Div.
**IFR OFF-AIRWAY ROUTES, NON PART 95**
Nov. 1972 22 p
Avail: NTIS HC $3.25

A consolidation of Instrument Flight Rules Off-Airway Non-95 Routes for November 1972 is presented. Information is presented alphabetically by principal cities and geographical locations involved. The name of the airlines providing service, the routing, and appropriate air traffic control data are provided.
P.N.F.

**N73-14697#** Lincoln Lab., Mass. Inst. of Tech., Lexington.
**THE USE OF SUPPLEMENTARY RECEIVERS FOR ENHANCED POSITIONAL ACCURACY IN THE DAB SYSTEM**
E. J. Kelly 4 Dec. 1972 86 p refs
(Contracts F19628-70-C-0230; DOT-FA72WAI-261)
(TN-1972-38) Avail: NTIS HC $6.50

An analysis of the performance of two general schemes which might be used to obtain enhanced accuracy of aircraft position determination in the Discrete Address Beacon (DAB) system. Both schemes use supplementary receivers to detect DABS replies, permitting multilateration or hyperbolic position finding, while differing in the way bistatic path lengths are measured. Detailed derivations and theoretical numerical results are presented. Author

**N73-14698#** Mitre Corp., McLean, Va.
**ENGINEERING AND DEVELOPMENT PROGRAM PLAN: CONCEPTS, DESIGN, AND DESCRIPTION FOR THE UPGRADED THIRD GENERATION AIR TRAFFIC CONTROL SYSTEM**
Aug. 1972 141 p refs Revision
(Contract DOT-FA70WA-2448)
(MTR-6152-Rev-1; FAA-ED-01-1A) Avail: NTIS HC $9.25

The Air Traffic Control (ATC) system for the next 10 to 20 years is described. The design of the system is based upon significant improvements in the third generation ATC system now being deployed. Key features are: (1) metering and spacing automation, (2) intermittent positive control (IPC), (3) ATC data link services, (4) the discrete address beacon system (DABS), (5) the application of area navigation to ATC, (6) the microwave landing system (MLS), and (7) the application of satellites to oceanic ATC. The role of automation in both ATC and the delivery of flight services will be greatly expanded to assure system safety, while increasing airport and control system capacities in a productive manner. Author

**N73-14699*#** Research Triangle Inst., Durham, N.C.
**DEVELOPMENT OF SIMULATION TECHNIQUES SUITABLE FOR THE ANALYSIS OF AIR TRAFFIC CONTROL SITUATIONS AND INSTRUMENTATION**
Dec. 1972 417 p refs
(Contract NAS1-10847)
(NASA-CR-112195; RTI-43U-718) Avail: NTIS HC $23.00 CSCL 17G

A terminal area simulation is described which permits analysis and synthesis of current and advanced air traffic management system configurations including ground and airborne instrumentation and new and modified aircraft characteristics. Ground elements in the simulation include navigation aids, surveillance radars, communication links, air-route structuring, ATC procedures, airport geometries and runway handling constraints. Airborne elements include traffic samples with individual aircraft performance and operating characteristics and aircraft navigation equipment. The simulation also contains algorithms for conflict detection, conflict resolution, sequencing and pilot-controller data links. The simulation model is used to determine the sensitivities of terminal area traffic flow, safety and congestion to aircraft performance characteristics, avionics systems, and other ATC elements. Author

**N73-14701*#** Arizona Univ., Tucson. Engineering Experiment Station.
**A PROBLEM OF COLLISION AVOIDANCE**
Thomas L. Vincent, Eugene M. Cliff, Walter J. Grantham, and Willy Y. Peng Nov. 1972 86 p refs

(Grant NGR-03-002-224)
(NASA-CR-129988; EES-Ser-39) Avail: NTIS HC $6.50

Collision avoidance between two vehicles of constant speed with limited turning radii, moving in a horizontal plane is investigated. Collision avoidance is viewed as a game by assuming that the operator of one vehicle has perfect knowledge of the state of the other, whereas the operator of the second vehicle is unaware of any impending danger. The situation envisioned is that of an encounter between a commercial aircraft and a small light aircraft. This worse case situation is examined to determine the conditions under which the commercial aircraft should execute a collision avoidance maneuver. Three different zones of vulnerability are defined and the boundaries, or barriers, between these zones are determined for a typical aircraft encounter. A discussion of the methods used to obtain the results as well as some of the salient features associated with the resultant barriers is included. Author

**N73-14702#** Litchford Systems, Northport, N.Y.
**STUDY AND ANALYSIS OF SC-117, NATIONAL AND USAF PLANS FOR A NEW LANDING SYSTEM, PART 1 Final Report, May 1971 - Apr. 1972**
George B. Litchford Jul. 1972 252 p refs
(Contract F33615-71-C-1601)
(AD-749505; L-AF-05-Pt-1; AFFDL-TR-72-76-Pt-1) Avail: NTIS CSCL 17/2

With SC-117, national, and USAF plans partially formulated for the design of a new Microwave Landing System (MLS) to meet common civil/military and common CTOL/VSTOL requirements, attention is now focused on technical and operational areas of landing where critical decisions must be made to narrow the competing techniques to a single national standard. The Air Force missions utilize not only conventional, fixed MLS installations, but also mobile MLS units quickly installed at remote or foreign airfields. A design of a very-low-cost MLS is outlined since the number of military aircraft to be equipped with MLS will be determined by the minimum cost (and minimum service configurations) of the national MLS system. Author (GRA)

**N73-14705#** Mitre Corp., McLean, Va.
**ENGINEERING AND DEVELOPMENT PROGRAM PLAN - PROGRAM STRUCTURE AND OBJECTIVES**
Jul. 1972 44 p
(Contract DOT-FA70WA-2448)
Avail: NTIS CSCL 17/7

The Office of Systems Engineering Management (OSEM) has initiated an activity for the preparation of Program Plans covering the present twenty-one engineering and development programs within the Federal Aviation Administration (FAA). These plans are required to provide more detailed information on the objectives, goals, program structure, technical approach, resources, possible implementation, and a number of other aspects for each of these programs. This planning process has been formalized in order to provide a record of the status and availability of each plan. The document presents an introductory background to the planning process, the objectives in each of the program areas, and an index of the plans, available or under preparation. Author (GRA)

**N73-14728#** Lockheed-Georgia Co., Marietta.
**THE GENERATION AND RADIATION OF SUPERSONIC JET NOISE. VOLUME 5: AN EXPERIMENTAL INVESTIGATION OF JET NOISE VARIATION WITH VELOCITY AND TEMPERATURE Final Technical Report, 1 May 1971 - 31 May 1972**
Peter A. Lush and Robert H. Burrin Wright-Patterson AFB, Ohio AFAPL Jul. 1972 175 p refs 6 Vol.
(Contract F33615-71-C-1663; AF Proj. 3066)
(AD-749140; AFAPL-TR-72-53-Vol-5) Avail: NTIS CSCL 20/1

A series of experiments was conducted for the purpose of clearly isolating and quantifying the noise sources associated with supersonic jet noise and for establishing the effect of refraction on the radiated field of these sources, as well as the radiation field characteristics of these sources. Results from the turbulent-mixing tests and the shock-associated tests are appended to this report in separate volumes. The turbulence noise 1/3 octave corrected data appear in Appendix I and the shock-associated narrow-band spectra appear in Appendix 2. Author (GRA)

**N73-14729#** Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering.
**MODELING OF V/STOL NOISE IN CITY STREETS**
Richard H. Lyon, Lalit Pande, and Wayne A. Kinney 15 Nov. 1971 56 p refs
(Contract DOT-TSC-93)
(PB-211953; Rept-1; DOT-TSC-93-1) Avail: NTIS HC $3.00 CSCL 20A

The goals of this work were two-fold. First, to develop modeling techniques that will be helpful in studying a variety of noise propagation problems. These involve not only aircraft sources, but also surface traffic (automobiles, trucks, and rail vehicles) as well. The second and more narrow goal is the application of these modeling techniques to a specific problem, the propagation of V/STOL aircraft noise into an urban area. Author (GRA)

**N73-14792*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**GAS TURBINE EXHAUST NOZZLE Patent Application**
David M. Straight, inventor (to NASA) Filed 19 Dec. 1972 12 p
(NASA-Case-LEW-11659-1; US-Patent-Appl-SN-316618) Avail: NTIS HC $3.00 CSCL 21E

An exhaust nozzle is described for reducing the noise of gas turbine engines by mixing low velocity secondary gas (air) with high velocity primary gas (engine or afterburner exhaust). A hollow sting is coaxially disposed in an exhaust nozzle composed of an outer housing, and an inner pressure shell. Air from the engine inlet flows into the sting, and between the combustion chamber and the outer housing. The sting air cools the nozzle plug over which it is directed, and serves as a low velocity core of secondary gas which provides noise reduction for the primary exhaust gas, while the other gas provides an outer velocity layer for further noise reduction. F.O.S.

**N73-14795*#** Pratt and Whitney Aircraft, East Hartford, Conn.
**HIGH LOADING, 1800 FT/SEC TIP SPEED, TRANSONIC COMPRESSOR FAN STAGE. 2: FINAL REPORT**
A. L. Morris and D. H. Sulam Dec. 1972 234 p refs
(Contract NAS3-13493)
(NASA-CR-120991; PWA-4463) Avail: NTIS HC $13.75 CSCL 21E

Tests were conducted on a 0.5 hub/tip ratio, single-stage fan-compressor designed to produce a pressure ratio of 2.285 an efficiency of 84 percent with a rotor tip speed of 1800 feet per second. A peak efficiency of 82 percent was achieved by the stage at a stall margin of 6.5 percent. Tests showed that stall-limit line was slightly sensitive to tip-radial distortion, but stall-line improvements were noted when the stage was subjected to circumferential and hub-radial flow distortions. Rotor blade passage and trailing edge shock positions were inferred from static pressure contours over the rotor tips. Author

**N73-14796#** Royal Aircraft Establishment, Bedford (England). Aerodynamics Dept.
**OPTIMUM ENGINE THRUST DEFLECTION FOR HIGH-SPEED CRUISING AIRCRAFT**
J. Pike London Aeron. Res. Council 1972 43 p refs Supersedes RAE-TR-71123; ARC-33614
(ARC-CP-1222; RAE-TR-71123; ARC-33614) Avail: NTIS HC $4.25; HMSO 70p; PHI $2.95

It is assumed that the variation in the lift-to-drag ratio with lift of the caret wing is typical of that of a lifting configuration for Mach numbers in the range where nozzle deflections are

most significant. Numerical optimization studies using this assumption show that optimum nozzle thrust deflection angles are commonly 50% larger than those suggested by analyses at constant lift-to-drag ratio. Analytical results are obtained for the optimum deflection angle based on Newtonian, Busemann second order and linear theory relationships. Author (ESRO)

N73-14800# Boeing Co., Seattle, Wash.
**THRUST REVERSER AND THRUST VECTORING LITERATURE REVIEW Technical Report, Jul. - Sep. 1971**
John E. Petit and Michael B. Scholey Apr. 1972 120 p
(Contract F33615-71-C-1850; AF Proj. 643A)
(AD-749476; AFAPL-TR-72-11) Avail: NTIS CSCL 21/5

The state-of-the-art of thrust reverser and thrust vectoring technology has been surveyed to identify the available test data and prediction methods in the literature. The literature review resulted in a bibliography of documents related to thrust reverser and thrust vectoring systems. The bibliography contains references to approximately 160 reports and is organized in three sections: Literature review summary, abstracts and data review summary. Author (GRA)

N73-14802# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**THE CORRELATION OF THE CHARACTERISTICS OF FLAMEOUT AND IGNITION OF FLAMES DURING DIFFUSION COMBUSTION ON FUEL BEHIND SYSTEMS OF ANGLED STABILIZERS**
V. A. Khristich and V. N. Litoshenko 2 Jun. 1972 16 p refs Trans. into ENGLISH from Izv. Vysshikh Uchebn. Zavedenii, Mashinostr. (Moscow), no. 5, 1970 p 78-82
(AD-749635; FTD-MT-24-1744-71) Avail: NTIS CSCL 21/5

Experimental investigation of the working process of an annular combustion chamber (built into the turbine body) for preheating a gas turbine employing gaseous fuel. The results are used to derive empirical expressions correlating the ignition and flameout characteristics for stabilizers over a wide range of stabilizer parameters (shape, width, apex angle) and chamber shadings. Author (GRA)

N73-14803# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**AIR COOLING OF NOZZLE BLADES WITH DEFLECTORS**
L. A. Moslov and L. M. Ronkin 25 Aug. 1972 10 p refs Transl. into ENGLISH from Energomashinostroenie (USSR), v. 17, 1971 p 34
(AD-749654; FTD-HT-23-1271-71) Avail: NTIS CSCL 21/5

Considered is an open air cooling system design with coolant air discharge through the leading nozzle vane edges as a means of increasing the reliability of deflector type gas turbine working elements when the inlet air flow temperature is elevated before injection. Criteria are given for estimating (1) the average nozzle vane profile perimeter temperature attainable at given coolant air flow rates and (2) the inhomogeneity of temperature distribution over this perimeter as basic characteristics of the cooling efficiency of the system. Experiments show that the cooling efficiency is increased appreciably when 15 percent of coolant air is discharged through additional outlets in the trailing edges of the deflectors. Author (GRA)

N73-14805# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**THE INVESTIGATION OF THE EFFECT OF CERTAIN FACTORS ON THE CHARACTERISTICS OF ENDURANCE OF HEAT-RESISTANT ALLOYS USED FOR THE MANUFACTURE OF TURBINE BLADES**
L. M. Akimov, N. I. Kononchuk, I. K. Skadnov, N. I. Zverev, and S. M. Pliskin 30 Jun. 1972 16 p Transl. into ENGLISH from "Termoprochnost Materialov i Konstruktsionnyke Elementov" Kiev, Naukova Dumka, 1965 p 228-235
(AD-749752; FTD-HT-23-753-72) Avail: NTIS CSCL 21/5

To clarify the reasons for the change in endurance, an analysis of the destruction of blade models was made during the transition of tests with a symmetrical cycle to an asymmetrical one; during the transition of tests in an air medium to tests in fuel combustion products; and during comparative tests of alitized and nonalitized models. The endurance characteristics obtained through the tests of the blade models reflect the effect of the shape, cycle asymmetry, working medium, thermal cycling, surface protection and test temperature on the endurance of heat-resistant alloys. Author (GRA)

N73-14898# Advisory Group for Aerospace Research and Development, Paris (France).
**ACOUSTIC FATIGUE DESIGN DATA, PART 2**
A. G. R. Thomson (Engineering Sci. Data Unit Ltd.) and R. F. Lambert (Engineering Sci. Data Unit Ltd.) Nov. 1972 59 p refs
(AGARD-AG-162-Pt-2; AGARDOGRAPH-162-Pt-2) Avail: NTIS HC $5.00

Data for use in aerodynamic structural design to reduce the effects of acoustic fatigue are presented. The subjects discussed are: (1) endurance of aluminum alloy structural elements subjected to acoustic loading, (2) natural frequencies of flat or singly-curved sandwich panels with cores of zero flexural stiffness, and (3) stress response of flat or singly-curved sandwich panels with cores of zero flexural stiffness subjected to random acoustic loading. Author

N73-14903# Royal Aircraft Establishment, Farnborough (England). Structures Dept.
**DESIGN DEVELOPMENT OF AN AIRCRAFT STRUT IN CARBON FIBRE REINFORCED PLASTIC**
T. A. Collings London Aeron. Res. Council 1972 63 p refs Supersedes RAE-TR-72032; ARC-33853
(ARC-CP-1229; RAE-TR-72032; ARC-33853) Avail: NTIS HC $5.25; HMSO £1; PHI $3.90

An actuator reaction strut from the VC 10 aileron power control circuit, made from steel, has been redesigned, made and tested in carbon fiber reinforced plastic (CFRP) with aluminum alloy ends, partly to demonstrate the weight saving potential of CFRP in this type of application and partly to investigate some of the problems of jointing and load diffusion which CFRP presents. The strut has overall axial strength and stiffness requirements in both tension and compression. All have been met with the redesigned CFRP strut with the exception of tensile stiffness, the low value of which was shown to be fundamental to the form of end attachment adopted. The CFRP strut weighed 43% less than the original steel component. Author (ESRO)

N73-14958* California State Polytechnic Coll., San Luis Obispo. Orbital Mechanics Branch.
**AVOIDANCE OF TRAILING VORTEX HAZARD BY AIRPORT WARNING SYSTEM**
Robert S. Rudland *In* Auburn Univ. The NASA-ASEE Summer Fac. Fellowship Program Sep. 1972 p 507-532 refs

CSCL 01E

In an effort to improve airport traffic operation near jumbo jets, an airport trailing vortex warning system (ATVWS) was developed to predict trailing vortex turbulence. The ATVWS consists of a computer simulator which is compatible with a vortex sensor such as a laser Doppler velocimeter or an acoustic radar. A study of the traffic in one of the ten busiest airports, Atlanta Municipal Airport, provided information on traffic patterns of a statistical nature. With this information, airport traffic patterns can be studied and hazard statistics developed. Based on a careful study of this simulation model, requirements for the development and testing of an ATVWS can be accurately specified. Author

N73-14977# Pisa Univ. (Italy). School of Engineering.
**ON SOME EXPERIMENTAL ACTIVITIES OF THE AERONAUTICAL INSTITUTE OF THE UNIVERSITY OF PISA IN**

**THE FIELD OF APPLIED AERODYNAMICS [SU ALCUNE ATTIVITA SPERIMENTALI DELL' ISTITUTO DI AERONAUTICA DELL' UNIVERSITA DI PISA NEL CAMPO DELLA AERODINAMICA APPLICATA]**

G. Barsotti, C. Casarosa, A. DelPuglia, and A. Salvetti 1969 82 p refs In ITALIAN *Its* Ser. 28a

(Publ-1352; Rept-24) Avail: NTIS HC $6.25

The research is reported on air transport problems using STOL and VTOL aircraft. The principle characteristics of a STOL model, and the simulation technology are described along with the construction problems. The aerodynamic balance results are discussed. Trans. by F.O.S.

