NASA SP-7037 (77)

NASA SP-7037(77) Aeronautical Engineering Pages 399-240 DECEMBER 1976

AERONAUTICAL ENGINEERING

A SPECIAL BIBLIOGRAPHY

WITH INDEXES

Supplement 77

DECEMBER 1976

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

ACCESSION NUMBER RANGES

Accession numbers cited in this Supplement fall within the following ranges:

STAR (N-10000 Series)	N76-30147 –N76-32123
IAA (A-10000 Series)	A76-41507 –A76-44716

This bibliography was prepared by the NASA Scientific and Technical Information Facility operated for the National Aeronautics and Space Administration by Informatics Information Systems Company.

NASA SP-7037 (77)

AERONAUTICAL ENGINEERING

A Special Bibliography

Supplement 77

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in November 1976 in

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

Scientific and Technical Information Office
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
DECEMBER 1976
Washington, D.C.

This Supplement is available from the National Technical Information Service (NTIS), Springfield, Virginia 22161, for $4 00 For copies mailed to addresses outside the United States, add $2 50 per copy for handling and postage

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 304 reports, journal articles, and other documents originally announced in November 1976 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

An annual cumulative index will be published

AVAILABILITY OF CITED PUBLICATIONS

IAA ENTRIES (A76-10000 Series)

All publications abstracted in this Section are available from the Technical Information Service, American Institute of Aeronautics and Astronautics, Inc (AIAA) as follows Paper copies are available at $5 00 per document up to a maximum of 20 pages The charge for each additional page is 25 cents Microfiche[1] are available at the rate of $1 50 per microfiche for documents identified by the # symbol following the accession number A number of publications, because of their special characteristics, are available only for reference in the AIAA Technical Information Service Library Minimum airmail postage to foreign countries is $1 00 Please refer to the accession number e g (A76-10091), when requesting publications

STAR ENTRIES (N76-10000 Series)

One or more sources from which a document announced in *STAR* is available to the public is ordinarily given on the last line of the citation The most commonly indicated sources and their acronyms or abbreviations are listed below If the publication is available from a source other than those listed, the publisher and his address will be displayed on the availability line or in combination with the corporate source line

Avail NTIS Sold by the National Technical Information Service to U S customers at the price shown in the citation following the letters HC (hard, paper, or facsimile copy) Customers outside the U S should add $2 50 per copy for handling and postage charges to the price shown (Prices shown in earlier *STAR* volumes, 1962-1975 have been superseded but may be calculated from the number of pages shown in the citation The price schedule by page count was published in *STAR* Numbers 2 and 3 of 1976, or it may be obtained from NTIS)

Microfiche[1] is available at a standard price of $3 00 (plus $1 50 for non-U S customers) regardless of source or the quality of the fiche, for those accessions followed by a # symbol Accession numbers followed by a + sign are not available as microfiche because of size or reproducibility

Initially distributed microfiche under the NTIS SRIM (Selected Research in Microfiche) is available at greatly reduced unit prices For this service and for information concerning subscription to NASA printed reports, consult the NTIS Subscription Unit

NOTE ON ORDERING DOCUMENTS When ordering NASA publications (those followed by the * symbol), use the N accession number NASA patent applications (only the specifications are offered) should be ordered by the US-Patent-Appl-SN number Non-NASA publications (no asterisk) should be ordered by the AD PB, or other *report* number shown on the last line of the citation, not by the N accession number It is also advisable to cite the title and other bibliographic identification

Avail SOD (or GPO) Sold by the Superintendent of Documents, U S Government Printing Office, in hard copy The current price and order number are given following the availability line (NTIS will fill microfiche requests, at the standard $3 00 price, for those documents identified by a # symbol)

(1) A microfiche is a transparent sheet of film 105 by 148 mm in size containing as many as 60 to 98 pages of information reduced to micro images (not to exceed 26 1 reduction)

Avail NASA Public Document Rooms Documents so indicated may be examined at or purchased from the National Aeronautics and Space Administration, Public Documents Room (Room 126), 600 Independence Ave., S.W., Washington, D.C. 20546, or public document rooms located at each of the NASA research centers, the NASA Space Technology Laboratories, and the NASA Pasadena Office at the Jet Propulsion Laboratory

Avail ERDA Depository Libraries Organizations in U.S. cities and abroad that maintain collections of Energy Research and Development Administration reports, usually in microfiche form, are listed in *Nuclear Science Abstracts* Services available from the ERDA and its depositories are described in a booklet, *Science Information Available from the Energy Research and Development Administration* (TID-4550), which may be obtained without charge from the ERDA Technical Information Center

Avail Univ. Microfilms Documents so indicated are dissertations selected from *Dissertation Abstracts* and are sold by University Microfilms as xerographic copy (HC) and microfilm All requests should cite the author and the Order Number as they appear in the citation

Avail USGS Originals of many reports from the U.S. Geological Survey, which may contain color illustrations, or otherwise may not have the quality of illustrations preserved in the microfiche or facsimile reproduction, may be examined by the public at the libraries of the USGS field offices whose addresses are listed in this Introduction The libraries may be queried concerning the availability of specific documents and the possible utilization of local copying services, such as color reproduction

Avail HMSO Publications of Her Majesty's Stationery Office are sold in the U.S. by Pendragon House, Inc. (PHI), Redwood City, California The U.S. price (including a service and mailing charge) is given, or a conversion table may be obtained from PHI

Avail BLL (formerly NLL) British Library Lending Division, Boston Spa, Wetherby, Yorkshire, England Photocopies available from this organization at the price shown (If none is given, inquiry should be addressed to the BLL.)

Avail ZLDI Sold by the Zentralstelle fur Luftfahrtdokumentation und -Information, Munich, Federal Republic or Germany, at the price shown in deutschmarks (DM)

Avail Issuing Activity, or Corporate Author, or no indication of availability Inquiries as to the availability of these documents should be addressed to the organization shown in the citation as the corporate author of the document

Avail U.S. Patent Office Sold by Commissioner of Patents, U.S. Patent Office, at the standard price of 50 cents each, postage free

Other availabilities If the publication is available from a source other than the above, the publisher and his address will be displayed entirely on the availability line or in combination with the corporate author line

GENERAL AVAILABILITY

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

ADDRESSES OF ORGANIZATIONS

American Institute of Aeronautics
and Astronautics
Technical Information Service
750 Third Ave
New York, N Y 10017

British Library Lending Division,
Boston Spa, Wetherby, Yorkshire,
England

Commissioner of Patents
U S Patent Office
Washington, D C 20231

Energy Research and Development
Administration
Technical Information Center
P O Box 62
Oak Ridge, Tennessee 37830

ESA-Space Documentation Service
ESRIN
Via Galileo Galilei
00044 Frascati (Rome) Italy

Her Majesty's Stationery Office
P O Box 569, S E 1
London England

NASA Scientific and Technical Information
Facility
P O Box 8757
B W I Airport Maryland 21240

National Aeronautics and Space
Administration
Scientific and Technical Information
Office (KSI)
Washington, D C 20546

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161

Pendragon House, Inc
899 Broadway Avenue
Redwood City California 94063

Superintendent of Documents
U S Government Printing Office
Washington D C 20402

University Microfilms
A Xerox Company
300 North Zeeb Road
Ann Arbor, Michigan 48106

University Microfilms, Ltd
Tylers Green
London, England

U S Geological Survey
1033 General Services Administration
Building
Washington, D C 20242

U S Geological Survey
601 E Cedar Avenue
Flagstaff, Arizona 86002

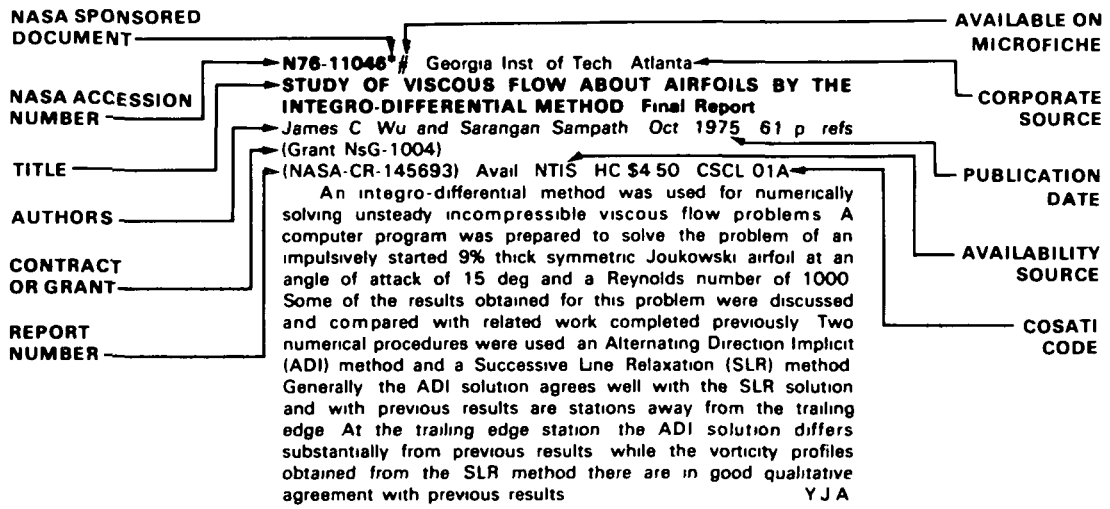
U S Geological Survey
345 Middlefield Road
Menlo Park, California 94025

U S Geological Survey
Bldg 25, Denver Federal Center
Denver, Colorado 80225

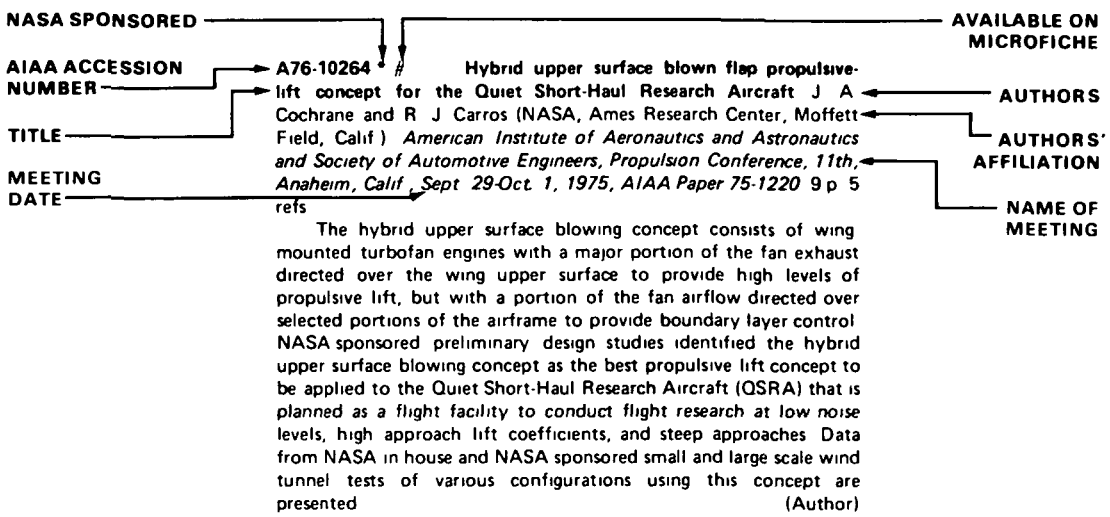
Zentralstelle fur Luftfahrtdoku-
mentation und -Information
8 Munchen 86
Postfach 880
Federal Republic of Germany

TABLE OF CONTENTS

TYPICAL CITATION AND ABSTRACT FROM *STAR*



TYPICAL CITATION AND ABSTRACT FROM *IAA*



AERONAUTICAL ENGINEERING

A Special Bibliography (Suppl. 77)

DECEMBER 1976

IAA ENTRIES

A76-41522 **B-1 composite horizontal stabilizer development** W Ludwig, H Erbacher, and J Visconti (Grumman Aerospace Corp, Bethpage, N Y) *(Society for the Advancement of Material and Process Engineers, National Symposium, 21st, Los Angeles, Calif, Apr 6-8, 1976) Journal of Composite Materials,* vol 10, July 1976, p 205-219

The design of the composite horizontal stabilizer for the B-1 aircraft has evolved after ten years of experience in the design, processing and testing of graphite and boron epoxy structures A concentrated effort has been made to develop a stabilizer configuration which makes optimum use of graphite and boron materials to obtain a reasonable weight and production cost saving The procedures used for the design, test data from the major elements, results of the full scale static test and production cost data are presented The resulting composite structure has demonstrated a weight saving of 15% for the total stabilizer and 21% for the composite box over the existing metal configuration Cost savings of 17% are indicated in production (Author)

A76-41524 **Hard object impact damage of metal matrix composites** J Awerbuch (USAF, Nonmetallic Materials Div, Wright-Patterson AFB, Ohio) and H T Hahn (Dayton, University, Dayton, Ohio) *Journal of Composite Materials,* vol 10, July 1976, p 231-257 15 refs

Boron/aluminum and boron/titanium matrix composites are tested for effects of soft impact and hard impact by spheres and cantilever plates at 50 to 4000 ft/sec, with radiographic and scanning electron microscope examination Local damage by hard objects and soft objects, and overall structural damage by soft objects, are investigated with varying impact parameters (mass, materials, velocity, geometry of target and ballistic projectile encounter), with attention given to residual strength after impacts, extent of strength degradation and fatigue, stresses at roots of target blades, and types of damage (indentation, perforations, peeling, spallation, lateral and axial cracks) The study simulates impacting of hard objects (stones, rivets, ice balls) and soft objects (birds) on metal composite aircraft structures (engine fan and compressor blades) (Author)