**N73-14981*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

**AIRFOIL SHAPE FOR FLIGHT AT SUPERSONIC SPEEDS Patent Application**

Richard T. Whitcomb, inventor (to NASA) Filed 9 Nov. 1971 27 p

(NASA-Case-LAR-10585-1; US-Patent-Appl-SN-197183) Avail: NTIS HC $3.50 CSCL 01A

An airfoil is reported that has an upper surface shaped to control flow accelerations and pressure distribution over the upper surface to prevent separation of the boundary layer due to shock wave formulation at high subsonic speeds well above the critical Mach number. A highly cambered trailing edge section improves overall airfoil lifting efficiency. NASA

**N73-14983*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**PERFORMANCE OF A SINGLE-STAGE AXIAL-FLOW TRANSONIC COMPRESSOR STAGE WITH A BLADE TIP SOLIDITY OF 1.7**

Royce D. Moore and Lonnie Reid Washington Dec. 1972 113 p refs

(NASA-TM-X-2658; E-6730) Avail: NTIS HC $3.00 CSCL 20D

The overall and blade-element performance of a transonic compressor stage is presented over the stable operating range at rotative speeds from 50 to 100 percent of design speed. Stage peak efficiency of 0.784 was obtained at a weight flow of 28.6 kilograms per second and a pressure ratio of 1.706. Stall margin at design speed was 11.4 percent. The peak efficiency being significantly less than design efficiency was attributed to: (1) the stator loss and the radial gradient of losses being much higher than design, (2) the losses and blockages associated with the rotor part-span dampers not being incorporated into the design, and (3) mismatch of the rotor and stator blade elements. Author

**N73-14984*#** National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

**PRESSURES AND TEMPERATURES ON THE LOWER SURFACES OF AN EXTERNALLY BLOWN FLAP SYSTEM DURING FULL-SCALE GROUND TESTS**

Donald L. Hughes Washington Jan. 1973 34 p

(NASA-TN-D-7138; H-729) Avail: NTIS HC $3.00 CSCL 01B

Full-scale ground tests of an externally blown flap system were made using the wing of an F-111B airplane and a CF700 engine. Pressure and temperature distributions were determined on the undersurface of the wing, vane, and flap for two engine exhaust nozzles (conical and daisy) at several engine power levels and engine/wing positions. The test were made with no airflow over the wing. The wing sweep angle was fixed at 26 deg; and the angle of incidence between the engine and the wing was fixed at 3 deg; and the flap was in the retracted, deflected 35 deg, and deflected 60 deg positions. The pressure load obtained by integrating the local pressures on the undersurface of the flap, F sub p was approximately three times greater at the 60 deg flap position than at the 35 deg flap position. At the 60 deg flap position, F sub p was between 40 percent and 55 percent of the engine thrust over the measured range of thrust. More than 90 percent of F sub p was contained within plus or minus 20 percent of the flap span centered around the engine exhaust centerline with both nozzle configurations. Maximum temperatures recorded on the flaps were 218 C (424 F) and 180 C (356 F) for the conical and daisy nozzles, repectively. Author

**N73-14985*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**SOME OBSERVED EFFECTS OF PART-SPAN DAMPERS ON ROTATING BLADE ROW PERFORMANCE NEAR DESIGN POINT**

Genevieve M. Esgar and Donald M. Sandercock Washington Jan. 1973 27 p refs

(NASA-TM-X-2696; E-7067) Avail: NTIS HC $3.00 CSCL 01A

Detailed measured radial distributions of flow parameters for eight rotors with part-span dampers are used to study the effects of dampers on rotor performance and flow parameters at near design operation. All rotors had a blade tip diameter of about 20 in. and operated at a blade tip speed of about 1400 ft/sec. Several examples demonstrate that, when the local loss variations in the damper flow region are included in an aerodynamic design or analysis procedure, the computed spanwise distributions of flow parameters compare closely with measured distributions. Author

**N73-14986#** National Aerospace Lab., Tokyo (Japan).

**AN APPROXIMATE CALCULATION METHOD OF INCOMPRESSIBLE, TURBULENT WAKES BEHIND AEROFOILS - SYMMETRICAL WAKE FLOW CASE**

*Youji Ishida* Jul. 1972 14 p *refs In JAPANESE; ENGLISH* summary

(NAL-TR-292) Avail: NTIS HC $3.00

An approximate method of calculating the development of incompressible, symmetrical turbulent wake flows downstream of airfoils is presented. In this method, the integral method using the momentum integral equation and the energy integral equation is applied. New models for the mean-velocity and the mixing-length distributions across the wake are worked out which properly describe the change of the flow characteristics from the boundary-layer type on the aerofoil surface to that of the wake far downstream. In the model for the velocity distribution which is based on Coles' two-layer model, it is assumed that the wake component of the mean velocity at the trailing edge is kept unchangeable, and only the wall component at the trailing edge changes in the new inner layer with the distance from the trailing edge. The mean-velocity distribution is given as a one-parameter family of curves by the above model, and the streamwise variation of the parameter, together with the wake thickness is determined by way of the two integral equations mentioned above. The external inviscid stream velocity at the edge of the wake flow must be given in advance. Author

**N73-14989*#** General Dynamics/Convair, San Diego, Calif.

**STEADY INVISCID TRANSONIC FLOWS OVER PLANAR AIRFOILS: A SEARCH FOR A SIMPLIFIED PROCEDURE**

R. Magnus and H. Yoshihara Washington NASA Jan. 1973 58 p refs

(Contract NAS2-6377)

(NASA-CR-2186) Avail: NTIS HC $3.00 CSCL 01A

A finite difference procedure based upon a system of unsteady equations in proper conservation form with either exact or small disturbance steady terms is used to calculate the steady flows over several classes of airfoils. The airfoil condition is fulfilled on a slab whose upstream extremity is a semi-circle overlaying the airfoil leading edge circle. The limitations of the small disturbance equations are demonstrated in an extreme example of a blunt-nosed, aft-cambered airfoil. The necessity of using the equations in proper conservation form to capture the shock properly is stressed. Ability of the steady relaxation procedures to capture the shock is briefly examined. Author

**N73-14990#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Abteilung Aeroelastik.

**CALCULATION OF THE UNSTEADY PRESSURE DISTRIBUTIONS ON HARMONICALLY OSCILLATING SLENDER CRUCIFORM WING AND CYLINDRICAL BODY COMBINATIONS [BERECHNUNG DER INSTATIONAEREN DRUCKVERTEILUNG AN HARMONISCH SCHWINGENDEN KREISZYLINDRISCHEN FLUGKOERPERN MIT KREUZFOERMIG ANGEORDNETEN FLUEGELN ODER LEITFLAECHEN]**

K. L. Chao Oct. 1971 97 p refs In GERMAN; ENGLISH summary

(DLR-FB-71-87; AVA-FB-7150) Avail: NTIS HC $7.00; DFVLR, Porz, West Ger. 28,80 DM

The theoretical relations for an analytical determination of the pressure distributions on harmonically oscillating slender cruciform wing and cylindrical body combinations in compressible flow based upon the Slender Body Theory are presented. For the analytical solution of the Laplace equation, the method of conformal mapping has been applied, where the cross-section geometry is transformed into a straight line. The mutual interference effects of the cruciform wings and the influence of the fuselage body are investigated in detail for heaving, pitching, and rolling oscillations. Author (ESRO)

**N73-14991#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Abteilung Aerodynamik.

**INFLUENCE OF THE TRAILING EDGE SHAPE ON THE DRAG OF A RECTANGULAR WING IN THE MACH NUMBER RANGE FROM Ma=0.5 TO 2.2 [DER EINFLUSS DER HINTERKANTENFORM AUF DEN WIDERSTAND EINES RECHTECKFLUEGELS IM MACHZAHLBEREICH VON Ma = 0,5 BIS 2,2]**

M. Tanner Oct. 1971 91 p refs In GERMAN; ENGLISH summary

(DLR-FB-71-85; AVA-FB-7149) Avail: NTIS HC $6.75; DFVLR, Porz, West Ger. 28,80 DM

*Drag and lift measurements were performed on two* rectangular wings with an aspect ratio of Lambda = 2 in the Mach number range from 0.5 to 2.2. One wing had a sharp trailing edge and the other a blunt trailing edge. The shape and thickness of the blunt trailing edge were varied. The drag of the wing with a blunt trailing edge was considerably reduced by using a broken trailing edge shape. The total drag was split into its components to show the magnitude of the various drag components. Author (ESRO)

**N73-14992#** Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany).

**FURTHER DEVELOPMENT AND APPLICATION OF THE SUBSONIC PANEL METHOD [WEITERENTWICKLUNG UND ANWENDUNG DES UNTERSCHALL-PANEL-VERFAHRENS]**

Werner Kraus 20 Sep. 1972 39 p refs In GERMAN Presented at the 5th DGLR Ann. Meeting, Berlin, 4-6 Oct. 1972

(MBB-UFE-889-72-O; DGLR-Paper-72-105) Avail: NTIS HC $4.00

The development is described of a subsonic numerical panel method for calculating the flow around arbitrarily shaped bodies, based on potential flow. The application of this method is *demonstrated by the following examples: delta wing, reentry* body, body-wing configuration, exterior two-dimensional flow, water drop trajectories for ice formation determination, three-dimensional exterior flow and wing wakes, and wing combinations. Author (ESRO)

**N73-14995#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**INFLUENCE OF AN ANNULAR JET FLOWING FROM THE PLANE OF A WING ON THE AERODYNAMIC CHARACTERISTICS OF A WING MOVING NEAR AN INTERFACE**

L. F. Kalitievskii and Yu. F. Usik 1 Sep. 1972 12 p refs Transl. into ENGLISH from Teplo. Massoperenos (Minsk), no. 11, 1969 p 431-435

(AD-750933; FTD-HT-23-785-72) Avail: NTIS CSCL 01/1

The article presents some results of research on the aerodynamic characteristics of a wing moving close to an interface with the presence of an annular jet flowing from the wing surface *and impinging on a screen. A similar problem arises during research* on the aerodynamic characteristics of a wing-like apparatus on an air cushion. Author (GRA)

**N73-14996** International Civil Aviation Organization, Montreal (Quebec).

**LEXICON OF TERMS USED IN CONNEXION WITH INTERNATIONAL CIVIL AVIATION. VOLUME 1: VOCABULARY**

1971 268 p In ENGLISH, FRENCH, and SPANISH 2 Vol.

(Doc-8800-Vol-1) Copyright. Avail: Issuing Activities

A number of terms, in English, French and Spanish, which are relevant to the work of the International Civil Aviation Organization (ICAO) are collected. In addition to strictly aeronautical terminology related to aircraft and their operation, the vocabulary presented here extends to various allied fields to which an important part of ICAO's work is devoted. Volume I contains a trilingual vocabulary and five appendices, as well as two alphabetical reference indexes, one in French and one in Spanish. Author

**N73-14997** International Civil Aviation Organization, Montreal (Quebec).

**LEXICON OF TERMS USED IN CONNEXION WITH INTERNATIONAL CIVIL AVIATION. VOLUME 2: DEFINITIONS**

1971 98 p In ENGLISH, FRENCH, and SPANISH 2 Vol.

(Doc-8800-Vol-2) Copyright. Avail: Issuing Activity

A list of ICAO approved definitions for civil aviation terminology are presented in English, French, and Spanish. Arranged in the English alphabetical order, they are assigned consecutive index numbers. References appearing in the center column indicate the sources of the definitions. Author

**N73-14998#** Advisory Group for Aerospace Research and Development, Paris (France).

**FLUID DYNAMICS OF AIRCRAFT STALLING**

Nov. 1972 342 p refs Partly in ENGLISH and partly in FRENCH Presented at Fluid Dyn. Panel Specialists Meeting, Lisbon, 25-28 Apr. 1972

(AGARD-CP-102) Avail: NTIS HC $19.25

The proceedings of a conference on the fluid dynamics of aircraft stalling are presented. The subjects discussed are: (1) two dimensional laminar separation bubbles, (2) turbulent boundary layers flows, (3) aerodynamics of high lift airfoil systems, (4) low speed stalling of wings with high lift devices, (5) stall characteristics of various military aircraft, and (6) airflow separation and buffet onset during fighter aircraft maneuvers.

**N73-14999** Queen Mary Coll., London (England). Dept. of Aeronautical Engineering.

**ROLE OF FLUID DYNAMICS IN AIRCRAFT STALL AND POSTSTALL GYRATIONS**

G. J. Hancock *In* AGARD Fluid Dyn. of Aircraft Stalling Nov. 1972 16 p refs

The airworthiness requirements for stall and post stall behavior of an aircraft are reviewed. The definition of stall as the limiting condition for normal flight operations is established. The distinct dynamic and aerodynamic contributions to a stall maneuver and post stall gyration are described. The pilot's influence is assessed and some implications on airframe design are outlined. The effects of flow separation on wings, the control of flow separation, and the role of model experiments are reported. Author

**N73-15001** Centre National de la Recherche Scientifique, Meudon (France).

**THEORETICAL AND EXPERIMENTAL RESEARCH OF TAKE**

**OFF DRAG DEFORMATION OF LOCAL SURFACE [RECHERCHES THEORIQUES ET EXPERIMENTALES SUR LES DECOLLEMENTS LIES A UNE DEFORMATION LOCALE DE SURFACE]**

S. Burnel, G. B. Diep, P. Gougat, and B. Prunet-Foch *In* AGARD Fluid Dyn. of Aircraft Stalling Nov. 1972 11 p refs In FRENCH

A theoretical and experimental study was made of incompressible flow during takeoff. Velocity profiles were measured in the boundary layer by hot wire anemometers, and the signals obtained used to determine frequency distribution. Static pressure distribution on the inner surface was also determined. A plate containing a cavity was used to measure deformation on the hollow ledge. Spectral density fluctuations in velocity permits the measurement of natural instabilities in the boundary layer. The instabilities are correlated with exterior speed. Author

**N73-15004** Technische Hochschule, Stuttgart (West Germany). Inst. fuer Aerodynamik und Gasdynamik.

**DESIGN OF AIRFOILS WITH HIGH LIFT AT LOW AND MEDIUM SUBSONIC MACH NUMBERS**

F. X. Wortmann *In* AGARD Fluid Dyn. of Aircraft Stalling Nov. 1972 9 p refs

The design of airfoils with high lift at low and medium subsonic speeds is discussed. It is stated that the maximum lift of a symmetrical airfoil at low Mach numbers can be increased from 15 to 20 percent if the airfoil nose is modified and designed to yield lower velocity peaks and less pronounced laminar separation bubbles. The performance of the airfoil at various subsonic speeds and angles of attack is described. Author

**N73-15005** National Aerospace Lab., Amsterdam (Netherlands).

**COMMENTS ON THE METHODS DEVELOPED AT NLR FOR CONDUCTING TWO DIMENSIONAL RESEARCH ON HIGH LIFT DEVICES**

O. DeVries *In* AGARD Fluid Dyn. of Aircraft Stalling Nov. 1972 7 p refs

Avail: NTIS

Two experimental approaches for analyzing two dimensional flow on high lift devices are described. The first method consists of pressure measurements at the mid-span section of a two dimensional wing with boundary layer control at the tunnel wall-wing junctions by blowing slots. The second approach consists of potential flow calculations by means of a singularity method with a source distribution on the contour of the airfoil. This is applied with a limited number of contour points on the airfoils. The calculations are compared with the experimental results. Author

**N73-15006** Avions Marcel Dassault, Saint-Cloud (France).

**BLOCKAGE CORRECTIONS IN BLOWING TESTS OF EFFECTS OF TAKE-OFF [CORRECTION DE BLOCAGE DANS LES ESSAIS EN SOUFFLERIE EFFETS DES DECOLLEMENTS]**

Jean-Ch. Vayssaire *In* AGARD Fluid Dyn. of Aircraft Stalling Nov. 1972 22 p refs In FRENCH; ENGLISH summary

The application of blockage corrections to wind tunnel test measurements made on aircraft models is discussed. The procedure corrects the velocity to infinity upstream and restores to the wall-affected aerodynamic coefficients the values which are fairly equivalent to those obtained on a model placed in an unlimited fluid stream. The corrective blockage terms which modify the reference kinetic pressure are analyzed. The terms are affected by volume, wake, and separations. Each of them is usable in incompressible, compressible, two dimensional, and three dimensional flows on whole or half models. Author

**N73-15007** Douglas Aircraft Co., Inc., Santa Monica, Calif.

**AERODYNAMICS IN HIGH LIFT AIRFOIL SYSTEMS**

A. M. O. Smith *In* AGARD Fluid Dyn. of Aircraft Stalling Nov. 1972 27 p refs

The aerodynamic processes that occur in flow past unpowered multi-element airfoils in the high lift attitude are discussed. Charts showing permissible pressure recovery for retarded flows are presented. The best possible load carrying pressure distributions are described, as well as airfoils that develop the maximum possible lift in fully attached flow. It is shown that for a given optimum type of pressure distribution a two-element airfoil can develop more lift than a single element airfoil shaped to develop the same pressure distribution. Author

**N73-15008** Royal Aircraft Establishment, Farnborough (England).

**THE LOW SPEED STALLING OF WINGS WITH HIGH LIFT DEVICES**

D. N. Foster *In* AGARD Fluid Dyn. of Aircraft Stalling Nov. 1972 12 p refs

The mechanism of the stall of wing sections with high-lift devices in two dimensional flow is discussed. The similarities to the stalling mechanism for single airfoils, and the differences which arise as a result of the close proximity of the multiple lifting elements of the wing section to each other are described. The effect of sweepback is discussed for an infinite sheared wing and for a finite aspect ratio wing with high lift devices. The effects of practical features such as part-span flaps, and flap and slat support brackets, are illustrated by reference to flow patterns measured on a swept back wing. Author

**N73-15009** General Dynamics/Fort Worth, Tex.

**A SIMPLIFIED MATHEMATICAL MODEL FOR THE ANALYSIS OF MULTIELEMENT AIRFOILS NEAR STALL**

I. C. Bhateley and R. G. Bradley *In* AGARD Fluid Dyn. of Aircraft Stalling Nov. 1972 12 p refs

Potential-flow analysis methods, based on distributed-singularity models, are adequate for the prediction of aerodynamic characteristics for 2-D multiple-airfoil systems where viscous effects are negligible. However, for analysis and design of high-lift systems where viscous effects dominate, potential-flow methods are not adequate. In order that these viscous effects may be accounted for, a method has been formulated by which a solution is obtained through analysis of an equivalent airfoil system in potential flow. The mathematical model for the equivalent system consists of a linearly varying vorticity distribution over the surface of each airfoil element and a source distribution embedded inside each airfoil element to simulate the separated wake. The boundary-layer displacement thickness is superimposed on the airfoil contour to form an equivalent airfoil surface for each element. The flow downstream of a separation point is allowed to develop as a free streamline flow with no surface boundary conditions. The mathematical model is evaluated for cases where the location of the separation point is specified from experimental data. The predicted chordwise pressure distributions are shown to correlate well with experimental data for several multiple airfoils (including leading-edge slats and trailing-edge slotted flaps) for angles of attack near stall. Author

**N73-15010** Royal Aircraft Establishment, Farnborough (England).

**THE EFFECT OF LEADING EDGE GEOMETRY ON HIGH SPEED STALLING**

G. F. Moss, A. B. Haines (Aircraft Res. Assoc.), and R. Jordon (Aircraft Res. Assoc.) *In* AGARD Fluid Dyn. of Aircraft Stalling Nov. 1972 16 p refs

It is shown by means of an example how small modifications to the leading-edge profile of a sweptwing can result in large effects on lift performance at the stall in the higher range of subsonic speeds. The basic types of leading-edge pressure distribution for any one fixed geometry over the whole range of subsonic speed are discussed and the difficulties in designing a profile shape which gives a satisfactory compromise in wing performance across this range is emphasized. Two types of variable-geometry device at the leading edge are discussed, each of which allows some degree of optimization in the shape required for good aerodynamic performance across the range of Mach numbers. Author

**N73-15011** Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio. Control Criteria Branch.
**A PRACTICAL LOOK AT THE STALL AND HIGH LIFT OPERATION OF EXTERNALLY BLOWN FLAP STOL TRANSPORT CONFIGURATIONS**
David J. Moorehouse *In* AGARD Fluid Dyn. of Aircraft Stalling Nov. 1972 13 p refs

Some practical design aspects of the stall of powered-lift aircraft having externally blown flaps are considered. Techniques are examined for predicting the increment in maximum lift coefficient due to power. Numerical results are presented for an existing theory based on the assumption of a leading-edge stall and the use of basic jet-flap theory. The accuracy of the theory is better than might be expected, and an empirical factor is added to produce good correlation with measured values. A completely empirical approach is shown to be effective as a simple technique to provide quick approximations to the increment in maximum lift coefficients. Author

**N73-15012** British Aircraft Corp., Warton (England). Aerodynamics Dept.
**FLIGHT DEVELOPMENT OF THE STALLING CHARACTERISTICS OF A MILITARY TRAINER AIRCRAFT**
W. D. Horsfield and G. P. Wilson *In* AGARD Fluid Dyn. of Aircraft Stalling Nov. 1972 9 p

The modifications to the Jet Provost Mk. 5 and the Strikemaster 167 aircraft to improve the stall warning characteristics are reported. The procedures for obtaining the desired characteristics of a clearly marked stall with adequate warning of the approach without penalty on maximum lift and without involving large aircraft modifications are described. Diagrams and illustrations of the final configurations are included. Author

**N73-15013** General Dynamics/Fort Worth, Tex.
**STALL/POST-STALL CHARACTERISTICS OF THE F-111 AIRCRAFT**
Charles A. Anderson *In* AGARD Fluid Dyn. of Aircraft Stalling Nov. 1972 9 p

The stall/post-stall characteristics of the F-111 aircraft are described. The characteristics have been defined on the basis of wind tunnel tests, free-flight model tests, radio controlled drop model tests, analytical analysis, and flight tests. The extent of each type of testing is discussed and a summary of the results is presented. A discussion of the regression techniques used to obtain aerodynamic derivatives in the high angle of attack simulator is included. Author

**N73-15014** Hawker Siddeley Aviation, Ltd., Kingston upon Thames (England).
**POST-STALL AERODYNAMICS OF THE HARRIER GR1**
Cliff L. Bore *In* AGARD Fluid Dyn. of Aircraft Stalling Nov. 1972 7 p refs

The post-stall aerodynamics of the Harrier GR1 aircraft are discussed. The requirement to achieve high usable lift coefficients during maneuvering at subsonic speeds, without incurring a weight penalty for leading edge devices is described. The resulting characteristics of boundary layer separation after buffet onset are analyzed. The effects of arrays of fences and vortex generators are examined. Author

**N73-15015** Royal Netherlands Aircraft Factories Fokker, Amsterdam.
**AERODYNAMICS OF WING STALL OF THE FOKKER F28**
Tj. Schuringa *In* AGARD Fluid Dyn. of Aircraft Stalling Nov. 1972 5 p

The aerodynamic development of the F28 wing with regard to the stall are described. First, the investigation in the wind tunnel is reported, dealing with the influence of boundary layer fences, secondly the correlation with flight tests is presented. It may be concluded that, apart from minor modifications, satisfactory agreement was found between wind tunnel and flight test results. Author

**N73-15016** Boeing Co., Seattle, Wash.
**PREDICTING THE LOW SPEED STALL CHARACTERISTIC OF THE BOEING 747**
John K. Wimpress *In* AGARD Fluid Dyn. of Aircraft Stalling Nov. 1972 9 p

The pre-flight estimates for the Boeing 747, based on wind tunnel data obtained at a Reynolds Number of approximately 1 million, are presented. These test results were adjusted to full scale flight values using correlation factors developed from other Boeing transport airplanes. As an indepedent check, high lift data were obtained in a pressurized wind tunnel up to a Reynolds Number of 7.5 million and extrapolated to the full scale value of 40 million. Flight results show that the correlation factors were moderately successful in predicting stall speeds. Also, extrapolating the pressure tunnel data to full scale Reynolds Numbers predicted the flight value of maximum lift coefficient with reasonable accuracy. The wind tunnel data at all Reynolds Numbers predicted satisfactory handling characteristics throughout the stall that were confirmed during flight testing. Author

**N73-15017** Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio. Aeromechanics Branch.
**ON AIRFLOW SEPARATION AND BUFFET ONSET DURING FIGHTER AIRCRAFT MANEUVERING**
Peter J. Butkewicz *In* AGARD Fluid Dyn. of Aircraft Stalling Nov. 1972 10 p refs

An experimental flight test program was sponsored to determine the buffet characteristics of four high performance aircraft. The aircraft were flown in transonic maneuvers encountering conditions of buffeting onset through heavy buffeting. The aircraft were instrumented with accelerometers, wing root strain gages, wing static pressure taps, and one wing was tufted for flow visualization photographs. The aircraft were flown in the baseline configuration as well as with various deflections of leading and trailing edge flaps. The results of the flight test program, the effects of mechanical high lift devices on buffet, and some wind tunnel/flight test correlations are presented. Author

**N73-15018** Royal Aircraft Establishment, Bedford (England).
**THE DYNAMIC ANALYSIS OF BUFFETING AND RELATED PHENOMENA**
J. G. Jones *In* AGARD Fluid Dyn. of Aircraft Stalling Nov. 1972 10 p refs

A dynamic analysis of buffeting and related aerodynamic phenomena is presented. The closed-loop interaction between the fluid motion, involving separated flow, and the motion of the wing surface is analyzed. The problem of formulating an appropriate theoretical model for buffeting is discussed. An analogous problem concerning the choice of appropriate analytical models for oscillatory rigid-body motion, known as wing rocking, is examined. Buffeting measurements obtained from flight tests of small combat trainer aircraft are included. Author

**N73-15019*** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**MANEUVER AND BUFFET CHARACTERISTICS OF FIGHTER AIRCRAFT**
Edward J. Ray (McDonnell Aircraft Co., St. Louis), Linwood W. McKinney, and Julian G. Carmichael *In* AGARD Fluid Dyn. of Aircraft Stalling Nov. 1972 11 p refs

The high subsonic and transonic characteristics of fighter aircraft and the factors affecting aerodynamic boundaries, such as maximum obtainable lift, buffet onset, pitchup, wing rock, and nose slice are discussed. Investigations were made using a general research configuration which encompassed a systematic matrix of wing design parameters. These results emphasized the sensitivity to section and planform geometry at the selected design point. The incorporation of variable-wing-geometry devices in the form of leading-edge slats or flaps was shown in a number of flight and wind-tunnel studies to provide controlled flow over a wide range of flight conditions and substantial improvements in maneuver capabilities. Additional studies indicated that the

blending of a highly swept maneuver strake with an efficient moderately swept wing offers a promising approach for improving maneuver characteristics at high angles of attack without excessive penalties in structural weight. Author

**N73-15020** Naval Air Systems Command, Washington, D.C.
**AERODYNAMIC DESIGN AND FLIGHT TEST OF US NAVY AIRCRAFT AT HIGH ANGLES OF ATTACK**
W. R. Burris and J. T. Lawrence *In* AGARD Fluid Dyn. of Aircraft Stalling Nov. 1972 10 p refs

The aerodynamic design, engineering development, and flight testing of naval aircraft at high angles of attack are discussed. The flight regime beginning with buffet onset and proceeding up through departure from controlled flight is investigated. Post-stall gyrations and spin recovery are analyzed. The importance of the design process for low speed flight stability is emphasized. Author

**N73-15021#** Department of Civil Aviation, Melbourne (Australia). Airways Engineering Research and Development Section.
**MEASUREMENT OF SONIC BOOM FROM CONCORDE-002 AUSTRALIA 1972**
M. E. L. Williams and N. W. Page Aug. 1972 44 p refs
(R/D-896) Avail: NTIS HC $4.25

Measurements were made of the sonic boom produced by the Concorde 002 aircraft during two supersonic flights. For both flights the aircraft was cruising at about Mach 2 at an altitude of about 52,000 feet. The overpressures measured indicated that, for a signature undistorted by atmospheric turbulence, the maximum overpressure on the ground was about 90 Pa for both flights. Ray paths and ground overpressure distributions were calculated using atmospheric data measured for each flight. Author

**N73-15022#** National Aerospace Lab., Tokyo (Japan).
**TRANSONIC AND SUPERSONIC FLUTTER CHARACTERISTICS OF LOW ASPECT RATIO AND SWEPTBACK THIN CANTILEVER WINGS**
Eiichi Nakai, Toshiyuki Morita, Takao Kikuchi, Minoru Takahashi, and Masatoshi Tookubo May 1972 17 p refs In JAPANESE; ENGLISH summary
(NAL-TR-288) Avail: NTIS HC $3.00

The transonic and supersonic flutter characteristics of thin cantilever wings with sweepback angles of 42.5 deg at the leading edge and 10 degrees at the trailing edges an aspect ratio of 1.344, and a taper ratio of 0.63 are presented. The experiments were conducted in a transonic blowdown wind tunnel at subsonic and supersonic speeds. The flutter boundary of the stiffness-altitude coefficients is characterized by having a maximum value near Mach 1.05 in the transonic speed range and by increasing in value with an increase of Mach number in the supersonic range. Author

**N73-15023#** Aeronautical Research Labs., Melbourne (Australia).
**DYNAMIC TESTS OF A YIELDING SEAT BELT SYSTEM**
S. R. Sarrailhe Jun. 1972 39 p refs
(ARL/SM-340) Avail: NTIS HC $4.00

The performance of crash protective seat belts can be improved by incorporating energy absorbers to allow the system to yield at constant force. The principle can be applied to the whole system or to critical components. As upper torso restraint is desirable but strength for attachment is limited in aircraft, dynamic tests were carried out with lap/sash seat belts incorporating energy absorbers in the sash (shoulder) straps. For comparison conventional assemblies were also tested. The tests showed that with energy absorbers allowing an increase in dummy movement of five inches or less the shoulder strap forces could be reduced by 30 percent. Alternatively energy absorbers allowed an increase of 50 percent on the input deceleration without increase in shoulder strap force. It was considered that energy absorption in the seat and lap belts could allow similar improvement in these components. The load distribution between the strap and the friction force between the dummy and seat was examined and it was found that the seat force was of similar magnitude to the combined lap strap forces. Author

**N73-15024#** National Transportation Safety Board, Washington, D.C.
**AIRCRAFT ACCIDENT PRELIMINARY REPORT, EASTERN AIR LINES, INCORPORATED, L-1011, N310EA NEAR MIAMI, FLORIDA, 29 DECEMBER 1972**
11 Jan. 1973 10 p
Avail: NTIS $3.00

The conditions and circumstances existing at the time of the crash of a Lockheed L-1011 aircraft near Miami, Florida on 29 Dec. 1972 are presented. The aircraft experienced nose gear system malfunction during the approach to the airport and this problem was being investigated at the time of the crash. No statement is made concerning the cause of the accident which resulted in fatalities to five crew members and ninety-four passengers. P.N.F.

**N73-15025*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**ACOUSTIC PROPERTIES OF A SUPERSONIC FAN**
Arthur W. Goldstein, Frederick W. Glaser, and James W. Coats Washington Jan. 1973 39 p refs
(NASA-TN-D-7096; E-6953) Avail: NTIS HC $3.00 CSCL 20A

Tests of supersonic rotors designed to reduce forward propagating pressure waves and the accompanying blade passing tones and multiple pure tones showed the wave propagation and noise reduction to have been obtained at the expense of increased noise radiation rearward. Outlet guide vanes served to muffle the noise propagating rearwards, but did not affect forward propagation at all. Author

**N73-15026*#** Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
**EXCITATION, RESPONSE, AND FATIGUE LIFE ESTIMATION METHODS FOR THE STRUCTURAL DESIGN OF EXTERNALLY BLOWN FLAPS**
Eric E. Ungar, K. L. Chandiramani, and J. E. Barger Oct. 1972 107 p refs
(Contract NAS1-9559-67)
(NASA-CR-112216; Rept-2469) Avail: NTIS HC $7.50 CSCL 01B

Means for predicting the fluctuating pressures acting on externally blown flap surfaces are developed on the basis of generalizations derived from non-dimensionalized empirical data. Approaches for estimation of the fatigue lives of skin-stringer and honeycomb-core sandwich flap structures are derived from vibration response analyses and panel fatigue data. Approximate expressions for fluctuating pressures, structural response, and fatigue life are combined to reveal the important parametric dependences. The two-dimensional equations of motion of multi-element flap systems are derived in general form, so that they can be specialized readily for any particular system. An introduction is presented of an approach to characterizing the excitation pressures and structural responses which makes use of space-time spectral concepts and promises to provide useful insights, as well as experimental and analytical savings. Author

**N73-15027*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**EXTERNALLY BLOWN FLAP TRAILING EDGE NOISE REDUCTION BY SLOT BLOWING: A PRELIMINARY STUDY**
D. J. McKinzie, Jr. and R. J. Burns 1973 16 p refs Presented at 11th Aerospace Sci. Meeting Tech. Display, Washington, D. C., 10-12 Jan. 1973; sponsored by AIAA
(NASA-TM-X-68172; E-7251) Avail: NTIS HC $3.00 CSCL 01B

Short takeoff and landing (STOL) aircraft using externally blown flaps (EBF) for lift augmentation develop considerable

jet-flap interaction noise. A proposed method to reduce the EBF trailing edge noise is to locate a slot near the trailing edge of a flap through which low velocity secondary air is blown. Limited OASPL noise data were obtained from the interaction of the jet exhaust from a 5.08 cm diameter convergent nozzle with the trailing edge of a plate, and are presented for five slot configurations located near or at the trailing edge of the plate. Also presented are some significant jet trailing edge interaction data using a mixer nozzle with one of the slot configurations. Author

**N73-15028*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**JET NOISE OF AN AUGMENTOR WING-ADVANCED SUPERSONIC TRANSPORT**
Leo Franciscus Dec. 1972 12 p refs
(NASA-TM-X-68177; E-7270) Avail: NTIS HC $3.00 CSCL 01B

A preliminary mission study was made of the range and jet noise of an advanced supersonic transport (AST) employing an augmentor wing and four duct burning turbofan engines. The airplane weight and aerodynamic characteristics of the Boeing 2707-300 airplane with a gross weight of 750,000 pounds and 234 passengers was used for the study. Engine thrust was fixed at 58,000 pounds per engine and engine size was increased to obtain the required thrust at reduced power settings for jet noise reduction. Turbofan engine core noise was reduced to FAR 36 noise levels and lower by proper selection of turbine inlet temperature, bypass ratio and fan pressure ratio. The study showed that an augmentor wing can reduce the bypass jet noise sufficiently so that total noise levels below FAR 36 can be attained without significant range penalties if the augmentor wing can be designed without severe weight and performance penalties. Author

**N73-15029*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**OPTIMIZATION OF ENGINES FOR A COMMERCIAL MACH 0.85 TRANSPORT USING ADVANCED TURBINE COOLING METHODS**
Gerald A. Kraft Nov. 1972 42 p refs
(NASA-TM-X-68173; E-7212) Avail: NTIS HC $4.25 CSCL 21E

A parametric study was made of a group of separate-flow-turbofan engines for use in advanced technology airplanes designed for a cruise Mach number of 0.85 at 40,000 feet. The three-engined airplanes were sized to carry 200 passengers 3000 nautical miles. Supercritical aerodynamics were assumed. Film-cooled turbines were used and sea-level-static turbine-rotor-inlet temperature was always 2600 F. The optimum cycle depends on the noise goal assumed. Without a noise goal the best fan pressure ratio (FPR) is about 1.90. At noise goals of FAR 36, -10 EPNdb, and -20 EPNdb, the best FPR's are 1.85, 1.76, and 1.70, respectively, at cruise. The take-off FPR's are progressively less than the cruise value as the noise goal approaches -20 EPNdb. The penalties in take-off gross weight incurred were 8.5, 19, and 64 percent at goals of FAR 36, -10 EPNdb, and -20 EPNdb, respectively. Author

**N73-15030*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**FLAP NOISE MEASUREMENTS FOR STOL CONFIGURATIONS USING EXTERNAL UPPER SURFACE BLOWING**
Robert G. Dorsch, Meyer Reshotko, and William A. Olsen 1972 39 p refs Presented at 8th Propulsion Joint Specialists Conf., New Orleans, La., 29 Nov. - 1 Dec. 1972; sponsored by AIAA and ASME
(NASA-TM-X-68167; E-7227) Avail: NTIS HC $4.00 CSCL 01B

Screening tests of upper surface blowing on externally blown flaps configurations were conducted. Noise and turning effectiveness data were obtained with small-scale, engine-over-the-wing models. One large model was tested to determine scale effects. Nozzle types included circular, slot, D-shaped, and multilobed. Tests were made with and without flow attachment devices. For STOL applications the particular multilobed mixer and the D-shaped nozzles tested were found to offer little or no noise advantage over the round convergent nozzle. High aspect ratio slot nozzles provided the quietest configurations. In general, upper surface blowing was quieter than lower surface blowing for equivalent EBF models. Author

**N73-15031*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**EFFECT OF ROTOR DESIGN TIP SEED ON AERODYNAMIC PERFORMANCE OF A MODEL VTOL LIFT FAN UNDER STATIC AND CROSSFLOW CONDITIONS**
N. O. Stockman, I. J. Loeffler, and S. Lieblein 1973 32 p refs Proposed for presentation at Ann. Gas Turbine Conf., Washington, D. C., 8-12 Apr. 1973; sponsored by Am. Soc. of Mech. Engr.
(NASA-TM-X-68169; E-7230) Avail: NTIS HC $3.75 CSCL 01B

Results are presented for a wind tunnel investigation of three single VTOL lift fan stages designed for the same overall total pressure ratio at different rotor tip speeds. The stages were tested in a model lift fan installed in a wing pod. The three stages had essentially the same aerodynamic performance along the operating line. However, differences in stage thrust characteristics were obtained when a variation in back pressure was imposed on the stages by cross-flow effects and thrust-vectoring louvers. Author

**N73-15032*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**COMPARATIVE PERFORMANCE OF SEVERAL SST CONFIGURATIONS POWERED BY NOISE LIMITED TURBOJET ENGINES**
John B. Whitlow, Jr. Dec. 1972 67 p refs
(NASA-TM-X-68178) Avail: NTIS HC $5.50 CSCL 01B

A simplified study was made in which the mission performances of three Mach 2.7 airplane configurations were compared. Both wing loading and size of the unaugmented turbojet engines were varied at different levels of suppressor technology. The lowest gross weight and the best return on investment were obtained with an advanced arrow wing configuration when a mission range of 4200 nautical miles was specified. This comparison was made for the takeoff noise levels specified in F.A.R. 36 using retractable jet noise suppressors assumed to be capable of 15 PNdb of suppression with only a 7.5-percent thrust loss. With less advanced suppressor technology, a modified delta configuration is a close competitor of the arrow wing. Despite its good takeoff characteristics, a swing-wing configuration was too structurally heavy to be competitive at F.A.R. 36 noise levels. Engine performance and weight commensurate with engine definition in 1975 were postulated. Author