A76-41571 **Acoustic emission for in-flight monitoring on aircraft structures** C D Bailey (Lockheed Georgia Co, Marietta, Ga) *Materials Evaluation,* vol 34, Aug 1976, p 165 171 10 refs

The acoustic emission technique is used to locate fatigue cracks on aircraft structural test specimens A prototype acoustic system called flight structural monitoring system for detecting unstable crack growth in an aircraft structure is developed and flight tested The technique involves listening for the sounds generated by the crack extension and is not dependent on the accessibility to the crack location The problem of obtaining significant signal to-noise ratios on test specimens is solved by a combination of signal processing techniques involving spatial discrimination, frequency filtering, and signal amplitude discrimination Two structural specimens are monitored a lap joint fatigue test specimen and an inner wing midbeam specimen The results of a high-precision noise measurements survey conducted on an aircraft during flight provides basic data to determine the feasibility of developing an airborne acoustic emission system to detect fatigue crack initiation and monitor crack growth during flight S D

A76-41648 **Dynamic strength behavior of rivet joints in aircraft construction (Das Schwingfestigkeitsverhalten von Nietverbindungen im Flugzeugbau)** K Hoffer (Vereinigte Flugtechnische Werke-Fokker GmbH, Bremen, West Germany) *Materialprufung,* vol 18, Aug 1976, p 273-276 In German

Dynamic tests performed on the front part of aircraft fuselages indicate that an overwhelming majority of failures can be traced to cracks in the rivet holes Since the cost of rivet joints in a large transport aircraft can account for 40% of the cost of the empty frame, systematic tests of all the parameters affecting the dynamic strength of such joints must be carried out The present work contributes to this end by presenting some results on the elongation of the inner and outer sides of a butt-joint riveting at the middle of the joint as a function of tensile stress and results of multistep loading tests of representative rods with different design parameters P T H

A76-41695 # **In-plane stresses in edge stiffened swept panels** B Dattaguru and A K Rao (Indian Institute of Science, Bangalore, India) *AIAA Journal,* vol 14, Aug 1976, p 1038 1041 11 refs

Swept panels under extension present a significant structural problem in modern aircraft design A simple and elegant analysis for swept panels is introduced for the case of a parallelogrammic panel bounded by flexible constant stress edge members The stress function is assumed in two alternative infinite series in polar coordinates, one function with origin at the acute corner isolates the finite stress concentration at that corner, and the other centered at the obtuse corner separates out the singularity at that abtuse corner The arbitrary constants in the series are determined by a collocation procedure for approximately satisfying the skew conditions along the relevant diagonal of the panel The solutions converge rapidly in the region around their origin, but their convergence far from the corner is normally poor Accurate results for the entire panel are obtained by combining the solutions with origins at the two corners, each solution contributing the data for the region where it is more rapidly convergent (Author)

A76-41697 # **High frequency thin-airfoil theory for subsonic flow** R K Amiet (United Technologies Research Center, East Hartford, Conn) *AIAA Journal,* vol 14, Aug 1976, p 1076 1082 17 refs

A large parameter solution procedure of Schwartzschild and Landahl is adapted to the task of calculating closed-form approximate solutions for the pressure and lift of a flat-plate, infinite-span airfoil Two general cases are treated (1) the two dimensional subsonic flow problem, in which the large parameter is the upwash frequency, and (2) the three-dimensional incompressible flow problem, in which the large parameter is the spanwise wavenumber of the upwash For the first case, the four problems of a gust drifting with the freestream, a gust moving at other than the freestream velocity, a plunging motion, and a linear upwash are treated For the second case, the two problems of a gust drifting with the freestream and a generalized gust moving at other than the freestream velocity are considered Comparison of the solutions with available numerical results generally shows good agreement when the appropriate

parameter is large The solutions for the gust convecting with the freestream for both the two-dimensional compressible and the three-dimensional incompressible cases were derived previously by Adamczyk using the Wiener-Hopf technique (Author)

A76-41698 # **Approximate unsteady thin-airfoil theory for subsonic flow** N H Kemp (Avco Everett Research Laboratory, Inc , Everett, Mass) and G Homicz (Calspan Corp , Buffalo, N Y) *AIAA Journal,* vol 14, Aug 1976, p 1083-1089 13 refs

The nonsteady load distribution on two-dimensional thin airfoils oscillating in subsonic flow is governed by the Possio integral equation which has no known exact analytical solution For a given airfoil motion, the forces depend on the stream Mach number and the reduced frequency of oscillation An analytical solution of the Possio integral equation for low reduced-frequency is obtained which is correct to the order of reduced frequency times Mach number divided by one minus Mach number squared The resulting loading, lift, and moment differ from those derived from Glauert-Amiet Siers Prandtl (GASP) theory by Osborne (1973), but in agreement with recent work of Amiet who has shown GASP theory to be *inapplicable to two-dimensional flow with shed vorticity Explicit* formulas for lift and moment are given for a generalized gust, an upwash varying like any integral power of chordwise distance, constant upwash (plunging), linear upwash (pitching), and a sinusoidal gust A phase-corrected form is shown to yield highly accurate results within 10% S D

A76-41700 # **Impingement of a two-dimensional supersonic jet upon a normal ground surface** D J Pollard and L J S Bradbury (Surrey, University, Guildford, England) *AIAA Journal,* vol 14, Aug 1976, p 1095 1098 11 refs

A brief report is presented of experimental work on rectangular supersonic jets of nominal Mach no 1 4 under freely discharging conditions and also impinging upon a normal ground surface The mixing region and the fully developed region of the free jet are investigated and show good agreement with other authors' work The pressure distribution on the ground surface under the impinging jet is correlated for various nozzle heights above the ground on the basis of a dimensional argument Finally, some results of a numerical prediction for the shock wave shape in the impingement region are *also presented* (Author)

A76-41717 # **Wake effects in finite amplitude nonsteady motion of slender profiles** M G Chopra (Cambridge University, Cambridge, England) *AIAA Journal,* vol 14, Aug 1976, p 1145-1148 11 refs

Unsteady motion of thin wings is always accompanied by shedding of the boundary layer from the separation point in the form of a thin sheet deforming into vortices A method is proposed for finding the vortex intensity induced on an airfoil due to an arbitrarily placed wake vortex, which is helpful in the evaluation of wake vorticity A procedure for determining the complete vorticity distribution for the case of an airfoil making finite-amplitude oscillations is outlined Once the complete vorticity distribution is known, the analysis can be followed up for the evaluation of lift, moment, and drag for problems of aerodynamic and ship hydrodynamic interest, or for the calculation of forward thrust and subsequently hydromechanical propulsive efficiency for certain problems of animal locomotion S D

A76-41718 * # **Influence of nonconservative differencing on transonic streamline shapes** P A Newman and J C South, Jr (NASA, Langley Research Center, Subsonic Transonic Aerodynamics Div , Hampton, Va) *AIAA Journal,* vol 14, Aug 1976, p 1148, 1149 5 refs