**N73-15033*#** Lockheed Aircraft Corp., Burbank, Calif.
**STUDY OF LOAD ALLEVIATION AND MODE SUPPRESSION (LAMS) ON THE YF-12A AIRPLANE**
Lester D. Edinger, Frederick L. Chenk, and Alan R. Curtis Washington NASA Dec. 1972 140 p refs Sponsored by NASA Prepared in cooperation with Honeywell, Inc., Minneapolis (Contract F33657-71-C-0021)
(NASA-CR-2158) Avail: NTIS HC $3.00 CSCL 01B

The potentials and capability for implementing a LAMS (load alleviation and mode suppression) system on the YF-12A for the purpose of flight research were evaluated. The nature of the research is to minimize the design risk in application of LAMS to future aircraft. The results of the study show that the YF-12A would be a suitable test bed for continuing development of LAMS technology. This was demonstrated by defining five candidate LAMS systems and analytically evaluating them with regard to performance and mechanization. Each of the five systems used a different combination of force producers. A small canard vane or a mass-reaction device mounted near the cockpit was considered as a possible LAMS force producer, together with the existing inboard and outboard elevons. It was concluded that a combination of canard vane and outboard elevons would provide the most effective system for the YF-12A. Author

N73-15034*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**MOTION SIMULATOR STUDY OF LONGITUDINAL STABILITY REQUIREMENTS FOR LARGE DELTA WING TRANSPORT AIRPLANES DURING APPROACH AND LANDING WITH STABILITY AUGMENTATION SYSTEMS FAILED**
C. T. Snyder, E. B. Fry, F. J. Drinkwater, III, R. D. Forrest (FAA), B. C. Scott (FAA), and T. D. Benefield (FAA) Dec. 1972 109 p refs
(NASA-TM-X-62200) Avail: NTIS HC $7.50 CSCL 01B

A ground-based simulator investigation was conducted in preparation for and correlation with an in-flight simulator program. The objective of these studies was to define minimum acceptable levels of static longitudinal stability for landing approach following stability augmentation systems failures. The airworthiness authorities are presently attempting to establish the requirements for civil transports with only the backup flight control system operating. Using a baseline configuration representative of a large delta wing transport, 20 different configurations, many representing negative static margins, were assessed by three research test pilots in 33 hours of piloted operation. Verification of the baseline model to be used in the TIFS experiment was provided by computed and piloted comparisons with a well-validated reference airplane simulation. Pilot comments and ratings are included, as well as preliminary tracking performance and workload data. Author

N73-15035# Ryan Aeronautical Co., San Diego, Calif.
**THE AVSYN AIR VEHICLE SYNTHESIS PROGRAM FOR CONCEPTUAL DESIGN**
K. L. Sanders and P. A. Staley 1972 32 p refs Presented at IPAD Colloq., Hampton, Va., 2-5 Oct. 1972
Avail: NTIS HC $3.75

A digital computer program for the rapid sizing, parametric analyses and optimization of general aircraft configurations and propulsion concepts, for a specified mission profile, performance, and payload, is described. The program, Air Vehicle Synthesis (AVSYN), was developed to serve as a key analytical tool for conceptual design efforts. Input consists of a total of 140 variables describing the geometric, aerodynamic, and weight characteristics (independent variables) of the baseline configuration, and the speeds, altitudes, and distances of the mission segments. A combat case may be represented by a steady state, sustained turn requirement. The program uses a generalized geometric model, empirical weight and drag relationships; permits computation of parameter trade-offs for selected sizing options and constraints; and finally converges on a solution for gross weight, vehicle and engine size for a balanced mission. Author

N73-15036# Lockheed Missiles and Space Co., Huntsville, Ala.
**WAKE VORTEX AVOIDANCE SYSTEM Final Report, Apr. - Dec. 1972**
D. J. Wilson, M. R. Brashears, E. A. Carter, and K. R. Shrider Dec. 1972 131 p refs
(Contract DOT-FA72WA-2878)
(LMSC/HREC-D306226; HREC-2878-2; FAA-RD-72-108) Avail: NTIS HC $8.75

A conceptual design for a predictive-detective system to: (1) predict the movement and decay of aircraft-generated vortices in air corridors near the air terminal using forecast meteorological conditions; (2) periodically update the prediction by monitoring vortex movements; (3) provide a forecast of separation requirements for optimum aircraft spacing according to prevailing vortex conditions, and (4) provide a waveoff (or hold) capability for rare cases when vortices stray unpredictably into a hazard zone. The predictive system computer model includes the meteorological input data and the fluid mechanics used to develop the vortex prediction. Fluid mechanic discussions include wind, wind shear and buoyancy effects upon vortex transport and decay. Computer runs are presented to demonstrate vortex transport under numerous meteorological conditions at example airports. A test for proof of the predictive system concept is discussed. Author

N73-15037*# Recovery Systems Research, Inc., Alamogordo, N. Mex.
**DESIGN STRESS ANALYSIS AND PERFORMANCE CHARACTERISTICS FOR 140 FT. DIAMETER RSR RIBCO PARACHUTE SYSTEM Final Report, 2 Dec. 1971 - 1 Apr. 1972**
Joe A. Haden 30 Jul. 1972 32 p refs
(Contract F19628-72-C-0131; NASA Order L-9698)
(NASA-CR-130304; AFCRL-72-0451) Avail: NTIS HC $3.75 CSCL 01B

The design, stress analysis and high altitude performance of the RSR RIBCO Parachute System are discussed. A 140-foot diameter parachute system was tested. This system was released from a balloon at 100,000 feet altitude with a payload of 611 pounds. Performance characteristics (opening time, opening shock, snatch force, rate of descent and total descent time) were very nearly as predicted. Test results indicate that the RIBCO System offers many advantages over conventional parachute systems. Author

N73-15038# National Aerospace Lab., Tokyo (Japan).
**EFFECT OF GROUND PROXIMITY ON THE LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF AN AIRPLANE WITH A JET-FLAPPED HIGH LIFT WING**
Hiroshi Endo, Hiroshi Takahashi, Teruomi Nakaya, and Tadaharu Watanuki Aug. 1972 30 p refs In JAPANESE; ENGLISH summary
(NAL-TR-294) Avail: NTIS HC $3.50

The effect of ground proximity on the lift, drag, and pitching moment of an aircraft equipped with a jet-flapped rectangular wing was investigated in a low speed wind tunnel using a moving belt technique. It was found that ground effect is more pronounced in pitching moment and drag than in lift. The effect on the pitching moment is due to suppression by ground proximity of the downwash of the tail, which otherwise generates a positive pitching moment on the tail. Author

N73-15039# Toronto Univ. (Ontario). Inst. for Aerospace Studies.
**AN EXPERIMENTAL AND THEORETICAL INVESTIGATION OF PROPELLERS OPERATING IN TURBULENCE**
T. A. P. S. AppaRao Nov. 1972 130 p refs
(UTIAS-183) Avail: NTIS HC $8.50

The effect of atmospheric turbulence on the forces and moments on a propeller have been studied both experimentally and theoretically. The experimental study consisted of measuring the normal force and pitching moment responses of a model propeller operating in a turbulent field generated in a wind. The theoretical part of the investigation includes the development of a method of calculating the response of the propeller in terms of the turbulence spectra and the aerodynamic derivatives. Results of the two methods of investigation are compared. Author

N73-15040*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**A SUBJECTIVE EVALUATION OF SYNTHESIZED STOL AIRPLANE NOISES**
Clemans A. Powell, Jr. Washington Jan. 1973 36 p refs
(NASA-TN-D-7102; L-8596) Avail: NTIS HC $3.00 CSCL 01B

A magnitude-estimation experiment was conducted to evaluate the subjective annoyance of the noise generated by possible future turbofan STOL aircraft as compared to that of several current CTOL aircraft. In addition, some of the units used to scale the magnitude of aircraft noise were evaluated with respect to their applicability to STOL noise. Twenty test subjects rated their annoyance to a total of 119 noises over a range of 75 PNdb to 105 PNdb. Their subjective ratings were compared with acoustical analysis of the noises in terms of 28 rating scale units. The synthesized STOL noises of this experiment were found to be slightly more annoying than the conventional CTOL noises at equal levels of PNL and EPNL. Over the range of levels investigated the scaling units, with a few exceptions, were capable of predicting the points of equal annoyance for all of the noises with plus or minus 3 dB. The inclusion of duration corrections, in general, improved the predictive capabilities of the various scaling units; however, tone corrections reduced their predictive capabilities. Author

**N73-15041*#** McDonnell Aircraft Co., St. Louis, Mo. Aircraft Advanced Engineering Group.
**CONCEPTUAL DESIGN OF A V/STOL LIFT FAN COMMERCIAL SHORT HAUL TRANSPORT Summary Report**
Washington NASA Jan. 1973 88 p refs
(Contract NAS2-5499)
(NASA-CR-2184) Avail: NTIS HC $3.00 CSCL 01C

Conceptual designs 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. Engine concepts studied included both integral remote fans. The scope of the study included definition of the hover control concept for each propulsion system, aircraft design, aircraft mass properties, cruise performance noise, and ride qualities evaluation. Economic evaluation was also studied on a basis of direct operating cost and route structure. Author

**N73-15044#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Porz (West Germany). Inst. fuer Angewandte Gasdynamik.
**CONTRIBUTION TO WAVE DRAG REDUCTION AT ZERO LIFT IN FRONT OF SYMMETRICAL POINTED WINGS OF FINITE THICKNESS AND OF THE SAME VOLUME AS GEOMETRICAL FUNCTIONS OF WING PLANFORM AND DISPLACEMENT OF THE MAXIMUM THICKNESS IN SPAN- AND CHORDWISE DIRECTION [BEITRAG ZUR VERRINGERUNG DES WELLENWIDERSTANDES BEI NULLAUFTRIEB VORN SPITZER SYMMETRISCHER FLUEGEL ENDLICHER DICKE UND GLEICHEN VOLUMENS ALS FUNKTIONEN DER GEOMETRIE VON GRUNDRISSFORM UND VERSCHIEBUNG DER MAXIMALEN DICKE IN SPANNWEITEN- UND TIEFENRICHTUNG]**
Friedrich Keune Jul. 1971 46 p refs In GERMAN; ENGLISH summary
(DLR-FB-71-61) Avail: NTIS HC $4.50; DFVLR Porz, West Ger. 19.20 DM

The influence of a pronounced displacement of the maximum thickness in a spanwise direction on wave drag was investigated theoretically for a certain analytically defined distribution of finite thickness and planform. It is shown that a much larger displacement of the maximum thickness can be achieved than was considered. The change in drag is therefore markedly larger than was found previously. The most favourable cases lead to a wave drag divergence up to 2/3 of the original value. For wings with sharp leading edges this value increases or reaches a minimum. Author (ESRO)

**N73-15045#** Aerospatiale Usines de Toulouse (France).
**THE TECHNICAL DEVELOPMENT OF AIR TRANSPORT IN THE 70'S. EUROPEAN CONTRIBUTION [DIE TECHNISCHE ENTWICKLUNG DES LUFTTRANSPORTS IN DEN 70ER JAHREN. EUROPAEISCHER BEITRAG ZU DIESER ENTWICKLUNG]**
Henri Ziegler 1972 54 p In GERMAN
Avail: NTIS HC $4.75

A survey is presented of the present state of development of air transportation. The trends during the next decades are analyzed. These include speed and capacity increase, V/STOL aircraft, and organization of third level traffic. The French program is presented along these lines. It includes the supersonic transport Concorde, the European Airbus development, the STOL Breguet 941 and the Corvette. Economics of third level traffic are discussed. Author (ESRO)

**N73-15046#** Vereinigte Flugtechnische Werke-Fokker G.m.b.H., Bremen (West Germany).
**VFW 624: MARKET, OPERATION, AND TECHNIQUES [VFW 624: MARKT, BETRIEB UND TECHNIK]**
H.-J. Hoeppner 1972 46 p In GERMAN Presented at the 5th DGLR Ann. Meeting, Berlin, 4-6 Oct. 1972
(DGLR-Paper-72-54) Avail: NTIS HC $4.50

The role of conventional STOL aircraft in future passenger transportation in Europe is discussed. One of the main problems is noise reduction, and it is pointed out that the CSTOL is an improvement with its steep takeoff and landing characteristics. The CSTOL is also a means of increasing the traffic capacity of existing airports, so that saturation level will not be reached until 1990. The planned air traffic control organization at European level (Eurocontrol), will allow better use of air highway capacity. Advantages of CSTOL in comparison to high speed rail transportation are indicated. The technology of CSTOL is demonstrated using the VFW 614 characteristics, which are similar. Author (ESRO)

**N73-15047#** Bodenseewerk Geraetetechnik G.m.b.H., Ueberlingen (West Germany).
**INTEGRATION PROBLEMS OF AIRCRAFT INSTRUMENTS AND CONTROL SYSTEM FOR NEW APPROACH METHODS [PROBLEME DER INTEGRATION VON FLUGGERAET UND FLUGFUEHRUNGSSYSTEM BEI NEUEN ANFLUGVERFAHREN]**
G. Schaenzer 1972 31 p refs In GERMAN Presented at the 5th DGLR Ann. Meeting, Berlin, 4-6 Oct. 1972
(DGLR-Paper-72-096) Avail: NTIS HC $3.75

A newly developed STOL integrated flight control system is described, in which the angle of incidence and flight path position as well as all important variables of state are strongly coupled to elevator, thrust, and lift flaps. This system enables accurate control of the aerodynamic flow condition as well as the exact path guidance for nonlinear approach profiles. The results of simulation and flight tests with a DO-28 aircraft, for more than 500 automatic STOL landings for testing new approach methods, are discussed with regard to four separate problems: aircraft instrumentation, beam guidance system, flight control system, and displays. Author (ESRO)

**N73-15048#** Messerschmitt-Boelkow-Blohm G.m.b.H., Ottobrunn (West Germany).
**EFFICIENCY INCREASE BY CONTROL SYSTEM SUPPORTED AIRCRAFT DESIGN [LEISTUNGSERHOEHUNG DURCH REGLERGESTUETZTEN FLUGZEUGENTWURF]**
Gerhard Loebert Sep. 1972 28 p refs In GERMAN Presented at the 5th DGLR Ann. Meeting, Berlin, 4-6 Oct. 1972
(MBB-UFE-895-72-O; DGLR-Paper-72-094) Avail: NTIS HC $3.50

The advantages of the control configured vehicle concept compared to conventional aircraft design, are pointed out for several examples. The improvements are found especially in the specific performance surplus at high lift coefficients, and in an increase of the obtainable maximal lift coefficients. The dynamic flight characteristics of these aircraft can be made similar to or better than aerodynamically stable aircraft by a suitable artificial stabilization. Author (ESRO)

**N73-15049#** Eidgenossisches Flugzeugwerk, Emmen (Switzerland). Versuchs- und Forschungsabteilung.
**CONTRIBUTION TO THE PROBLEM OF INGESTION OF FOREIGN BODIES INTO ENGINE INTAKES [BEITRAG ZUM PROBLEM DES EINSAUGENS VON FREMDKOERPERN IN TRIEBWERKSEINLAEUFE]**
Hans Pflugshaupt Sep. 1972 55 p refs In GERMAN Presented at the 5th DGLR Ann. Meeting, Berlin, 4-6 Oct. 1972
(FO-1149; DGLR-Paper-72-107) Avail: NTIS HC $4.75

The design of an aerodynamic screen for the short-range Mercury aircraft engine intake is presented. The danger of ingestion of foreign bodies into the engine intake nozzle because of vortex formation is one of the inconveniences of engine under wing arrangement on low wing aircraft. Blow away jets generated by the engine compressor and directed towards the center of the vortex on the ground are used to eliminate this danger. Author (ESRO)

**N73-15050#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung fuer Theoretische Aerodynamik.
**THEORETICAL PARAMETER STUDIES OF WING-FUSELAGE COMBINATIONS [THEORETISCHE PARAMETERUNTERSUCHUNGEN AN FLUEGEL-RUMPF-KOMBINATIONEN]**

Horst Koerner Aug. 1972 42 p refs In GERMAN; ENGLISH summary
(DLR-FB-72-63) Avail: NTIS HC $4.25; DFVLR. Porz, West Ger. 11 DM

A parameter study is presented of the influence of the main geometry parameters on the aerodynamic characteristics of a wing-fuselage combination in incompressible flow. A prediction method for wing-fuselage combinations with cylindrical fuselage developed by the Author is used. The parameters investigated in this study are body diameter, wing position, sweep, planform taper, and aspect ratio. Results are given for the lift slope, the aerodynamic centre of the total arrangement; and in some cases the local values along the span. Author (ESRO)

**N73-15051#** Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
**EVALUATION OF LATERAL-DIRECTIONAL HANDLING QUALITIES AND ROLL-SIDESLIP COUPLING OF FIGHTER CLASS AIRPLANES, VOLUME 2 Final Report**
Edward M. Boothe and Michael L. Parrag Wright-Patterson AFB, Ohio AFFDL May 1972 225 p
(Contract F33615-71-C-1240; AF Proj. 9219)
(AD-748436; CAL-BM-3053-F-2-Vol-2; AFFDL-TR-72-36-Vol-2) Avail: NTIS CSCL 01/3

Maneuvering tasks representative of the fighter mission and a precision bank angle tracking task were performed for evaluations. Evaluations were conducted at three Dutch roll frequencies, three roll-to-sideslip ratios and at values of Dutch roll damping on either side of the MIL-F-8785B(ASG) boundary. Satisfactory flying qualities were not obtained for any of the low Dutch roll frequency configurations investigated in this experiment. The Dutch roll damping requirements were found to be adequate, especially when the additional increment of damping as a function of Dutch roll frequency and roll-to-sideslip ratio is added. The roll-sideslip coupling requirements in terms of sideslip excursions were found to be conservative, especially at low to moderate values of roll-to-sideslip ratio. Author (GRA)

**N73-15052#** National Aeronautical Establishment, Ottawa (Ontario).
**A SUGGESTED METHOD FOR ESTIMATING PATCH LENGTH FROM TURBULENCE MEASUREMENTS USING RESULTS FROM LOW ALTITUDE FLIGHTS BY A T-33 AIRCRAFT**
D. G. Gould and J. I. MacPherson Aug. 1972 26 p refs
(AD-750607; NAE-LR-562; NRC-12793) Avail: NTIS CSCL 01/1

When an aircraft encounters a patch of turbulence, the RMS turbulence intensity is usually constant only over a portion of the total period of exposure. A method is suggested for estimating the patch length as a function of intensity for turbulence encounters that have two or more regions of different turbulence intensities. It makes use of the fact that the amplitude or level crossing distributions that fall between the normal distribution and the exponential distribution be closely approximated by a superposition of normal distributions of different intensities. Level crossing distributions of vertical acceleration from a series of T-33 low altitude turbulence research flights are analyzed using this procedure, and results from flatland and hilly lakeland are compared. Author (GRA)

**N73-15053#** Army Air Mobility Research and Development Lab., Moffett Field, Calif.
**A THEORETICAL AND EXPERIMENTAL INVESTIGATION OF FLAP-LAG STABILITY OF HINGELESS HELICOPTER ROTOR BLADES**
Robert A. Ormiston and William C. Bousman 1972 15 p refs
Avail: NTIS CSCL 01/3

A substantial insight into the fundamental stability characteristics of the hingeless rotor may be obtained by considering only the flap and lead-lag degrees of freedom of a single blade. Although portions of this problem have been examined in previous research, the effects of many basic rotor parameters are poorly understood. The present study was undertaken to provide a rigorous formulation of the problem, and to systematically investigate the important parameters which characterize actual hingeless rotor blade configurations. In the absence of available experimental data a model rotor was designed and tested to validate the theoretical analysis. Author (GRA)

**N73-15054#** Naval Air Development Center, Warminster, Pa. Air Vehicle Technology Div.
**INVESTIGATION OF AN IMPROVED RESCUE HOIST SYSTEM FOR H-3 HELICOPTERS Final Report**
Howard B. Jopson 28 Sep. 1972 18 p ref
(AD-750289; NADC-72173-VT) Avail: NTIS CSCL 01/3

The report discusses the uses and shortcomings of the at-sea lift and rescue hoist system of the H-3 helicopter and desired capabilities for the future. Recommendations for providing an improved helicopter hoist system are presented. Author (GRA)

**N73-15056#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**REDUCTION OF BASE DRAG DURING SUPERSONIC VELOCITIES USING POWER METHOD**
B. I. Buryshev 7 Sep. 1972 9 p Transl. into ENGLISH from Teplo-1 Massoperenos (USSR), no. 12, 1969 p 35-38
(AD-750950; FDT-HC-23-0836-72) Avail: NTIS CSCL 01/3

The article describes the results of experimental drag investigation of a nacelle containing two engines and a wing of a long range supersonic plane for reduction of base during supersonic velocities using power method. GRA

**N73-15057#** Frankford Arsenal, Philadelphia, Pa.
**DYNAMIC RESPONSE INDEX MINIMIZATION FOR PERSONNEL ESCAPE SYSTEMS**
Leonard A. DeStefano 1972 15 p refs
(AD-750318) Avail: NTIS CSCL 01/3

The paper outlined a technique which may be employed with minimum modification to existing rocket catapult components to reduce the probability of injury to users of aircraft emergency escape systems. Experimental tests have verified the results of theoretical analyses and have demonstrated the ability to modify the catapult ballistics and thus moderate the dynamic response index (DRI). In addition, this technique may also be employed to upgrade the performance of existing and future aircraft escape systems by permitting maximization of the ejection velocity with respect to the allowable catapult stroke and DRI specification limit. Author (GRA)

**N73-15058#** Army Electronics Command, Fort Monmouth, N.J.
**INFRARED TECHNOLOGY AND ITS APPLICATION FOR MEASUREMENT OF AIRCRAFT**
Leonard H. Holden, Jr. and Edward Valenzuela Mar. 1972 202 p refs
(DA Proj. 1F1-62208-A-148)
(AD-749798; ECOM-5386) Avail: NTIS CSCL 01/3

The report confined to the measurement of infrared radiation emitted by aircraft, includes a catalog of each type of aircraft in the US Army inventory. Each type is represented because the measurement procedures used may differ for each depending upon size, speed, and intended tactical use. A brief discussion of the physical laws involved in taking such measurements is also included, as is a discussion on the different backgrounds encountered in a measurement program. The need for adequate instrument calibration is emphasized. Various measurement techniques and their application are discussed. Data reduction and analysis are covered briefly, and several parameters that are routinely determined by analysis are considered. Author (GRA)

**N73-15059#** Naval Aerospace Medical Research Lab., Pensacola, Fla.
**ORIENTATION-ERROR ACCIDENTS IN REGULAR ARMY UH-1 AIRCRAFT DURING FISCAL YEAR 1969: RELATIVE INCIDENCE AND COST**

W. Carroll Hixson, Jorma I. Niven, and Emil Spezia Aug. 1972 35 p refs
(AD-749695; NAMRL-1163; USAARL-73-1) Avail: NTIS CSCL 01/2

The report deals with the magnitude of the pilot disorientation/vertigo accident problem in Regular Army UH-1 helicopter operations. Incidence and cost data presented for fiscal year 1969 include a total of 46 major and minor orientation-error accidents (16 of which were fatal), resulting in 39 fatalities, 67 nonfatal injuries, and $8,130,297 aircraft damage.
Author (GRA)

**N73-15060#** Naval Ordnance Lab., White Oak, Md.
**A TECHNIQUE FOR THE CALCULATION OF THE OPENING SHOCK FORCES FOR SEVERAL TYPES OF SOLID CLOTH PARACHUTES**
William P. Ludtke 20 Jun. 1972 67 p refs
(AD-749690; NOLTR-72-146) Avail: NTIS CSCL 01/3

In 1965, the Naval Ordnance Laboratory was engaged in a project which required the deployment of a 35-foot-diameter extended-skirt parachute (type T-10) as the second stage of a retardation system at an altitude of 100,000 feet. At that time, there were no available data on the T-10 parachute deployed under similar circumstances. This new parachute opening-shock calculation technique was generated as a solution to this dilemma. A drag area ratio-time ratio signature derived from infinite mass wind-tunnel parachute deployments is combined with Newton's second law of motion to develop instantaneous velocity ratios and shock factors during the deployment process. Methods of computing the reference time (to) and the inflation time (tf) are presented.
Author (GRA)

**N73-15061#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**SELF-ADJUSTING AUTOMATIC CONTROL SYSTEMS OF AEROELASTIC AIRCRAFT**
F. I. Fedorenko, V. A. Vishnevetskaya, V. I. Glukhov, and L. R. Lvov 17 Aug. 1972 17 p refs Transl. into ENGLISH from Inform. Mater. (Moscow), no. 7, 1970 p 36-42
(AF Proj. 487T)
(AD-750501; FTD-MT-24-353-72) Avail: NTIS CSCL 01/3

High quality control of an aircraft as a rigid body can be achieved (with allowance for the nonlinearity and inertia of the actuator) by using appropriate compensating devices and by placing adaptive filters in the angular velocity sensor circuits to eliminate noise caused by high and low frequency elastic oscillations. The primary low frequency components flexural vibrations in the wings and fuselage can be damped by special control surfaces on the wings and fuselage. This damping should not be altered from accelerometer sensors positioned in selected points. Required phase relationships are obtained with compensating necessary and either phase lead or phase lag filters. Automatic control of optimal gain in the stabilization loops is accomplished with the aid of spectrum analyzers. The synthesis of controller structure and parameters should be based on graph theory methods.
Author (GRA)

**N73-15062#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**PROSPECTIVE AUTOMATIC FLIGHT CONTROL SYSTEMS**
A. D. Aleksandrov 18 Aug. 1972 21 p refs Transl. into ENGLISH from Inform. Mater. (Moscow), no. 7, 1970 p 20-29
(AF Proj. 487T)
(AD-750502; FTD-MT-24-354-72) Avail: NTIS CSCL 01/3

The report contains a description of nonlinear self adjusting and variable structure automatic control systems for piloted and pilotless flight vehicles. Control problems considered include load stabilization, limitation of critical regimes, and control of variable pitch and roll angles. Emphasis is placed on the extension of stability ranges by appropriate switching of the controller structure. The additional use of adaptive loops is demonstrated and oscillations arising from intrinsic nonlinear characteristics of electric servo systems (dead zones and time lags) are examined.
Author (GRA)

**N73-15063#** Air Force Academy, Colo. Dept. of Aeronautics.
**THE EFFECTS OF EXTERNAL STORES ON THE LONGITUDINAL STATIC STABILITY OF AIRCRAFT Progress Report, 1 Sep. 1971 - 15 Jun. 1972**
Edgar W. Lorson Jun. 1972 57 p refs
(AD-750120; DFAN-TR-72-2) Avail: NTIS CSCL 01/3

Studies were made of experimental data to determine the effects of various external store characteristics, spanwise positions, and Mach number on the static longitudinal stability of various aircraft. Data used included results of wind tunnel tests run at the USAF Academy as well as tests run at the Arnold Engineering Development Center, the Naval Ship Research and Development Center and Breguet Aviation. External store characteristics considered were store frontal area, volume, and side projected area. The correlation between any of the three characteristics and change in static margin was approximately the same. Loss in static margin tended to increase to a maximum at moderate values of frontal area, volume, or side projected area and then to decrease for higher values.
Author (GRA)

**N73-15064#** Honeywell, Inc., Minneapolis, Minn. Systems and Research Div.
**AN INVESTIGATION OF AIRBORNE DISPLAYS AND CONTROLS FOR SEARCH AND RESCUE (SAR). VOLUME 4: AVIONICS REQUIREMENTS FOR A UTILITY AIRCRAFT Final Report, Sep. 1971 - Jan. 1972**
O. H. Lindquist, B. A. Olson, R. J. Kirk, and J. W. Wingert Sep. 1972 79 p Sponsored in part by Naval Air Systems Command, ECOM, Coast Guard Headquarters, and AFFDL
(Contract N00014-69-C-0460; NR Proj. 213-072)
(AD-750463; Honeywell-12609-FRI-Vol-4; JANAIR-720901) Avail: NTIS CSCL 06/7

An analytical study was conducted to define an avionics system concept for a U.S. Coast Guard multimission fixed-wing twin-engine aircraft. The system requirements were compiled from a previous concept definition study done under this contract for a search and rescue helicopter and from analysis of mission scenarios fitted to the unique USCG missions. The study tasks included development of representative mission scenarios, avionics and sensor package selection, man/machine function allocation, workload analysis and simulation, aircraft ride qualities and crew visibility analyses, and definition of a recommended cockpit configuration and sensor installation.
Author (GRA)

**N73-15065#** Army Air Mobility Research and Development Lab., Fort Eustis, Va.
**DYNAMIC COMPATIBILITY OF HELICOPTER PROPULSION SYSTEMS**
John M. Vance and James Gomez, Jr. 1972 16 p refs
Avail: NTIS CSCL 01/3

The overall problem of achieving dynamic compatibility in helicopter propulsion systems can be conveniently divided into four major areas: engine vibration limits; design of the engine/airframe interface; whirling and vibration of power transmission shafting, gearboxes, and bearings; and torsional stability of the engine and drive train with closed-loop fuel controls. These four areas are discussed each with a review of the state of the art and recommendations for future research and development.
Author (GRA)

**N73-15066#** Army Air Mobility Research and Development Lab., Moffett Field, Calif.
**NEAR OPTIMAL TAKEOFF PERFORMANCE OF A HEAVILY LOADED HELICOPTER IN GROUND EFFECT**
C. Rande Vause and Fredric H. Schmitz 1972 16 p refs
Avail: NTIS CSCL 01/2

The purpose of the investigation was to quantitatively define, through mathematical modeling, those parameters which are important to the pilot who must perform a heavily loaded STOL takeoff. The mathematical model can be used to quantitatively predict takeoff performance of single rotor Army helicopters. The resulting equations are physically easy to interpret and offer new insight into the delicate power balance of the takeoff maneuver.
Author (GRA)

**N73-15067#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.
**AN EXAMINATION OF THE CURRENT UNITED STATES AIR FORCE AIRCRAFT ENGINE STATUS REPORTING SYSTEM M.S. Thesis**
James F. Brady and Michael J. Scritchfield Sep. 1972 91 p refs
(AD-750910; SLSR-9-72) Avail: NTIS CSCL 21/5

By 1972, the United States Air Force has had an aircraft engine status reporting system for over twenty-two years. Since new advances in engine design could possibly overburden the system, a cross examination was made. The decision making environment of the Engine Item Manager was evaluated, along with the current reporting system. In addition, maintenance, supply, and transportation information systems were examined to see what parallel engine data they presented. As a result of this research, a new system was proposed that would eliminate the Engine Status Reporting System at a substantial saving to the Air Force. Author (GRA)

**N73-15068#** Army Natick Labs., Mass.
**A DISCUSSION OF THE APPLICABILITY OF PARACHUTES WITH PULLED DOWN VENTS FOR AIRDROP OF SUPPLIES AND EQUIPMENT FROM A 500 FOOT ALTITUDE Final Report**
Edward J. Giebutowski Oct. 1971 25 p ref
(DA Proj. 1F1-62203-D-195)
(AD-750585; USA-NLABS-TR-72-23-AD) Avail: NTIS CSCL 01/3

Data from thirty-one airdrop tests were plotted to show the variation of vertical, horizontal and total velocities and system orientation angle from the vertical as a function of altitude loss from the launch altitude. The purpose was to determine the applicability of using standard G-11A parachutes modified with pulled down vents for airdrop of Army supplies and equipment from an altitude of 500 feet. It was concluded that the system second vertical was the earliest event which could be considered a suitable criterion for acceptable impact conditions of horizontal and vertical velocity and system orientation angle. Author (GRA)

**N73-15069#** Ohio State Univ. Research Foundation, Columbus.
**AIR-CUSHION PRESSURE DURING STIFF-OPERATION FOR AIR-CUSHION LANDING SYSTEMS. PART 2: EXPERIMENTS Technical Report, Jul. 1971 - Jan. 1972**
Lit S. Han Mar. 1972 105 p
(Contracts F33615-70-C-1019; F33615-69-C1001; AF Proj. 1369)
(AD-750936; AFFDL-TR-71-4-Pt-2) Avail: NTIS CSCL 01/2

The report describes the experimental verification of the theory developed in Part I for ACLS in its stiff-mode operation. It also reports the discharge coefficient data required for computing air flow requirements. At low ground clearances, the theory was verified to be in excellent agreement with the experimental data obtained. At higher values of the ground clearance where the viscous flow theory is not expected to hold, appreciable difference between the experimental data and theoretical computation was observed. A multi-jet theory yet to be developed is expected to bridge the gap. Author (GRA)

**N73-15070#** Aeronautical Systems Div., Wright-Patterson AFB, Ohio.
**RESEARCH AND DEVELOPMENT CONTRIBUTIONS TO AVIATION PROGRESS (RADCAP). VOLUME 1: SUMMARY REPORT Final Report**
John G. Paulisick Aug. 1972 129 p refs
(AD-750108; ASD-TR-72-3073-Vol-1) Avail: NTIS CSCL 01/2

A two volume report contains the results of a joint DoD-NASA-DoT study of U.S. aeronautical progress since 1925. Volume 1 reviews the positive contributions of military aeronautical research and development programs to civil aviation, and assesses some possible future contributions of those military programs. The summary of detailed results is concerned with a review of the progress that has been made in aviation since 1925, an examination of current and planned military aeronautical programs with an assessment of their relevancy to civil aviation, relationships to the needs of civil airliner technology, and important findings and observations in the RADCAP Study. GRA

**N73-15071#** Aeronautical Systems Div., Wright-Patterson AFB, Ohio.
**RESEARCH AND DEVELOPMENT CONTRIBUTIONS TO AVIATION PROGRESS (RADCAP). VOLUME 2: APPENDICES 1 THRU 9 Final Report**
Charles R. Hudson, Jr., James B. Gebhard, Robert E. Dean, Richard J. Framme, and Albert Olevitch Aug. 1972 613 p refs
(AD-750109; ASD-TR-72-3073-Vol-2) Avail: NTIS CSCL 01/2

Volume 2 of a two volume report provides supplementary information concerning the results discussed in Volume 1. It covers the several technical disciplines in order to identify the major technological advances that have been made in aviation since 1925, the relevancy of currently planned and funded DoD aeronautical R-D programs to the R-D needs of civil transport aviation. Author (GRA)

**N73-15072#** Princeton Univ., N.J.
**THE PRINCETON PENNSYLVANIA ARMY AVIONICS RESEARCH PROGRAM. TAKE OFF OF HEAVILY LOADED HELICOPTERS Final Task Report, 1 Sep. 1966 - 30 Dec. 1971**
G. J. Born, E. J. Durbin, and F. H. Schmitz Jan. 1972 93 p refs
(Contract DA-28-043-AMC-02412(E); DA Proj. 1H1-62202-A-219)
(AD-750615; ECOM-02412-7) Avail: NTIS CSCL 01/2

In the report are given the results of the optimal control theory applied to the take-off of heavily loaded helicopters and the instrumentation requirements to enhance VTOL-STOL pilot flight control during the take-off maneuvers. The analysis and computation determined constrained and unconstrained extremal trajectories which maximize final altitude at a given distance (Research and Development Technical Report, ECOM 02412-4, August, 1969). The constrained optimal leads to a slightly decreased performance, but this is more than offset by the ease of implementation. The proposed take-off technique was simulated on an analog computer. A parameter sensitivity study was made which resulted in the formulation of specific instrumentation requirements. Author (GRA)

**N73-15073#** Princeton Univ., N.J.
**THE PRINCETON PENNSYLVANIA ARMY AVIONICS RESEARCH PROGRAM. ELEMENTS OF HELICOPTER HOVERING AND NEAR HOVER OPERATIONS WITH A SLING LOAD Final Report, 1 Sep. 1966 - 30 Dec. 1971**
Theodor A. Dukes Sep. 1972 72 p refs
(Contract DA-28-043-AMC-02412(E); DA Proj. 1H1-62202-A-219)
(AD-750618; ECOM-02412-12) Avail: NTIS CSCL 01/2

Three aspects of hovering and near-hover maneuvering of helicopters with sling loads are investigated. An elementary helicopter-load model is developed for the case of large attitude rate damping and is used to identify the most significant parameters and their effects on the dynamics. Various feedback loop closures are explored for their usefulness to provide damping to the pendulous helicopter-load motion. Three simple maneuvers are analyzed: arresting a swinging load motion, acceleration-deceleration and changing the hover location. Ideal thrust angle inputs are determined with which these elementary tasks can be performed so that there is no relative helicopter-load swinging motion at the end of the maneuver. A new Hover Mode of the earlier developed Integrated Trajectory Error Display (ITED) is described. Author (GRA)

**N73-15074#** Rochester Applied Science Associates, Inc., N.Y.
**INVESTIGATION OF THE DISSIPATION OF THE TIP VORTEX OF A ROTOR BLADE BY MASS INJECTION Final Report**

Richard P. White, Jr. and John C. Balcerak Aug. 1972 97 p refs
(Contract DAAJ02-71-C-0036; DA Proj. 1F1-62203-A-143)
(AD-750634; RASA-72-03; USAAMDRL-TR-72-43) Avail: NTIS CSCL 01/3

The report describes an experimental research program in which the outer section of a UH-1D helicopter blade was modified to incorporate a system for injecting the tip vortex produced by the blade with a mass of linearly directed air. The effects of nozzle geometry, the velocity of injection, the turbulence wavelength, and the angle of injection on the resulting strength of the trailed tip vortex were investigated, and the results are presented in terms of quantitative measurements of the circulation strength as a function of the injected mass of air. Author (GRA)

**N73-15075#** Boeing Co., Philadelphia, Pa. Vertol Div.
**SECTIONALIZED MAIN ROTOR BLADE ADVANCED DESIGN STUDY Final Technical Report**
Tadeusz Tarczynski Aug. 1972 124 p refs
(Contract DAAJ02-70-C-0072; DA Proj. 1F1-62203-A-119)
(AD-750633; D210-10293-1; USAAMRDL-TR-72-8) Avail: NTIS CSCL 01/3

The report covers a study undertaken for the advanced design of a sectionalized main rotor blade. After investigation of the whole spectrum of design arrangements, a bolted-together design (with field replaceable boxes, L.E. tip and trailing edge) was chosen. For direct replacement of existing blades, a bolted design was selected with essentially the same dynamic rotor characteristics of the current production blade. The parameters that were closely matched to achieve this were: natural frequency, loads, and dynamic balance axis. A cost increase of approximately 50 percent is indicated over present UH-1H rotor blades to match current design features, utilizing ground rules on inherent and external damage specified by the procuring agency.
Author (GRA)

**N73-15076#** National Transportation Safety Board, Washington, D.C. Bureau of Aviation Safety.
**AIRCRAFT ACCIDENT REPORT: TANDY CORPORATION GATES LEARJET MODEL 25, N658TC, NEAR THE VICTORIA COUNTY, FOSTER AIRPORT, VICTORIA, TEXAS 18 JANUARY 1972**
Aug. 1972 16 p
(PB-212484; NTSB-AAR-72-24) Avail: NTIS HC $3.00 CSCL 01B

A Gates Lear Jet Model 25, crashed at approximately 0745 central standard time, on January 18, 1972, during a nonprecision instrument approach to the Victoria County-Foster Airport, Victoria, Texas. The two crewmembers and seven passengers received fatal injuries. The airplane was destroyed. The airplane was enroute from Fort Worth, Texas, on an IFR clearance to Victoria, Texas. Witnesses in the area of the crash reported heavy fog and visibility restricted to approximately 100 feet. One nautical mile visibility is required for this airplane to be authorized for a landing at the Victoria County-Foster Airport. The probable cause of this accident was the lack of altitude awareness on the part of the flightcrew while descending into known weather conditions which were conducive to a rapid deterioration in forward visibility. Author (GRA)

**N73-15188#** Research Inst. of National Defence, Stockholm (Sweden).
**ARTIFICIAL TARGETS**
S. A. Vakin and L. N. Sjustov May 1971 29 p refs Transl. into SWEDISH from Russian Rept. FOA-337 In SWEDISH
(FOA-3-C-3649-66; FOA-337) Avail: NTIS HC $3.50

Jamming of control data transmission sequences to aircraft or missiles and garbling of voice communication between ground and aircraft are achieved by pulse amplitude modulation and irregular pulse time interruptions to telemetry systems. Mathematical models and graphic drawings of these electronic countermeasures are included. Transl. by G.G.