A computer program recently developed by South and Brandt (1976) which contained the Murman (1973) conservative finite difference scheme is easily modified to use the Garabedian and Korn (1971) nonconservative finite difference scheme This program solves the transonic small disturbance equation for only symmetric flow, but incorporates several iterative solution techniques Results are presented for the case where the equally spaced computational grid extended to infinity in both the streamwise and normal directions Streamline shapes are obtained along several grid lines by a streamwise integration of the normal component of the perturbation velocity Comparison cases are run for a 10% thick parabolic arc airfoil at zero incidence for freestream Mach numbers of 0, 0 70, 0 84, and 0 95 It is shown that the use of a nonconservative finite difference scheme in transonic flow calculations destroys the global mass balance when shocks are present This lack of mass balance may prove to be more crucial in the case of an unconfined external flow S D

A76-41761 * **Vortex shedding from a blunt trailing edge with equal and unequal external mean velocities** D R Boldman, P F Brinich, and M E Goldstein (NASA, Lewis Research Center, Cleveland, Ohio) *Journal of Fluid Mechanics,* vol 75, June 25, 1976, p 721 735 5 refs

A flow-visualization study has shown that strong Karman vortices develop behind the blunt trailing edge of a plate when the free-stream velocities over both surfaces are equal and that the vortices tend to disappear when the surface velocities are unequal This observation provides an explanation for the occurence and disappearance of certain discrete tones often found to be present in the noise spectra of coaxial jets Both the vortex formation and the tones occur at a Strouhal number based on the lip thickness and the average of the external steady-state velocities of about 0 2 Results from theoretical calculations of the vortex formation, based on an inviscid incompressible analysis of the motion of point vortices, were in good agreement with the experimental observations (Author)

A76-41770 * # **Engineering flowfields and heating rates for highly swept wing leading edges** J J Bertin, S J Mosso, D W Barnette (Texas, University, Austin, Tex), and W D Goodrich (NASA, Johnson Space Center, Houston, Tex) *Journal of Spacecraft and Rockets,* vol 13, Sept 1976, p 540 546 14 refs Contract No NAS9-13680

An engineering flow model is developed (and verified experi *mentally) which describes the flowfield that arises when a supersonic* stream encounters a wedge/cylinder configuration whose angles are such that the flow includes only weak shock waves A numerical code using the perfect gas relations is used to describe the flow in the plane of symmetry inboard of the shock interaction region Theoretical surface-pressure and heat-transfer distributions are computed for freestream velocities ranging from 1167 to 7610 m/sec Nondimensionalization of the heat-transfer rates in terms of local flow parameters produced a correlation of Stanton number as a function of the local Reynolds number, which is independent of the freestream flow conditions and of the surface temperature (Author)

A76-41918 # **Effect of flap deflection on lift coefficients of biplane wings (Wplyw wychylenia klapy na wspolczynniki sily nosnej platow pracujacych w ukladzie dwuplata)** J Stasiak *Instytut Lotnictwa, Prace,* no 64, 1976, p 5-28 16 refs In Polish

The paper reports on experimental investigation of the effect of deflection of lift flaps on the upper or lower wing of a biplane system or on both wings simultaneously on increments of the lift force acting on the biplane cellule, of the effect of shortening the chord or altering the position of the lower wing with flap down on the upper wing, effect of flap position on the wing pressure distributions, and interference effects between biplane wings with flaps down A flaps-down upper wing can cancel out or even reverse the lift of the lower wing at practical angles of attack, but this can be offset by flaps with identical deflection angles on both wings (in vertical planes) Wing interference with flapped upper wing can be kept within bounds by shortening the lower wing chord R D V

A76-41919 # **Observations of the properties of acoustic materials and structures designed to lower noise level in aircraft cabins (Badania vlasnosci akustycznych materialow i konstrukcji**

stosowanych dla zmniejszenia poziomu halasu w kabinach samolotow) A Rudiuk *Instytut Lotnictwa, Prace,* no 64, 1976, p 29-46 9 refs In Polish

Detailed results of an experimental studies on sound-absorbing and sound insulating materials used in structural design of small aircraft to lower pilot cabin noise levels are reported Design limitations on wall thickness (to 50 mm) in small piston-driven aircraft and rotorcraft are crucial, since piston engine noise is dominated by low frequencies most readily absorbed by thick walls Data from tests on several dozen combinations of plexiglass, foamed plastic, glass laminate, dural, paper filler, voids, laths, felt packings, and other wall and window materials are presented and discussed
R D V

A76-41920 # **Physical models for analysis of computational results and measurement results on a supercharged diesel engine (Od modeli fizycznych do analizy wynikow obliczen i pomiarow doladowanego silnika wysokopreznego)** J Suski *Instytut Lotnictwa, Prace,* no 64, 1976, p 47-63 24 refs In Polish

A typical research cycle - encompassing physical models and mathematical models, methods of solution, and experimental verification up to and including analysis of computational results and measurements - is described in application to a supercharged diesel engine The known rate of mass change and pressure change of the working fluid and the average temperature of the boundary of the combustion space are used to find the engine thermal efficiency and strength A model for energy transfer is also discussed, among others
R D V

A76-41921 # **An inductively coupled goniometer for a long-wave and medium-wave aviation automatic radio direction finder (Goniometr indukcyjny do automatycznego radionamiernika lotniczego na fale dlugie i srednie)** A Mioduszewski *Instytut Lotnictwa, Prace,* no 64, 1976, p 65-89 9 refs In Polish

Results of an investigation of the performance of an inductive goniometer designed for operation at medium and long wavelengths in conjunction with the loop antenna system of an automatic radio compass are presented and discussed Some engineering solutions with internal coils and with ferromagnetic core coils are presented, and goniometer error sources are examined Techniques for measuring goniometer instrumental accuracy are discussed A ring inductive goniometer model is discussed, basic electrical parameters and goniometer errors are dealt with, and goniometer design and performance data are listed
R D V

A76-41968 * # **Civil uses of remotely piloted aircraft** W P Nelms, Jr (NASA, Ames Research Center, Moffett Field, Calif) and J R Aderhold (Lockheed Missiles and Space Co , Inc , Sunnyvale, Calif) In National Association for Remotely Piloted Vehicles, Annual Symposium, 3rd, Dayton, Ohio, May 3-5, 1976, Proceedings
Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1976 9 p

An overview of an ongoing study of civil applications of Remotely Piloted Vehicles (RPVs) is presented, including a summation of results to date and the status of work yet to be completed The intent of the study is to examine the total technical, economic, and environmental impact of RPVs in the civil environment in order to identify and assess the technological effort required to bring these vehicles to realization The paper describes a market survey in which some 35 civil applications of RPVs have been defined and categorized into groups which have similar mission requirements From this broad analysis of many potential uses, a smaller number of promising and representative applications have been selected for more in-depth analysis Using one or two of these applications as specific examples, the paper briefly describes system performance requirements and vehicle concepts, and compares the benefits and costs with those of present methods The paper also reports on the status-of-other-work such as subsystem concepts, assessment of the technology, and the influence of safety and environmental considerations on these future civil RPV systems (Author)