**N73-15209#** Lincoln Lab., Mass. Inst. of Tech., Lexington.
**A THEORY FOR OPTIMAL MTI (MOVING TARGET INDICATOR) DIGITAL SIGNAL PROCESSING. PART 2: SIGNAL DESIGN**
Robert J. McAulay 4 Oct. 1972 60 p refs
(Contract F19628-73-C-0002)
(AD-750747; TN-1972-14-Pt-2; ESD-TR-72-217) Avail: NTIS CSCL 17/9

In part 1 of the report the optimum MTI receiver was derived and analyzed for the case in which the radar pulses were emitted from the transmitter equally spaced in time. For typical long range ATC surveillance radars, aliasing of the target and clutter spectra results in detecting blind speeds at multiples of approximately 70 knots. It is well known operationally that these blind speeds can be eliminated by staggering the transmitter PRF. Heretofore, there has been no thorough theoretical analysis of the effect of staggered PRF on the spectral distribution of the target and clutter signals. It is shown in part 2 that the clutter spectral density continues to fold over at the PRF, but that the signal spectrum becomes dispersed in frequency, somewhat like an anti-jam signal. It is further noted that even when the target Doppler shifts are more than one PRF apart, the spectra are distinguishable, suggesting that unambiguous Doppler estimation may be possible. Author (GRA)

**N73-15217#** Ohio State Univ., Columbus.
**COMPUTATION OF LOW FREQUENCY SCATTERING FROM AIRPLANES**
Y. T. Lin Sep. 1972 77 p refs
(Grant AF-AFOSR-1710-69; AF Proj. 9769)
(AD-750486; ESL-2768-9; AFOSR-72-1991TR) Avail: NTIS CSCL 17/9

An efficient computational technique for obtaining radar scattering cross sections of electrically small airplanes is achieved by using a wire-grid reaction method. In this method, the airplane shape is approximated by a grid of thin wires, thereby leading to a mathematical representation of the airplane in the form of matrix, whose elements are evaluated by established reaction techniques, and which when inverted, yield scattering data very efficiently. A variety of wire-grid approximations were postulated for square plates, circular cylinders and several airplane types. Author (GRA)

**N73-15267#** Joint Publications Research Service, Arlington, Va.
**COLD FOG DISPERSAL OPERATIONS AT ORLY AIRPORT, PARIS, FRANCE, WINTER 1970 - 1971 Final Report**
R. Fabre Nov. 1972 41 p Transl. into ENGLISH from report from Paris Airport Authority, Equipment Dept., Orly Airport, Paris Sponsored by FAA
(FAA-RD-72-123) Avail: NTIS HC $4.25

Performance tests of a ground based fog dispersal system at Orly Airport, Paris, France are discussed. The effect on runway visual range improvement and the effectiveness of the fog dispersal operation are described. A cost effectiveness analysis showed that the propane fog dispersal installation benefits the airlines, airport, and passengers. Author

**N73-15268#** Naval Air Test Facility, Lakehurst, N.J.
**ARRESTING-GEAR TESTS FOR ELEVATED SHORT TAKE-OFF AND LANDING PORTS Final Report**
Anthony Zagarella and Daniel Spalluto Nov. 1972 16 p
(Contract DOT-FA72WAI-247)
(NATF-R125; FAA-RD-72-140) Avail: NTIS HC $3.00

Tests were conducted with an S-2A aircraft and the M-14B-2C arresting gear to determine the degree of angular displacement and the maximum off-center engagements that still allowed the aircraft to remain on the 300 foot wide by 2000 foot long surface of a short takeoff and landing area. Diagrams of the runway conditions and the allowable operating envelopes are presented. Author

**N73-15269#** National Aerospace Lab., Tokyo (Japan). Aero-engine Div.

**ON THE HIGH TEMPERATURE TURBINE TEST FACILITIES AND THE DATA PROCESSING SYSTEM**
Jun. 1972 50 p refs In JAPANESE; ENGLISH summary
(NAL-TR-282) Avail: NTIS HC $4.50

The development and operation of a high temperature turbine test facility are discussed. The use of the facility for conducting experiments on the aerodynamic and thermodynamic performance of air cooled, axial flow turbines is reported. Details of the data processing system of the test facility are included. Author

**N73-15280#** Deutsche Gesellschaft fuer Luft- und Raumfahrt, Cologne (West Germany). Arbeitsgemeinschaft Deutscher Verkehrsflughaefen.
**TODAY'S TRAFFIC LANDING SITES [DIE VERKEHRSLANDEPLAETZE HEUTE]**
Kurt Siebenwurst 1972 18 p In GERMAN Presented at the DGLR Symp. on Flugbetrieb, Cologne, 15 Sep. 1972
(DGLR-Paper-72-033) Avail: NTIS HC $3.00

The role of regional airports for irregular air traffic use in Germany is discussed. Special attention is paid to the infrastructural importance of these airports for certain user groups in trade and industry. The construction costs are generally estimated at 5 to 10 million DM, and the annual operation costs at from 30,000 to 300,000 DM. Economics, flight safety, and aircraft noise are also discussed. Author (ESRO)

**N73-15281#** Deutsche Gesellschaft fuer Luft- und Raumfahrt, Cologne (West Germany).
**AIRPORTS TODAY, SIGNIFICANCE AND PROBLEMS OF AIR TRAFFIC [FLUGHAEFEN HEUTE, BEDEUTUNG UND PROBLEME DER FLUGHAEFEN IM HEUTIGEN LUFTVERKEHR]**
U. Wolffram 1972 14 p In GERMAN Presented at the DGLR Symp. on Flugbetrieb, Cologne, 15 Sep. 1972
(DGLR-Paper-72-034) Avail: NTIS HC $3.00

The role of airports in the economic infrastructure of Germany is described and planning for future traffic developments is discussed. The influence on airport planning of technological advances, with regard to noise reduction, all weather operation, and STOL/VTOL aircraft, is surveyed. Author (ESRO)

**N73-15282#** Deutsche Lufthansa Aktiengesellschaft, Cologne (West Germany).
**FLIGHT OPERATIONS FROM AN AIRLINE COMPANY'S POINT OF VIEW [FLUGBETRIEB AUS DER SICHT EINER LUFTVERKEHRSGESELLSCHAFT]**
Rolf Bebber 1972 21 p In GERMAN Presented at the DGLR Symp. on Flugbetrieb, Cologne, 15 Sep. 1972
(DGLR-Paper-72-037) Avail: NTIS HC $3.25

The experiences of an airline operator with regard to the latest developments in air traffic are described. The basic principles of operation under present conditions, flight safety, passenger comfort, schedule adherence, and economy, are surveyed. It is concluded that technological problems are secondary to the influences of strikes, political unrest, and sabotage, and that flight safety should be increased. Author (ESRO)

**N73-15286#** Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
**CAPABILITY OF THE TOTAL IN-FLIGHT SIMULATOR (TIFS) Final Report**
Philip A. Reynolds, Richard Wasserman, Gardner J. Fabian, and Paul R. Motyka Feb. 1972 162 p refs
(Contract F33615-71-C-1110; AF Proj. 6848)
(AD-750745; CAL-TB-3020-F-4; AFFDL-TR-72-39) Avail: NTIS CSCL 01/3

TIFS is a newly developed, variable stability C-131 aircraft with the unique capability to vary its flying qualities in all six degrees of freedom. It also surpasses the utility of past variable stability aircraft through the realism possible in its separate, new evaluation cockpit. The capabilities and features of this in-flight simulator considerably broaden the ability of the aircraft designer to deal with difficult trade-offs in flying qualities problems. A base configuration can be set up and then its stability and control characteristics can be systematically varied for investigations to gain research knowledge pertinent to flight vehicle and flight control system design. The report describes the theoretical basis for in-flight motion reproduction and how this theory can be applied to determine the TIFS capability to simulate a given aircraft. Physical characteristics as determined in flight and examples of simulation are given. Flight test records of model-following performance are also included. The objective of the report is to give the reader the basic information for planning a TIFS experiment. Author (GRA)

**N73-15287#** Wyle Labs., Inc., Huntsville, Ala.
**ENVIRONMENTAL IMPACT OF NOISE FROM THE PROPOSED ARNOLD ENGINEERING DEVELOPMENT CENTER (AEDC) HIGH REYNOLDS NUMBER TUNNEL Final Report, 13 Mar. - 30 Jun. 1972**
K. J. Plotkin, J. E. Robertson, and J. A. Cockburn Oct. 1972 180 p refs
(Contract F40600-72-C-0007)
(AD-750465; WR-72-7; AEDC-TR-72-151) Avail: NTIS CSCL 14/2

A study to evaluate the environmental impact of the noise produced by a proposed High Reynolds Number Tunnel (HIRT) under consideration at the Arnold Engineering Development Center (AEDC) has been conducted by Wyle Laboratories. During earlier studies, the noise characteristics of the HIRT facility were defined. These studies included (1) theoretical analyses of the noise generation mechanisms associated with the operation of the facility, and (2) scale-model experiments to provide base-line data for extrapolation to full-scale conditions. The assessment of environmental impact, based on the predicted noise environment of the full-scale facility, is the subject of this report. This assessment contains all pertinent data of relevance to the noise impact which may be anticipated during HIRT operation and includes (1) a summary of the Noise Characteristics of HIRT, (2) Specification of Acceptable Noise Limits for people, animals, and buildings which will be exposed to HIRT noise, (3) the Environmental Impact of HIRT noise as evaluated by comparing HIRT noise with acceptable limit criteria, and (4) Special Considerations for Noise Protection and Control. Author (GRA)

**N73-15290#** Peat, Marwick, Mitchell and Co., San Francisco, Calif.
**HIGH SPEED GROUND ACCESS STUDY, LOS ANGELES INTERNATIONAL AIRPORT**
Apr. 1972 87 p refs Prepared for Los Angeles City Dept. of Airports
(Contract DOT-UT-312)
(PB-212023; UMTA-CA-09-0010-72-1) Avail: NTIS HC $3.00 CSCL 13F

A review of the projected ridership, construction costs, operating costs and resultant financial analysis relative to the proposed high speed ground access system between Los Angeles International Airport and San Fernando Valley is reported. The system is composed of a tracked air cushion vehicle system and an intra-airport system that interface. The intra-airport system is either an intra-airport transit system or a bus system. The report studies the three alternative high speed ground access systems: A 16 mile TACV/IAT System, a 16 mile TACV/Bus System, and an 8 mile TACV/Bus System. Author (GRA)

**N73-15326#** Mississippi State Univ., State College. Dept. of Aerophysics and Aerospace Engineering.
**AERODYNAMICS OF ROTORS AND PROPELLERS Final Report**
Charles B. Cliett, Joe F. Thompson, Zahir U. A. Warsi, and Donald W. Boatwright 31 Aug. 1972 23 p refs
(Contract DA-ARO(D)-31-124-G156; DA Proj. 200-61102-B-35E)
(AD-750175; AASE-72-78; EIRS-ASE-73-1; AROD-10234-5-E) Avail: NTIS CSCL 20/4

The work described in the report is part of a continuing effort in Research in the Area of Aerodynamics of Rotors and Propeller and will be continued under parallel contract DAH-C04-68-C-0003. The research involved is of a long term nature.

Technical reports and journal articles have been published which cover a portion of the described research. Additional papers have been submitted for review and others are in preparation. The report seeks to give the more important results and conclusions as well as the progress made toward the overall objectives of the research effort. Author (GRA)

N73-15334# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**CALCULATION OF THE DISTRIBUTION OF LOSSES OVER THE SPAN OF AN AXIAL-FLOW COMPRESSOR BLADE**
V. S. Beknev and V. Yu. Kozhevnikov 2 Aug. 1972 14 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Mashinostr. (USSR), no. 2, 1971 p 109-113
(AF Proj. 668A)
(AD-750931; FTD-MT-24-245-72) Avail: NTIS CSCL 13/7
On the basis of experimental data, relationships are obtained which make it possible to calculate the losses at each cross section with respect to the height of an axial compressor blade. The obtained results permit a judgment to be made concerning the influence of various cascade parameters upon the distribution of losses with respect to blade height. Author (GRA)

N73-15484# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abteilung Instrumentierung und Antheopotechnik.
**LEGIBILITY AND INTERPRETATION INVESTIGATION OF ELECTRONIC DISPLAYS: EFFECTIVENESS OF LUMINANCE AND COLOR CODING OF INDICATING ELEMENTS [LESBARKEITS UND INTERPRETATIONS-UNTERSUCHUNGEN AN ELEUTRONISCHEN DISPLAYS: WIRKSAMKEITSUNTERSUCHUNGEN ZUR LEUCHTDICHTE-UND FARBKODIERUNG VON ANZEIGE-ELEMENTEN]**
Ralf Beyer, Hans-Dieter Schenk, and Eckhart Zietlow May 1971 86 p refs In GERMAN; ENGLISH summary
(Contract T-0230-02330-01053)
(DLR-FB-71-57) Avail: NTIS HC $6.50; DFVLR, Porz, West Ger. 18 DM
The effectiveness of luminance and color coding are compared as means for coding display elements to electronic displays. Experimental investigations at the DFVLR are described along with results based on four types of experiments: an immediate-response task, a complex tracking task, the tachistoscopic presentation of information, and an exploration of subjective ratings on different types of color coding in an experimental electronic display. Author (ESRO)

N73-15498# Naval Air Development Center, Warminster, Pa. Air Vehicle Technology Dept.
**DEVELOPMENT OF COUNTING STRAIN GAGES FOR HIGH-G NAVAL AIRCRAFT Final Report**
David E. Weiss and Sidney Scheindlinger 15 Sep. 1972 26 p
(AD-750692; NADC-72090-VT) Avail: NTIS CSCL 14/2
The NAVAIRDEVCEN has developed and constructed an airborne Strain Level Counter which presents visually the numbers of times that each of four strain levels has been exceeded. The system has two major components: an inductive strain sensor, installed in the critical structural area, which develops a voltage proportional to the strain: an indicator unit which houses all the solid state circuity necessary to energize the sensor and condition its output. The output, after appropriate filtering, is displayed on four electro-mechanical counters. Laboratory and flight tests of the strain sensor alone have been completed and are described. Overall accuracy of the complete system over the temperature range of -55C to -125C is estimated to be within 5%. Author (GRA)

N73-15515# Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio.
**A STUDY OF THE PRACTICABILITY OF ACTIVE VIBRATION ISOLATION APPLIED TO AIRCRAFT DURING THE TAXI CONDITION**
Charles D. Corsetti and James D. Dillon Jul. 1972 171 p refs
(AF Proj. 8129)
(AD-750137; AFFDL-TR-71-159) Avail: NTIS CSCL 13/9
The feasibility of using an active control in the landing gear system of an aircraft to reduce wing fatigue damage resulting from ground induced vibrations during taxiing is considered. The characteristics of three vehicle models are discussed: a single landing gear system, a tricycle landing gear system and a system of five landing gears. Mathematical expressions for the runway inputs to each vehicle model are obtained in the form of random inputs represented by Gauss-Markov processes. The model for a linear hydraulic actuator which is used as the active control element in the landing gear system is presented. Author (GRA)

N73-15537# Army Cold Regions Research and Engineering Lab., Hanover, N.H.
**MEASUREMENTS OF LASER EXTINCTION IN ICE FOG FOR DESIGN OF SEV PILOTAGE SYSTEM**
Richard Munis and Allan Delaney Aug. 1972 23 p refs
(ARPA Order 1615)
(AD-750114; CRREL-RR-302) Avail: NTIS CSCL 17/7
Laser extinction measurements in ice fog were made at wavelengths of 0.6328, 1.15 and 3.39 microns. The ice fog was generated in an environmental chamber whose temperature could be lowered to -43C. Particle sampling was carried out simultaneously with the laser measurements using an impactor. Size distributions were derived from the impactor measurements. These data were used to compute Mie extinction coefficients at the three laser wavelengths. These coefficients were compared with the coefficients derived experimentally. Although some discrepancy exists between theory and experiment, both agree fairly well on the behavior of the extinction coefficient as a function of particle concentration. Author (GRA)

N73-15583# General Motors Corp., Indianapolis, Ind. Detroit Diesel Allison Div.
**BERYLLIUM REINFORCED METAL MATRIX COMPOSITES STUDY PROGRAM Final Report, 24, Jun. 1971 - 24 May 1972**
Robert W. Stusrud, Morris J. Tumey, Marvin Herman, and G. R. Sippel Aug. 1972 55 p refs
(Contract N00019-71-C-0324)
(AD-750764; DDAD-EDR-7518) Avail: NTIS CSCL 11/4
The program aimed to develop nondestructive inspection techniques for beryllium-titanium composites and to characterize beryllium-titanium composites fabricated by different techniques. The feasibility of producing sheet, tubes, bars and forging preforms of Be/Ti 6Al-4V composite material was demonstrated.
Author (GRA)

N73-15595*# Rensselaer Polytechnic Inst., Troy, N.Y. Tribiology Lab.
**CONSIDERATION OF MATERIALS FOR AIRCRAFT BRAKES**
Marshall B. Peterson and Ting-Long Ho Apr. 1972 74 p refs
(Grant NGR-33-018-152)
(NASA-CR-121116) Avail: NTIS HC $5.75 CSCL 11D
An exploratory investigation was conducted concerning materials and their properties for use in aircraft brakes. Primary consideration was given to the heat dissipation and the frictional behavior of materials. Used brake pads and rotors were analyzed as part of the investigation. A simple analysis was conducted in order to determine the most significant factors which affect surface temperatures. It was found that where size and weight restrictions are necessary, the specific heat of the material, and maintaining uniform contact area are the most important factors. A criterion was suggested for optimum sizing of the brake disks. Bench friction tests were run with brake materials. It was found that there is considerable friction variation due to the formation and removal of surface oxide films. Other causes of friction variations

are surface softening and melting. The friction behavior at high temperature was found to be more characteristic of the steel surface rather than the copper brake material. It is concluded that improved brake materials are feasible. Author

**N73-15610#** Douglas Aircraft Co., Inc., Long Beach, Calif.
**DEVELOPMENT OF A GRAPHITE HORIZONTAL STABILIZER Interim Technical Report, 1 Nov. 1971 - 30 Jun. 1972**
George M. Lehman Jul. 1972 100 p refs
(Contract N00156-70-C-1321)
(AD-750778; MDC-J5621) Avail: NTIS CSCL 11/4

Vibration and static test setups are described and results are presented for a graphite-epoxy stabilizer assembly for the A-4 Skyhawk aircraft. Natural vibration frequencies, mode shapes, and structural damping data are presented for both the graphite stabilizer and the analogous production metal stabilizer. Each configuration was tested both with and without the production elevator installed. Structural influence coefficients were derived from the vibration test results and used to analyze the flutter speed of the A-4 aircraft using the graphite stabilizer. The flutter characteristics of the graphite stabilizer are expected to be improved, with the flutter speed being increased by 22 percent. The reduced weight of the graphite stabilizer is not expected to have a significant effect on the fin flutter characteristics. The stabilizer was tested statically under two critical load conditions, a localized leading-edge condition and an unsymmetrical bending condition. Finite element analyses are expected to determine the magnitudes of secondary shears and bending moments through the thickness of the laminate and their influences on ultimate strength of the stabilizer. Author (GRA)

**N73-15611#** Monsanto Research Corp., Dayton, Ohio.
**ENGINEERING DATA ON ETHYLENE TERPOLYMER AS AN ADHESIVE FOR POLYCARBONATE COMPOSITE AIRCRAFT TRANSPARENCIES Technical Report, Feb. 1971 - Apr. 1972**
George L. Ball, III, I. O. Salyer, C. J. North, and P. H. Wilken
Wright-Patterson AFB, Ohio AFML Jul. 1972 44 p refs
(Contract F33615-71-C-1321; AF Proj. 7381)
(AD-750814; MRC-DA-332; AFML-TR-72-109) Avail: NTIS CSCL 11/1

A transparent ethylene terpolymer adhesive was optimized and engineering data established to describe its utility in polycarbonate composite aircraft transparencies. The hydroxyl content was adjusted to provide for the best balance of toughness and adhesion versus elongation. Improvements in toughness were also derived through increases in molecular weight of the ethylene terpolymer by the use of heretofore unavailable materials and processes. It was shown that a higher level of hydroxyl (3.4%) in the terpolymer would be desirable. Primarily, by the use of partial crosslinking, the form-stable temperature (zero tensile strength) was increased to 178F. Most significant, however, was the excellent mechanical performance of material designated ETA 138200 over the spectrum of temperature from -65F to -165F. Author (GRA)

**N73-15653#** Maryland Univ., College Park.
**LIMITED SHEAR ZONES: A HAZARD TO AVIATION**
Robert J. Becker and Kenneth S. Gage [1971] 6 p refs
Presented at Intern. Conf. on Aerospace and Aeron. Meteorology, Wash., D. C., 22 May 1972
(Contract AT(40-1)-4199)
(Conf-720535-2) Avail: NTIS

The dual hazard to aviation posed by turbulence and shear in a stably stratified environment in considered. The current state of our knowledge of instability and turbulence in stably stratified shear flow is briefly reviewed. The effect of concentrated vertical shear on aircraft performance is examined. A meteorological analysis of an incident of turbulence experienced by a 747 jumbo jet is also presented. Author

**N73-15660#** Battelle Memorial Inst., Richland, Wash.
**TAKE-OFF AND LANDING CRITICAL ATMOSPHERIC TURBULENCE (TOLCAT): EXPERIMENTS AND ANALYSIS Final Technical Report, Nov. 1969 - Oct. 1971**
C. E. Elderkin, D. C. Powell, A. G. Dunbar, and T. W. Horst Apr. 1972 307 p refs
(Contract F33615-68-M-5009)
(AD-750131; AFFDL-TR-71-172) Avail: NTIS CSCL 04/2

Measurements of turbulence were made from various arrays of tower mounted sensors to demonstrate methods of describing the temporal and spatial character of turbulence. Measurement and data reduction techniques for sonic and three-propeller anemometers were optimized to assure true and accurate measurements of the vertical and two horizontal wind components. Both analog and digital magnetic tape field recording options were demonstrated to provide flexibility in measurement array configurations and to optimize recording capabilities for a variety of measurement requirements. Probability density functions, both individual and joint, were calculated for any pair of wind component variables, oriented in a preselected coordinate system, and optionally high pass filtered for various aircraft response applications. Power spectra of each time series and cross spectra for different wind components at the same point and for the same component at different points were calculated for time series optionally tapered or detrended. Plots of the space-time dependence of correlation functions were obtained from turbulence measurements taken from a logarithmically spaced line of towers, offering a means of determining the turbulence spectra for a given wind component encountered by an aircraft flying through a field of turbulence at a given wind speed. Author (GRA)

**N73-15670#** Defence and Civil Inst. of Environmental Medicine, Downsview (Ontario). Behavioural Sciences Div.
**MAN AND AUTOMATION IN CANADIAN FORCES TERMINAL AIR TRAFFIC CONTROL**
L. G. Innes Feb. 1972 29 p refs
(DCIEM-825) Avail: NTIS HC $3.50

The human engineering aspects of the automation of the Canadian Forces IFR control center for terminal ATC are examined. Problems involved in the controller-computer interface are discussed against the background of experience of other ATC automation programs, and recommendations are made for controls and displays design. Communications requirements of controllers are identified and a communications management panel design is proposed. Suggestions are given for console design, acceptable temperature, humidity, noise and illumination levels, and room decor features are discussed. Author

**N73-15675#** IIT Research Inst., Annapolis, Md.
**ATCRBS PERFORMANCE ANALYSIS FOR JACKSONVILLE AIR ROUTE TRAFFIC CONTROL CENTER Final Report**
Charles A. Gettier Apr. 1972 54 p refs
(Contracts DOT-FA70WAI-175; F-19628-71-C-0221; FAA Proj. 213-503-015; AF Proj. 649E)
(ECAC-PR-72-014; FAA-RD-72-33) Avail: NTIS HC $4.75

The occurrence of excessive interrogation signals (hot spots) within air traffic control sectors supervised by the Air Traffic Control Radar Beacon System is evaluated. On-site observations of air traffic displays are discussed. An analysis of the Jacksonville, Florida Air Route Traffic Control Center is presented. Author

**N73-15676#** IIT Research Inst., Annapolis, Md.
**ATCRBS PERFORMANCE ANALYSIS: WASHINGTON AIR ROUTE TRAFFIC CONTROL CENTER Final Report**
Maximilian Ware, Jr. Jun. 1972 61 p refs
(Contracts DOT-FA70WAI-175; F19628-71-C-0221; FAA Proj. 213-503-015; AF Proj. 649E)
(ECAC-PR-72-022; FAA-RD-72-34) Avail: NTIS HC $5.25

The occurrence of excessive interrogation signals (hot spots) within air traffic control sectors by the Air Traffic Control Radar Beacon System is evaluated. On-site observations of air traffic displays are discussed. An analysis of the Washington, D.C. center is presented. Author

**N73-15677#** IIT Research Inst., Annapolis, Md.
**ATCRBS PERFORMANCE ANALYSIS FOR LOS ANGELES**

**ARTCC Final Report**
Charles A. Gettier Aug. 1972 44 p refs
(Contracts DOT-FA70WAI-175; F19628-73-C-0031; FAA Proj. 213-503-015; AF Proj. 649E)
(ECAC-PR-72-044; FAA-RD-72-36) Avail: NTIS HC $4.25

The occurrence of excessive interrogation signals (hot spots) within air traffic control centers by the Air Traffic Control Radar Beacon System is evaluated. On-site observations of air traffic displays are discussed. An analysis of the Los Angeles, California center is presented. Author

**N73-15678#** IIT Research Inst., Annapolis, Md.
**ATCRBS PERFORMANCE ANALYSIS: KANSAS CITY AIR ROUTE TRAFFIC CONTROL CENTER Final Report**
Maximilian Ware, Jr. Jun. 1972 28 p refs
(Contracts DOT-FA70WAI-175; F-19628-73-C-0031; FAA Proj. 213-503-015; AF Proj. 649E)
(ECAC-PR-72-023; FAA-RD-72-37) Avail: NTIS HC $3.50

The occurrence of excessive interrogation signals within air traffic control sectors supervised by the Air Traffic Control Radar Beacon System (ATCRBS) of the Federal Aviation Administration is evaluated. On-site observations of air traffic displays are discussed and the analyses of the air traffic electromagnetic environments using performance prediction model techniques are described. Each of the studies evaluates the possibility of hot spots affecting one of the following ATCRBS Air Route Traffic Control Centers: Jacksonville, Washington, New York, Kansas City, and Los Angeles. Author

**N73-15679#** Federal Aviation Administration, Washington, D.C. Flight Services Div.
**MINIMUM ENROUTE IFR ALTITUDES OVER PARTICULAR ROUTES AND INTERSECTIONS**
Nov. 1972 210 p
Avail: NTIS HC $12.50

The minimum enroute instrument flight rules altitudes over particular routes and intersections are presented. The data applies to airline operations in the United States, Alaska, and Hawaii. Author

**N73-15680#** Federal Aviation Administration, Washington, D.C. Systems Research and Development Service.
**ENGINEERING AND DEVELOPMENT PROGRAM PLAN: ALL WEATHER LANDING Final Report, period ending 1 Oct. 1972**
Oct. 1972 40 p refs
(FAA-ED-07-3) Avail: NTIS HC $4.00

This plan describes all FAA development activities funded in the all weather landing program including electronic and visual guidance, airborne systems, and data collection. It also discusses related projects funded in other programs. The related projects include weather measurement, ground guidance and control, and fog dispersal. The program includes investigation of advanced technology as continuing and long term development, including work on advanced cockpit displays, airport lighting techniques and continued recording of actual Category III experience. Related long term efforts include applications of the MLS to all weather landing operations, advanced weather measuring and fog dispersal techniques. Author

**N73-15681*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**POSITION DETERMINATION ACCURACY FROM THE MICROWAVE LANDING SYSTEM**
Luigi S. Cicolani Washington Jan. 1973 39 p refs
(NASA-TN-D-7116; A-4176) Avail: NTIS HC $3.00 CSCL 17G

Analysis and results are given for the position determination accuracy obtainable from the microwave landing guidance system. Siting arrangements, coverage volumes, and accuracy standards for the azimuth, elevation, and range functions of the microwave system are discussed. Results are given for the complete coverage of the systems and are related to flight operational requirements for position estimation during flare, glide slope, and general terminal area approaches. Range rate estimation from range data is also analyzed. The distance measuring equipment accuracy required to meet the range rate estimation standards is determined, and a method of optimizing the range rate estimate is also given. Author

**N73-15688#** Boeing Co., Seattle, Wash. Commercial Airplane Group.
**STUDY AND CONCEPT FORMULATION OF A FOURTH-GENERATION AIR TRAFFIC CONTROL SYSTEM. VOLUME 1: STUDY REPORT Final Report**
Apr. 1972 222 p refs 5 Vol.
(Contract DOT-TSC-145; DOT-TSC-306)
(PB-212178; D6-26058-1) Avail: NTIS HC $3.00 CSCL 17G

The operational concept, projected passenger demand, ATC system performance tradeoff data, and subsystem technological alternatives were evaluated to select the two most promising candidate systems for a fourth-generation (1995) ATC system. These two candidates and the upgraded third-generation system were then compared and a final recommended fourth-generation ATC system selected. The recommended system was described as to technology, operation, implementation plan, and required research and development. Author (GRA)

**N73-15689#** Boeing Co., Seattle, Wash. Commercial Airplane Group.
**STUDY AND CONCEPT FORMULATION OF A FOURTH-GENERATION AIR TRAFFIC CONTROL SYSTEM. VOLUME 2: TECHNOLOGICAL ALTERNATIVES Final Report**
Apr. 1972 492 p refs 5 Vol.
(Contracts DOT-TSC-145; DOT-TSC-306)
(PB-212179; D6-26058-2) Avail: NTIS HC $6.00 CSCL 17G

The document presents the results of studies of alternative subsystem approaches applicable to the Fourth Generation Air Traffic Control System. Equipment currently in operation, that planned for near future implementation, and various techniques proposed as possible future solutions to ATC requirements are included. Numerous ground-based and satellite-borne systems are discussed for providing the required navigation, surveillance, and communications functions. In addition the ground-based data processing and control equipment along with the required airborne equipment are treated. Author (GRA)

**N73-15690#** Boeing Co., Seattle, Wash. Commercial Airplane Group.
**STUDY AND CONCEPT FORMULATION OF A FOURTH-GENERATION AIR TRAFFIC CONTROL SYSTEM. VOLUME 3: DEMAND AND TRADE STUDY Final Report**
Apr. 1972 355 p refs
(Contracts DOT-TSC-145; DOT-TSC-306)
(PB-212180; D6-26058-3) Avail: NTIS HC $6.00 CSCL 17G

Techniques and resulting data are developed in the areas of demand, data acquisition, traffic management, and communications. Each area is subdivided to reflect the geographical region of operation as oceanic, domestic enroute, terminal area, and airport. ATC performance tradeoff information is developed parametrically to encompass a wide range of possibilities for the 1995 time period. Data are presented for STOL, CTOL, and SST/CTOL airplane mix configurations. Separation criteria to meet potential demands, resulting impact on safety, and required improvements for surveillance, navigation, procedure, and communications are included. The effect of airport and runway splits are discussed and parallel runway separation requirements are analyzed. Various mixes of voice and digital communications are considered. Principal computer models used in this study are discussed. Author (GRA)

**N73-15691#** Boeing Co., Seattle, Wash. Commercial Airplane Group.
**STUDY AND CONCEPT FORMULATION OF A FOURTH-**

**GENERATION AIR TRAFFIC CONTROL SYSTEM. VOLUME 4: SYSTEM SELECTION Final Report**
Apr. 1972 354 p refs 5 Vol.
(Contracts DOT-TSC-145; DOT-TSC-306)
(PB-212181; D6-26058-4) Avail: NTIS HC $6.00 CSCL 17G

The volume describes the methodology used in selecting a fourth generation Air Traffic Control System consistent with U.S. air transportation needs in 1995, and provides a summary of the results. It includes the derivation and use of the computerized evaluation model, including the computer program for it's implementation, the cost model and supporting cost data, implementation plans, the initial and final system selection processes and results, and recommendations for further study.
Author (GRA)

**N73-15692#** Boeing Co., Seattle, Wash. Commercial Airplane Group.
**STUDY AND CONCEPT FORMULATION OF A FOURTH-GENERATION AIR TRAFFIC CONTROL SYSTEM. VOLUME 5: RECOMMENDED RESEARCH AND DEVELOPMENT Final Report**
Apr. 1972 187 p refs 5 Vol.
(Contracts DOT-TSC-145; DOT-TSC-306)
(PB-212182; D6-26058-5) Avail: NTIS HC $3.00 CSCL 17G

Research and development needed to support the fourth-generation ATC system implementation is described. A methodology and program plan for operational concept evaluation, a requirements plan for a surface guidance system, and a testing and evaluation schedule for subsystem technical feasibility are described. The impact of future developments on subsystem changes and overall system characteristics is described. Finally, the time phasing of system implementation is also discussed together with the basic criteria used in ATC implementation planning.
Author (GRA)

**N73-15707*#** Techtran Corp., Silver Spring, Md.
**ENVIRONMENTAL NOISE POLLUTION CAUSED BY JET AIRCRAFT TRAFFIC**
N. G. Zimmermann Washington NASA Jan. 1972 26 p refs Transl. into ENGLISH of "Laermbelaestigung der Umwelt Durch den strahlflugverkehr" Max-Planck-Inst. fuer Stroemungsforsch., Goettingen, West Germany, 1971 27 p Presented at 4th DGLR Ann. Meeting, Baden-Baden, West Germany, 11-13 Oct. 1972
(Contract NASw-2485)
(NASA-TT-F-14655) Avail: NTIS HC $3.50

A survey is presented of commercial jet aircraft noise problems and possible ways to minimize these in the vicinity of airports. Acoustic measurements, such as perceived noise level are discussed, and the Q-formula for analyzing acoustic properties is presented. Possible methods of noise reduction are shown. The noise situation in the vicinity of airports is investigated with emphasis on noise abatement profiles to reduce annoyance.
Author

**N73-15708*#** Boeing Co., Seattle, Wash. Commercial Airplane Group.
**JET ENGINE NOISE SOURCE AND NOISE FOOTPRINT COMPUTER PROGRAMS**
D. G. Dunn, N. A. Peart, D. L. Miller, and K. C. Crowley Oct. 1972 148 p refs
(Contract NAS2-6969)
(NASA-CR-114517; D6-60169) Avail: NTIS HC $9.50 CSCL 20A

Calculation procedures are presented for predicting maximum passby noise levels and contours (footprints) of conventional jet aircraft with or without noise suppression devices. The procedures have been computerized and a user's guide is presented for the computer programs to be used in predicting the noise characteristics during aircraft takeoffs, fly-over, and/or landing operations.
Author

**N73-15709*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**SOME EFFECTS OF WING PLANFORM ON SONIC BOOM**
Lynn W. Hunton, Raymond M. Hicks, and Joel P. Mendoza Washington Jan. 1973 39 p refs
(NASA-TN-D-7160; A-4491) Avail: NTIS HC $3.00 CSCL 01B

A wind-tunnel investigation was conducted to determine the effect of wing planform on sonic boom at Mach numbers of 1.7, 2.0, and 2.7. The results of the investigation show that the wing leading-edge sweep is one of the primary planform variables affecting the overpressure characteristics.
Author

**N73-15718#** Princeton Univ., N.J.
**THE PRINCETON PENNSYLVANIA ARMY AVIONICS RESEARCH PROGRAM. A FUNDAMENTAL STUDY OF STATIC ELECTRIC PHENOMENA (APPLIED TO HELICOPTERS) Final Task Report, 1 Sep. 1966 - 30 Dec. 1971**
G. J. Born, W. F. Burke, and E. J. Durbin Mar. 1972 78 p refs
(Contract DA-28-043-AMC-02412(E); DA Proj. 1H1-62202-A-219)
(AD-750617; ECOM-02412-10) Avail: NTIS CSCL 20/3