A76-41970 # **Acceptable cost ratios for several RPV missions** D J O'Brien (Boeing Co , Seattle, Wash) In National Association for Remotely Piloted Vehicles, Annual Symposium, 3rd, Dayton, Ohio, May 3-5, 1976, Proceedings
Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1976 7 p

The cost effectiveness of using Remotely Piloted Vehicles in different roles (surveillance, strike, tank army defense suppression) is compared with that of alternative vehicles or weapons The RPVs offer significant savings in operation and maintenance costs and personnel for surveillance operations, and can reduce aircraft losses and release aircraft for other missions They offer the advantage of operation at very low altitudes under virtually all weather conditions If they are used to prepare the way for fighter bomber attacks, they can cause extensive damages to the enemy position while diverting defensive fire that would otherwise be directed to more costly aircraft
C K D

A76-41971 # **The role of propulsion in effecting low cost RPV operations** H L Burge, J A Hardgrove (TRW Space and Defense Systems, Redondo Beach, Calif), and W Stephens (TRW Space and Defense Systems, Redondo Beach, United Technologies Corp , Chemical Systems Div , Sunnyvale, Calif) In National Association for Remotely Piloted Vehicles, Annual Symposium, 3rd, Dayton, Ohio, May 3-5, 1976, Proceedings
Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1976 22 p 21 refs

To achieve low cost RPV operation requires design principles which result in across-the-board cost effectiveness This paper deals with two aspects of propulsion design cost effectiveness launch propulsion and sustaining flight propulsion In the case of the expendable vehicle the overall system must incorporate principles which are compatible with the expendable munitions round approach To achieve maximum cost effectiveness in massive sortie deployment while maintaining high mobility levels requires a low cost launching concept The jet tab thrust vector controlled booster motor is examined for the low cost launching propulsion The pulse jet is examined as a viable sustainer engine concept for the expendable vehicle (Author)

A76-41972 # **Design for attrition** W E Klosterman (Boeing Co , Seattle, Wash) In National Association for Remotely Piloted Vehicles, Annual Symposium, 3rd, Dayton, Ohio, May 3-5, 1976, Proceedings Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1976 8 p

An analytical technique which allows comparison of the capabilities of widely differing weapon systems in an attrition environment is used to investigate the design criteria for Remotely Piloted Vehicles It is shown that in a severe attrition environment, small strike vehicles are more effective The criteria used to evaluate the effectiveness of strike vehicles stress resources expended to obtain the desired result rather than system cost effectiveness
C K D

A76-41973 # **The future role of RPVs in TACAIR** G W Burkley (U S Department of Defense, Tactical Air Div , Washington, D C) In National Association for Remotely Piloted Vehicles, Annual Symposium, 3rd, Dayton, Ohio, May 3-5, 1976, Proceedings
Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1976 5 p

The role of tactical aircraft (TACAIR) in modern warfare is examined to identify windows of opportunity in the Department of Defense budget for the procurement of Remotely Piloted Vehicles (RPV) The inventory projections for early warning and control, reconnaissance, electronic warfare, air to-air capability, direct air support, and all-weather-interdiction are examined, and the ability of RPVs to serve a useful function in these areas is considered Two

opportune times for the introduction of TACAIR systems, including RPVs, are identified 1978-1984 and after 2010 C K D

A76-41974 # **The users experience with operational RPVs** F E Ruppenthal (USAF, 100th Strategic Air Command, Davis Monthan AFB, Ariz) In National Association for Remotely Piloted Vehicles, Annual Symposium, 3rd, Dayton, Ohio, May 3-5, 1976, Proceedings Dayton, Ohio, National Association for Remotely Piloted Vehicles, 1976 4 p

The Strategic Air Command's (SAC) Operational Remotely Piloted Vehicle (RPV) program is described, with emphasis on the problems encountered that have had an adverse effect upon the operational employment of RPV systems A brief review is given of SAC's operational concept and the equipment used for the past decade to accomplish these missions Ideas on the technical innovations necessary to alleviate problem areas associated with the employment of RPVs are discussed Subjects covered include command and control equipment, RPV recovery, training, and RPV design (Author)

A76-42020 # **Reliability of aircraft engines and power plants (Nadezhnost' aviatsionnykh dvigatelei i silovykh ustanovok)** V V Kostochkin Moscow, Izdatel'stvo Mashinostroenie, 1976 248 p 103 refs In Russian

Theoretical and engineering principles of achieving reliable aircraft power systems are outlined in this textbook The application of the principles of probability theory to reliability problems is demonstrated, and the physical aspects of reliability and methods of improving it are examined Methods of calculating the reliability of aircraft engines and their elements are demonstrated by examples, along with methods of gathering and analyzing statistical data on malfunctions that may occur during operation Guidelines for use in designing for reliability are proposed V P

A76-42023 # **Fundamentals of aviation /2nd revised and enlarged edition/ (Osnovy aviatsii /2nd revised and enlarged edition/)** B K Gusev and V F Dokin Moscow, Izdatel'stvo Transport, 1976 128 p 9 refs In Russian

The book, directed to a general readership, presents a broad introduction to the field of aviation Following a review of the history of Soviet aviation, the basic concepts of aerodynamics are discussed The major parts and systems of airplanes and helicopters are described and compared, with special attention given to the fuel system and to the structure and function of different types of aviation engines The characteristics and theoretical descriptions of different flight phases are outlined C K D

A76-42043 # **Service life of aircraft friction elements (Dolgovechnost' uzlov treniia samoletov)** K A Krylov and M E Khaimzon Moscow, Izdatel'stvo Transport, 1976 184 p 114 refs In Russian

The characteristics of the basic aircraft friction elements are discussed, along with the types of friction wear and the wear resistance of materials used in sliding and rolling friction elements The physical and statistical aspects of the dynamics of wear are examined, and a probabilistic mathematical model developed for friction wear is discussed The influence of the operational conditions on the wear intensity and service life of such elements as cog wheels and rolling contact bearings is demonstrated, along with the influence of lubricants and their contaminations on the putting failure of balls Attention is given to wear prediction methods and to methods of obtaining probabilistic service life estimates on the basis of experimental data Current trends in improving the service life of friction elements are examined V P

A76-42050 # **Handbook of masses of aviation and other materials Weight characteristics Volumes 1, 2, 4, 5 & 6 /4th revised and enlarged edition/ (Spravochnik po massam aviatsionnykh i drugikh materialov Vesovye kharakteristiki Volumes 1, 2, 4, 5 & 6 /4th revised and enlarged edition/)** L I Glezer, Ia I Zaiats, and P I Chudakov Moscow, Izdatel'stvo Mashinostroenie, 1975 Vol 1, 296 p , vol 2, 124 p , vol 4, 320 p , vol 5, 112 p , vol 6, 144 p In Russian