In the report is given a summary of the charging and discharging processes of a helicopter in flight. Emphasis is placed upon obtaining approximations for estimating the magnitude of the problem for given environmental conditions. The problems of electrostatic charging and discharging of helicopters with regard to safety of personnel, cargo and radio frequency interference are stated. Acceptable safety limits for personnel protection and safe cargo handling are presented. A solution to the cargo hook up problems of electrostatic charged helicopters is proposed, using current technology. A summary is given of the construction and test results of this safe-cargo hook up system. The Appendixes summarizes work on corona discharges, space charges, and environmental effects on charging and discharging phenomena.
Author (GRA)

**N73-15811#** Cranfield Inst. of Technology (England). School of Mechanical Engineering.
**TURBOFAN PERFORMACE ASSESSMENT: A NEW METHOD OF ANALYSIS AND PRESENTATION**
T. J. Corbishley and K. W. Ramsden May 1972 13 p refs
(CRANFIELD-SME-2) Avail: NTIS HC $3.00

The development of a method for assessing turbofan performance is discussed. The method introduces a dimensionless form for both thrust and specific fuel consumption. Each of the latter parameters are found to vary linearly with a new parameter, the in-pass ratio, over a wide range of typical engine operating conditions. The method is shown to facilitate, with little loss of accuracy, a savings in both computer time and graphical presentation.
Author

**N73-15815*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**CONTROL OF TURBOFAN LIFT ENGINES FOR VTOL AIRCRAFT**
J. F. Sellers and J. R. Szuch 1973 24 p refs Proposed for Presentation at Ann. Gas Turbine Conf., Washington, D. C., 8-12 Apr. 1973; sponsored by ASME
(NASA-TM-X-68175; E-7259) Avail: NTIS HC $3.25 CSCL 21E

The use of turbofan engines as lift units for VTOL aircraft poses new engine control problems. At low flight speeds, the lift units must provide the fast thrust response needed for aircraft attitude and height control. The results are presented of an analytical study of the dynamics and control of turbofan lift engines, and methods are proposed for meeting the response requirements imposed by the VTOL aircraft application. Two types of lift fan engines are discussed: the integral and remote. The integral engine is a conventional two-spool, high bypass ratio turbofan designed for low noise and short length. The remote engine employs a gas generator and a lift fan which are separated by a duct, and which need not be coaxial. For the integral engine, a control

system design is presented which satisfies the VTOL response requirements. For the remote engine, two unconventional methods of control involving flow transfer between lift units are discussed. Both methods are shown to have thrust response near the required levels. Author

**N73-15816*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**PROPULSION SYSTEM FOR RESEARCH VTOL TRANSPORTS**
Laurence W. Gertsma and Steve Zigan 1973 24 p refs Proposed for presentation at Gas Turbine Conf., Washington, D. C., 8-12 Apr. 1973; sponsored by ASME
(NASA-TM-X-68168; E-7228) Avail: NTIS HC $3.25 CSCL 21E

In anticipation of an eventual VTOL requirement for civil aviation, NASA has been conducting studies directed toward determining and developing the technology required for a commercial VTOL transport. In this paper, the commercial transport configurations are briefly reviewed; the propulsion system specifications and components developed by the engine study contractor are presented and described; and methods for using the lift-propulsion system for aircraft attitude control are discussed. Author

**N73-15817*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**ANALYSIS OF INTEGRAL LIFT-FAN ENGINE DYNAMICS**
John R. Szuch Washington Jan. 1973 52 p refs
(NASA-TM-X-2691; E-7079) Avail: NTIS HC $3.00 CSCL 21E

An integral lift-fan engine being considered for VTOL applications was simulated using the hybrid computer. A contractor-proposed fuel control and a simple model of the roll dynamics of a hovering VTOL airplane were used in the simulation. Both steady-state and transient data were generated. The desired engine time constant of 0.20 second was achieved for thrust increments less than 10 precent of the design thrust. For roll angle demands less than 10 deg, roll angle overshoot was acceptable with more than 84 percent of the demand achieved in 1 second. Author

**N73-15818*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**COLD-AIR AERODYNAMIC STUDY IN A TWO-DIMENSIONAL CASCADE OF A TURBINE STATOR BLADE WITH SUCTION-SURFACE FILM COOLING**
Douglas B. Brown and Ronald M. Helon Washington Jan. 1973 31 p refs
(NASA-TM-X-2685) Avail: NTIS HC $3.00 CSCL 21E

The effect on aerodynamic performance of a single row of spanwise-spaced coolant holes located at four positions chordwise along the suction surface was investigated. In addition, multiple-row data were obtained. The data are presented in terms of primary efficiency, coolant-to-primary-flow percentage, and coolant pressure ratio. Primary efficiencies of multirow blade configurations compare satisfactorily with that calculated from the single-row efficiency increments. At any given coolant flow percentage, the efficiency was about the same for all row locations. For a given coolant pressure, the efficiency varied by as much as 1 percent, depending on the row location. Author

**N73-15820#** National Aerospace Lab., Tokyo (Japan).
**REAL-TIME SIMULATION OF JET ENGINES WITH DIGITAL COMPUTER. 1: FABRICATION AND CHARACTERISTICS OF THE SIMULATOR**
Kenji Nishio, Nanahisa Sugiyama, Takeshi Koshinuma, Takeo Hashimoto, Toshimi Ohhata, and Hideo Ichikawa Jul. 1972 37 p refs In JAPANESE; ENGLISH summary
(NAL-TR-283) Avail: NTIS HC $4.00

The fabrication and performance of a real-time jet engine simulator using a digital computer are discussed. The use of the simulator in developing the components and control systems of a jet engine is described. Comparison of data from jet engine simulation tests with actual engine tests was conducted with good agreement. Author

**N73-15821*#** Boeing Co., Seattle, Wash.
**DESIGN OF A BLEED SYSTEM FOR A MACH 3.5 INLET**
J. Syberg and T. E. Hickcox Washington NASA Jan. 1973 91 p refs
(Contract NAS2-6643)
(NASA-CR-2187; D6-60168) Avail: NTIS HC $3.00 CSCL 21E

An analytical bleed system design procedure is applied to a Mach 3.5, axisymmetric, translating centerbody inlet. The design features a traveling centerbody bleed system with a ducting arrangement separating low-, medium-, and high-pressure bleed. Three forward plenums and nine throat plenums are installed on the centerbody to meet the bleed requirements in the started Mach range between 1.6 and 3.5. The cowl contains four stationary plenums, three for forward and one for throat bleed. To achieve maximum bleed plenum pressure and thereby minimize bleed drag all bleed holes are inclined 20 deg to the surface except in the cowl throat region. Here the requirement of high stability margin with minimum total pressure recovery penalty resulted in 90 deg bleed holes. The bleed hole diameter varies from bleed plenum to bleed plenum to achieve the most efficient boundary layer control, while the bleed exits are sized to operate at the highest possible plenum pressure without unchoking the bleed holes. Bleed flow rates, bleed plenum pressures, and boundary layer development along the cowl and centerbody are predicted over the entire started Mach range. Author

**N73-15822*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**INTERNAL PERFORMANCE OF A WEDGE NOZZLE FOR A SUPERSONIC CRUISE AIRCRAFT WITH A MULTISPOKE PRIMARY FOR NOISE SUPPRESSION**
Albert L. Johns Washington Jan. 1973 45 p refs
(NASA-TM-X-2689; E-7051) Avail: NTIS HC $3.00 CSCL 12D

Nozzle performance was obtained with cold primary and secondary flows over a range of nozzle pressure ratio from 2 to 31 and corrected secondary-to primary-flow ratio from 0 to 11 percent. Several fixed shroud positions were tested to simulate a translating outer cylindrical shroud to provide data for both supersonic cruise and takeoff configurations. The addition of 14 spokes in the primary nozzle for noise suppression reduced the thrust efficiency 3 percent at supersonic cruise and 4.5 percent at takeoff. Author

**N73-15828#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**THE CONNECTION OF THE INVARIANCE CONDITIONS WITH THE CHARACTERISTICS OF A TURBOJET ENGINE WITH AFTERBURNER MULTIDIMENSIONAL CONTROL SYSTEM**
V. A. Bodner and Yu. A. Ryazanov 25 Aug. 1972 17 p refs Transl. into ENGLISH from the publ. "Primeniye Invariantnykh Sistem Avtomaticheskogo Upravleniya" Moscow Nauka, 1970 p 310-317
(AD-749656; FTD-MT-24-1086-72) Avail: NTIS CSCL 21/5

The purpose of the work is the establishment of the connection of invariance conditions with the characteristics of a turbojet engine with afterburner multidimensional control system under variable flight conditions with the use of methods of synthesizing the characteristics by approximating the transfer functions. Author (GRA)

**N73-15833#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**DUCTED-FAN TURBOJET ENGINES: REVIEW OF DEVELOPMENT ON FOREIGN PUBLICATIONS**
L. N. Golub 29 Aug. 1972 20 p refs Transl. into ENGLISH from Tr. Riiga, Nauch.-Tekh. Sb. Trudov po Prikl. Gazotermodinam. (USSR), no. 89, 1966 p 115-127
(AD-750984; FTD-HC-23-813-72) Avail: NTIS CSCL 21/5

The author analyzes operating principles and the thermodynamic cycle of turbofan rocket engines. Given is a brief analysis of the present state of turbofan rocket engines abroad, an analysis of design characteristics of a series of power plants, and basic diagrams of engines, their merits and shortcomings. Indicated are also the advantages of turbofan rocket engines at high supersonic-flight M numbers in comparison with other types of engines, as well as the possible field of application of turbofan rocket engines. Author (GRA)

**N73-15834#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**CONTROLLING THE BOUNDARY LAYER IN HYPERSONIC AIR INTAKES**
D. A. Gorodnikov, V. T. Grin, and N. N. Zakharov 28 Jul. 1972 15 p Transl. into ENGLISH from the publ. "1st International Symposium on Air-Breathing Engines" Marseille, France, 19-23 Jun. 1972 p 1-8
(AD-750513; FTD-HT-23-1349-72) Avail: NTIS CSCL 21/5

An increase in the Mach number of airborne vehicles using airbreathing jet engines leads to a substantial decrease in the performance of the air intakes used in these engines. The main reason for the deterioration in performance is an increase in the influence of air viscosity. Despite the fact that the Mach number following compression in a hypersonic air intake intended for engines with supersonic combustion is greater than 1, the pressure ratio in it reaches p = 100 and higher. In principle, such a pressure ratio can be obtained in a system of weak compression shocks with relatively low levels of total-pressure losses. However, the realization of such compression involves the occurrence of separation of the boundary layer. To prevent separation of the boundary layer a system for controlling the boundary layer must be devised. Author (GRA)

**N73-15899** Engineering Sciences Data Unit, London (England).
**ENDURANCE OF ALUMINUM ALLOY STRUCTURAL ELEMENTS SUBJECTED TO SIMULATED ACOUSTIC LOADING**
Jun. 1972 25 p refs Supersedes ESDU-66022 Sponsored by Roy. Aeron. Soc.
(ESDU-72015; ESDU-66022) Copyright. Avail: Issuing Activity

Fatigue tests on aluminum alloy specimens, typical of aircraft structural elements, excited by narrow-band loading of random amplitude with zero mean load to simulate stress response to acoustic loading are reported. Methods used to detect failure are described and typical locations of failures are illustrated. Typical stress distributions across the failure lines are shown. The loading simulated for the skin-stiffener test specimens is limited to modes where skin-stiffener flexure predominates. Author

**N73-15902** Engineering Sciences Data Unit, London (England).
**PROPERTIES OF MATERIALS IN COMPRESSION**
Jul. 1972 4 p refs
(ESDU-00.01.01-Amend-A) Copyright. Avail: Issuing Activity

Values of compressive stress-strain parameters are given for a number of aircraft materials. The proof stresses were reduced from test results to correspond with the minimum tensile proof stresses in the appropriate material specifications. The results are given in tables. Author

**N73-15904** Engineering Sciences Data Unit, London (England).
**ESTIMATION OF rms STRESS IN SKIN PANELS SUBJECTED TO RANDOM ACOUSTIC LOADING**
Oct. 1972 2 p Sponsored by Roy. Aeronaut. Soc.
(ESDU-67028-Amend-A) Copyright. Avail: Issuing Activity

An existing theory for describing the response of skin panels to acoustics loads and stress is simplified. The simplified theory is outlined and experimental results are given to show the orders of accuracy which can be achieved on full scale structures in true noise environments. Experimental results are generally within a factor of 2 of the rms stress estimates. Author

**N73-15917#** National Aerospace Lab., Tokyo (Japan).
**ON THE NATURAL VIBRATION OF PLATE-BEAM COMBINATION STRUCTURES, 3**
Taketoshi Hanawa, Yoichi Hayashi, Yasuo Tada, Susumu Toda, and Kazuo Kusaka Jul. 1972 33 p refs In JAPANESE; ENGLISH summary
(NAL-TR-291) Avail: NTIS HC $3.75

A method for analyzing the natural vibration characteristics of plate-beam combination structures is presented. Structures of built up delta wings and fuselages are used as examples. Numerical analyses of the aerodynamic characteristics in supersonic flight are developed. Vibration tests were conducted to provide a comparison with the simulation tests. Author

**N73-15925*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**LIFE PREDICTION OF TURBINE COMPONENTS: ONGOING STUDIES AT THE NASA LEWIS RESEARCH CENTER**
David A. Spera and Salvatore J. Grisaffe Washington Jan. 1973 71 p refs
(NASA-TM-X-2664; E-7158) Avail: NTIS HC $3.00 CSCL 21E

An overview is presented of the many studies at NASA-Lewis that form the turbine component life prediction program. This program has three phases: (1) development of life prediction methods for major failure modes through materials studies, (2) evaluation and improvement of these methods through a variety of burner rig studies on simulated components in research engines and advanced rigs. These three phases form a cooperative, interdisciplinary program. A bibliography of Lewis publications on fatigue, oxidation and coatings, and turbine engine alloys is included. Author

**N73-15936#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**THE INVESTIGATION OF STRESSES IN A COMPRESSOR BLADE FOIL**
V. B. Gorlov 4 Aug. 1972 12 p refs Transl. into ENGLISH from the Publ. "Trudy, 5-y Vsesoyoznoy Konferentsii, 23-27 Iyunya 1964. Polyarizatsionno- Opticheskiy Metod Issledovaniya Napryazheniy" Leningrad Univ., 1966 p 330-334
(AF Proj. 668A)
(AD-750497; FTD-MT-24-12-72) Avail: NTIS CSCL 13/7

The paper contains the results of an investigation of stresses in compressor rotors and blades. Specifically, the stresses in dove tail joints (two dimensional problem) and the key end of a compressor blade with a considerable natural twist (three dimensional problem) were evaluated. A model of the rotor was constructed using a special alloy. The stresses between the blade slots on the rotor were measured using an optical polarization method. The distortion of a grid pattern after the test was used to measure the strain. Author (GRA)

**N73-15959*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**COMPARISON OF PRIMARY ZONE COMBUSTOR LINER WALL TEMPERATURES WITH CALCULATED PREDICTIONS**
Carl T. Norgren Washington Jan. 1973 26 p refs
(NASA-TM-X-2711; E-7172) Avail: NTIS HC $3.00 CSCL 20M

Calculated liner temperatures based on a steady-state radiative and convective heat balance at the liner wall were compared with experimental values. Calculated liner temperatures were approximately 8 percent higher than experimental values. A radiometer was used to experimentally determine values of flame temperature and flame emissivity. Film cooling effectiveness was calculated from an empirical turbulent mixing expression assuming a turbulent mixing level of 2 percent. Liner wall temperatures were measured in a rectangular combustor segment 6 by 12 in. and tested at pressures up to 26.7 atm and inlet temperatures up to 922 K. Author

N73-15971# CONSAD Research Corp., Pittsburgh, Pa.
**A COMMUNITY/AIRPORT ECONOMIC DEVELOPMENT MODEL. VOLUME 3: USER'S MANUAL Final Report, Apr. 1971 - May 1972**
Jere J. Hinkle May 1972 209 p
(Contract DOT-FA71WA-2565)
(FAA-EQ-72-3-Vol-3) Avail: NTIS HC $12.50

A description of the operations of the Community/Airport Economic Development Model is presented. Information is given in both narrative and graphic form regarding the kind of input that is required to be provided by the user of the program. The options that are available within the program and the format and ordering of the data that are required for program operation are given. Sample outputs are included. Author

N73-15972# Office of Naval Research, London (England).
**EUROPEAN SCIENTIFIC NOTES, VOLUME 26, NO. 9**
John M. Leonard, ed. and Victoria Hewitson, ed. 29 Sep. 1972 33 p

Avail: NTIS CSCL 05/2

Presents materials on combustion research, physiology, polymers, helicopter icing, salaries of instructors, marine cargo carriers, research in Japan, icebreakers, electronics engineering, metallurgy, computer aided design, oceanology, spectroscopy, and marine biology. GRA

N73-15975# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Systems and Logistics.
**A STUDY OF THE F-15 CONTRACT STRUCTURE AND ITS CONTRIBUTION TO EFFECTIVE PROGRAM MANAGEMENT M.S. Thesis**
Gerald A. Christenson and James C. Klorne 15 Sep. 1972 172 p refs
(AD-750849; SLSR-27-72B) Avail: NTIS CSCL 15/5

Government contracting personnel have had a history of accepting a procurement procedure which appeared to be successful in past program and erroneously applying those same procedures to new and different programs. The F-15 contract contains some new and some uniquely applied standard contract clauses. These clauses were described, analyzed, and presented independently in the thesis. After the independent study of the clauses, a summary of the interrelatedness of these clauses was presented. The author's interpretation of what external factors influenced the F-15 contract and how the F-15 contract philosophy evolved are also presented. The authors have made recommendations which apply to the future use of the F-15 contract clauses. Author (GRA)

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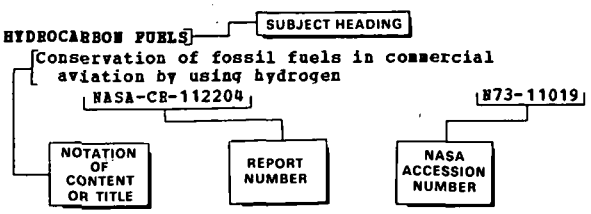


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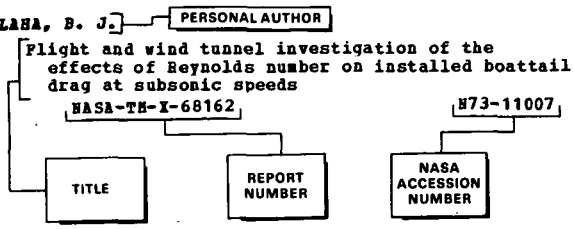


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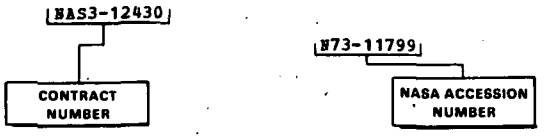


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