The handbook provides extensive tables with data on the weight per linear meter or square meter of a variety of construction materials such as sheets, tapes, strips, tubes, foils, and beam profiles made of heavy and light ferrous and nonferrous metals and alloys Data are also supplied on the weight characteristics of numerous types of metal products used in mechanical engineering such as bolts, screws, nuts, nails, cable, grids, chains, wire, ball bearings, and metal balls and vessels Data are also given on nonmetallic materials such as asbestos, paper, resins, wood, and textiles P T H

A76-42052 # **A modal transient rotordynamic model for dual-rotor jet engine systems** D W Childs (Louisville, University, Louisville, Ky) *(American Society of Mechanical Engineers, Paper 75-DE-S, 1975)* *ASME, Transactions, Series B - Journal of Engineering for Industry,* vol 98, Aug 1976, p 876-882 5 refs

A transient modal simulation model is developed for a 'typical' two-spool jet engine configuration, consisting of a low speed rotor, a high speed rotor, and the supporting case structure The formulation cited permits bearing connections from a rotor to the support structure and between rotors A conventional Jeffcott Green flexible rotor formulation is used to model each rotor as a collection of rigid bodies connected by a massless elastic structure The case structure is similarly modeled as a collection of axisymmetric elastically connected rigid bodies The transient modal simulation model development is based on eigendata for the complete structural dynamics model (elastically coupled rotors and case structure) at zero running speed The completed model readily accounts for gyroscopic effects, bearing damping and nonlinearities, structural modal damping, concentrated damping due to oil-film dampers, etc The applicability and utility of the model is demonstrated by the simulation of a turbine wheel blade loss (Author)

A76-42072 * **Flammability characteristics of aircraft interior composites** D A Kourtides, J A Parker, W J Gilwee, Jr , N R Lerner (NASA, Ames Research Center, Moffett Field, Calif), C J Hilado, L A LaBossiere (San Francisco, University, San Francisco, Calif), and M T S Hsu (San Jose State University, San Jose, Calif) *Journal of Fire and Flammability,* vol 7, July 1976, p 401 424, Discussion, p 424-426 19 refs

The thermochemical and flammability characteristics of two polymeric composites currently in use and seven others being considered for use as aircraft interior panels are described The properties studied included (1) oxygen index of the composite constituents, (2) fire containment capability of the composite, (3) smoke evolution from the composite, (4) thermogravimetric analysis, (5) composition of the volatile products of pyrolysis The performance of foam filled honeycomb laminated panels consisting of high-temperature laminating bismaleimide resins is compared with the performance of empty honeycomb laminated panels consisting of laminating epoxy or phenolic resins at similar densities Processing parameters of one of the bismaleimide composites is detailed (Author)

A76-42318 **A test facility for aircraft jet noise reduction** B L McGehee (Boeing Commercial Airplane Co , Seattle, Wash) *(Institute of Environmental Sciences, Annual Meeting, 22nd, Philadelphia, Pa , Apr 26-28, 1976) Journal of Environmental Sciences,* vol 19, July-Aug 1976, p 19-25 24 refs

An environmental facility known to Boeing as their 'Large Test Chamber' (LTC) was developed as the basic tool needed for advancing technology in jet aircraft noise reduction A variety of jet aircraft nozzle and chamber configurations were model-tested to ensure that facility design goals would satisfy the needs for current and future aircraft Test data accurate to plus or minus 1 dB of free-field was a facility objective This requires stringent control of the environment in the noise measurement arena A description is

given of the LTC major design considerations and the design development Chamber characteristics described are community isolation, anechoic quality, thermal gradients, and ventilation velocity Also, major test operational features are described They include jet engine simulation, test capacity, facility flexibility, and safety features In conclusion, achievement of major test facility goals are highlighted and the first year's test activities are noted Ongoing test facility capability development tasks are identified (Author)

A76-42403 # **Experimental investigations of a nozzle-wing propulsive-lift concept** P D Whitten, I G Kennon (General Dynamics Corp , Fort Worth, Tex), and S C Stumpfl (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 12th, Palo Alto, Calif , July 26-29, 1976, AIAA Paper 76-625* 11 p

Lift-enhancement through the use of a propulsive lift concept employing over-wing engine nozzles has been explored experimentally Conceptual wind tunnel tests of a small-scale nozzle-semiwing model were conducted at transonic Mach numbers to investigate the effectiveness of various nozzle/wing configurations A half-wedge/convergent divergent nozzle design is shown to provide superior efficiency in turning a high NPR jet at transonic freestream conditions Results obtained from transonic wind tunnel tests of a complete wing-body airplane model verify this design approach (Author)

A76-42404 # **A two-dimensional Airframe Integrated Nozzle design with inflight thrust vectoring and reversing capabilities for advanced fighter aircraft** G F Goetz (Boeing Aerospace Co , Seattle, Wash), J H Young (United Technologies Corp , Pratt and Whitney Aircraft Div , East Hartford, Conn), and J L Palcza (U S Navy, Naval Air Propulsion Test Center, Trenton, N J) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 12th, Palo Alto, Calif , July 26-29, 1976, AIAA Paper 76-626* 12 p 6 refs

An exploratory development program has been conducted to investigate the performance potential and design feasibility of a two dimensional Airframe Integrated Nozzle concept The program included wind tunnel performance evaluation of single and twin wedge nozzle/aftbody models to examine external flow interactions and installed performance effects with tails and inflight thrust vectoring/reversing A design study evaluated afterburner cooling requirements, nozzle loads, weights and identified development areas Ram air was investigated as an alternate source for wedge cooling These study results were applied to a tactical fighter-bomber indicating significant performance improvement potential (Author)

A76-42408 * # **Investigation of upper-surface-blowing nacelle integration at cruise speeds utilizing powered engine simulators** E T Meleason (NASA, Lewis Research Center, Cleveland, Ohio) and O D Wells (McDonnell Douglas Corp , Long Beach, Calif) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 12th, Palo Alto, Calif , July 26-29, 1976, AIAA Paper 76-623* 22 p 14 refs

Various overwing nacelle designs were investigated on a representative four-engine short-haul aircraft configuration during a combined analytical and experimental program Design conditions were a Mach number of 0 7 and a lift coefficient of 0 4 All nacelles had D-shaped nozzle exits and included a streamline-contoured design, a low boattail angle reference configuration, and a high boattail angle powered lift design Testing was done with the design four-engine airplane configuration as well as with only inboard nacelles installed Turbopowered engine simulators were used to provide realistic representation of nacelle flows Performance trends are compared for the various nacelle designs In addition, comparisons are presented between analytical and experimental pressure distributions and between flow-through and powered-simulator results (Author)

A76-42410 * # **Variable-cycle engines for supersonic cruising aircraft** E A Willis (NASA, Lewis Research Center, Cleveland, Ohio) and A D Welliver (Boeing Aerospace Co , Seattle, Wash) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 12th, Palo Alto, Calif , July 26-29, 1976, AIAA Paper 76-759* 11 p 22 refs NASA-supported research

The paper reviews the evolution and current status of selected recent variable-cycle engine (VCE) studies and describes how the results are influenced by airplane requirements The engine/airplane studies are intended to identify promising VCE concepts, simplify their designs and identify the potential benefits in terms of aircraft performance This includes range, noise, emissions, and the time and effort it may require to ensure technical readiness of sufficient depth to satisfy reasonable economic, performance, and environmental constraints A brief overview of closely related, on-going technology programs in acoustics and exhaust emissions is presented It is shown that realistic technology advancements in critical areas combined with well matched aircraft and selected VCE concepts can lead to significantly improved economic and environmental performance relative to first-generation SST predictions (Author)

A76-42411 * # **Flight experience with a digital integrated propulsion control system on an F-111E airplane** F W Burcham, Jr (NASA, Flight Research Center, Propulsion Control Branch, Edwards, Calif) and P G Batterton (NASA, Lewis Research Center, Analysis Section, Cleveland, Ohio) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 12th, Palo Alto, Calif , July 26 29, 1976, AIAA Paper 76-653* 15 p 6 refs

A digital integrated propulsion control system (IPCS) installed in the left side of an F 111 E aircraft was tested in flight The F-111 aircraft was selected for the IPCS program because it incorporated a variable geometry inlet and an afterburning turbofan engine and had two engines, one of which could remain in the normal configuration to ensure flight safety Flight data were compared with results of tests run in an altitude test chamber The digital system was found to be capable of duplicating the standard engine and inlet control systems Instabilities such as inlet buzz and afterburner rumble were detected and controlled The usefulness of an altitude chamber for developing a software and testing hardware was proven The flexibility of IPCS was demonstrated when an autothrottle, an in-flight thrust calculation, and a coannular noise study capability were added at the end of the flight tests S D

A76-42412 # **Recent development in engine performance refurbishment** R H Wulf (General Electric Co , Cincinnati, Ohio) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 12th, Palo Alto, Calif , July 26-29, 1976, AIAA Paper 76-646* 8 p

A practical program for engine performance refurbishment includes determination of an analytical deterioration model substantiated by inbound test cell runs, analytical teardowns to assign losses to specific parts/condition, incorporation of selected restoration items during maintenance action and measurement of results during outbound test cell runs Actual test results from a demonstrator program and fleetwide results from one DC10-10 operator are examined It was found that systematic restoration of the CF6-6 demonstrator engine recovered 92% of the measured sea level takeoff SFC loss from factory new, and about 80% of the EGT loss Analysis of outbound test cell trends for a typical airline indicated an average improvement of 13 9 C in takeoff EGT and 1 4% improvement in takeoff SFC for that fleet after incorporation of 65% of the performance items into the demonstrator engine B J

A76-42414 # **FADEC - Digital propulsion control of the future** B A Barclay (U S Navy, Naval Air Propulsion Test Center, Trenton, N J) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 12th, Palo Alto, Calif , July 26-29, 1976, AIAA Paper 76-652* 10 p Navy supported research

Inherent performance limitations and rising cost and weight of hydromechanical control systems make it necessary to find a new approach to engine control that would satisfy future propulsion system requirements The Full Authority Digital Electronic Control (FADEC) concept is seen to solve the control problem for future high-performance military propulsion systems The background, objectives, and approach to a recently initiated FADEC advanced development program are discussed At the conclusion of the program in 1979, additional control system demonstration tests will be conducted on advanced complex cycle engine designs currently being developed V P

A76-42415 # **Progress in electronic propulsion control for commercial aircraft** P W Kamber, W H Zimmerman (Boeing Commercial Airplane Co , Renton, Wash), R D Ransom (United Technologies Corp , Pratt and Whitney Aircraft Div , East Hartford, Conn), and J T Sullivan (United Technologies Corp , Hamilton Standard Div , Windsor Locks, Conn) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 12th, Palo Alto, Calif , July 26 29, 1976, AIAA Paper 76-655* 11 p 5 refs

Trade studies conducted by The Boeing Company, Pratt & Whitney and Hamilton Standard had shown potential functional and economic benefits associated with the application of full authority electronic control to commercial aircraft engines The three com panies conducted a 2-year joint program ending December 1975 to construct and test such a system to demonstrate its technical feasibility The system included advanced cockpit to-engine com munication links, thrust setting methods and displays, and a dual channel digital electronic engine control system Because system reliability is an important factor, techniques for fault accomodation were developed and demonstrated Successful engine tests were conducted at Pratt & Whitney and Boeing As a result, joint study programs have been initiated to examine advanced electronic control configurations for introduction on new and applicable current aircraft (Author)

A76-42418 * # **A report on the aerodynamic design and wind tunnel test of a Prop-Fan model** C Rohrbach (United Technologies Corp , Hamilton Standard Div , Windsor Locks, Conn) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 12th, Palo Alto, Calif , July 26-29, 1976, AIAA Paper 76-667* 12 p 9 refs Contract No NAS3-20219

Recent transport aircraft system studies have shown that the Prop-Fan propulsion system offers the potential for significant fuel savings over high bypass turbofans employing the same core engine technology for each This important finding has encouraged more detailed study of the Prop-Fan aerodynamics and has led to NASA sponsorship of a wind tunnel research program to explore the projected high efficiency levels of advanced propeller configurations for 0 80 Mach number, high-altitude cruise operation The aero-dynamic design philosophy for the Prop-Fan model is discussed The geometric characteristics and predicted performance of the wind tunnel model are presented Finally, the preliminary test results are reviewed and compared to the performance goals originally pro jected (Author)

A76-42419 # **Wind tunnel/flight test correlation program on the B-1 nacelle afterbody/nozzle** G K Richey (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio), M W Petersen (Rockwell International Corp , Los Angeles, Calif), and E A Price, Jr (ARO, Inc , Arnold Engineering Development Center, Arnold Air Force Station, Tenn) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 12th, Palo Alto, Calif , July 26-29, 1976, AIAA Paper 76-673* 26 p 6 refs

Results of wind tunnel tests of an instrumented 0 06-scale B 1 full aircraft configuration jet effects model are discussed with particular reference to the afterbody/nozzle region The objective was to investigate and improve correlation procedures between wind tunnel and flight test data for the flow fields associated with the inlet and nozzle of an integrated configuration with airframe/propulsion interference effects representative of advanced transonic/supersonic aircraft With pressure instrumentation on the nacelle afterbody/ nozzle, wind tunnel data indicate good correlation between the forces on the nacelle derived from pressure-area integration and direct measurement with a metric afterbody/nozzle balance In-vestigated areas include the effect of model configuration, nozzle pressure ratio, Reynolds number, strut effects, faired-over versus flow-through nacelle, and simulation of inlet bypass and spillage flow S D

A76-42420 # **Aftend drag data correlation and prediction technique for twin jet fighter type aircraft** K W Lee and J J Franz (U S Naval Material Command, Naval Air Development Center, Warminster, Pa) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 12th, Palo Alto, Calif , July 26-29, 1976, AIAA Paper 76-672* 6 p 6 refs

The NAVAIRDEVCEN has developed an empirical technique to provide methodology to evaluate and improve integrated airframe/ propulsion system design and performance This technique estimates the propulsion system influenced force of aftend drag for a twin jet 'fighter type' aircraft The technique was developed by formulating aftend drag/flow field and aircraft geometrical parameter correlations which were incorporated into an existing aftend drag predicting computer program The resulting methodology has demonstrated good aftend drag prediction capability as evidenced by the standard deviation of the F14B and F15 forecast drag levels, 6 5 and 15 2 drag counts respectively (Author)

A76-42423 # **Design and preliminary evaluation of inlet concepts selected for maneuver improvement.** J A Cawthon (General Dynamics Corp , Fort Worth, Tex) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 12th, Palo Alto, Calif , July 26-29, 1976, AIAA Paper 76-701* 14 p 10 refs

Five inlet design concepts that offer a potential for a significant improvement in aircraft maneuver capability at transonic speed were evaluated Each concept is derived from an analogy with wing leading edge high-lift devices, incorporating articulating flaps and slats, as well as tangential blowing for boundary layer control Four of the concepts address the problem of boundary layer separation near the leading edge of a thin surface such as a cowl lip or sideplate when the surface is subjected to severe flow incidence The fifth concept is also based on a boundary layer control technique, but in this case the wall boundary layer is energized by discrete jet nozzle flow directed downstream and parallel to the surface The five concepts were incorporated into two dimensional horizontal ramp supersonic inlet designs and wind tunnel tests indicated the viability of all five concepts B J

A76-42424 # **Variable cycle engines The next step in propulsion evolution** J E Johnson (General Electric Co , Cincinnati, Ohio) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 12th, Palo Alto, Calif , July 26-29, 1976, AIAA Paper 76-758* 39 p

This paper discusses the evolution of mixed mission aircraft propulsion from the afterburning turbojet through several variable cycle engine concepts A section of the paper addresses how existing engine concepts - turbojet, mixed flow turbofan, separated flow turbofan match mixed mission requirements Particular attention is given to inlet - engine flow matching potentials and installation losses that result from flow mismatches A detailed discussion with concept illustrations is included for some of the variable cycle engines studied by the General Electric Company during the last 15 years A final table describes the general configuration and potentials of the present variable cycle engines under study (Author)

A76-42426 # **Advanced integration technology to improve installed propulsion efficiency** R T Kawai (Douglas Aircraft Co ,

Long Beach, Calif) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 12th, Palo Alto, Calif , July 26 29, 1976, AIAA Paper 76-665* 11 p 15 refs

Past major improvements in transport aircraft productivity from advances in propulsive engines are reviewed, followed by an assessment of areas for future advancements Different trades will exist between weight, maintainability, and fuel consumption Past design approaches and concepts are re-evaluated because of the need to increase emphasis on reducing fuel consumption Recent studies have identified improvement possibilities through advancements in engine/airframe integration Current McDonnell Douglas advanced propulsion technology programs which are exploring these possibilities and can lead to significant fuel savings are described The barriers to utilization of this fuel conservative technology are discussed (Author)

A76-42430 # **Mission effects on engine structural life in current weapon systems** E E Abell (USAF, Aeronautical Systems Div , Wright Patterson AFB, Ohio) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 12th, Palo Alto, Calif , July 26-29, 1976, AIAA Paper 76-735* 6 p 8 refs

Several mission profiles flown by current U S Air Force aircraft are examined Types of missions examined are ground attack, air to air combat, and ferry or transport type operation These profiles and the resulting engine operation are evaluated for their effects on two example structural components of three turbine engines Additional comparisons to the 150 Hour Endurance Test used in previous engine qualification programs are given Resulting lives of the components are given for each type of operation (Author)

A76-42435 # **Supersonic cruise vehicle propulsion system integration studies** J L Benson, T A Sedgwick, and B R Wright (Lockheed-California Co , Burbank, Calif) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 12th, Palo Alto, Calif , July 26-29, 1976, AIAA Paper 76-756* 10 p 6 refs

The performance and systems integration aspects of a unique engine installation for a supersonic cruise vehicle, identified during an engine location study, are discussed This installation consists of four separate engine nacelles two located under the wing and two located over the wing at the same spanwise positions This nacelle arrangement, while having some propulsion system performance and weight penalties relative to a more conventional configuration employing four underwing nacelles, offers improved vehicle mission performance because of reduced noise, improved low speed lift characteristics and reduced tail size Propulsion system performance comparisons, integration studies and noise and mission performance results are presented showing that the over/under engine nacelle arrangement is an attractive supersonic cruise vehicle propulsion system configuration and worthy of additional study (Author)

A76-42436 # **Nacelle aerodynamic design and integration study on a Mach 2 2 supersonic cruise aircraft** H R Welge, R L Radkey, and P A Henne (Douglas Aircraft Co , Long Beach, Calif) *American Institute of Aeronautics and Astronautics and Society of Automotive Engineers, Propulsion Conference, 12th, Palo Alto, Calif , July 26-29, 1976, AIAA Paper 76-757* 12 p 20 refs

Results of a propulsion system integration study performed on a Mach 2 2 advanced supersonic cruise aircraft are discussed Numerous inlet-nacelle combinations were examined in a preliminary screening study Promising configurations were evaluated in a nacelle installation study in which structural weight and installed wave drag were traded leading to the selection of an axisymmetric single-engine pod installation as the most promising configuration A detailed nacelle shape study was conducted, and a wing reflex was designed A wind tunnel test of the refined nacelle with both mixed and external compression inlets was conducted with the nacelles installed on both a refined baseline wing and a reflexed wing Good agreement was observed between calculated and experimental increments in induced drag due to nacelle installation (Author)

A76-42479 **Wind energy concentrators** J L Loth (West Virginia University, Morgantown, W Va) In Energy crisis Two years progress towards self reliance, Proceedings of the Second Annual UMR MEC Conference on Energy, University of Missouri, Rolla, Mo , October 7 9, 1975 North Hollywood, Calif , Western Periodicals Co , 1976, p 93 107 10 refs NSF Grant No AER 7500367 000

This paper presents two alternatives to the shrouded propeller wind energy concentrator Their operation is based on generating a low pressure area, with high local wind velocity, around the windmill rotor The two types of wind energy concentrators considered are (1) the 'obstruction type' concentrator where a vertical cylinder or vertical flat surface is used to produce high local velocities around two counter rotating vertical axis rotors, and (2) the 'vortex type' concentrator where a horizontal vortex is generated by a vertical high lift wing of finite span The high local wind kinetic energy inside the vortex is harnessed by a horizontal axis rotor The performance parameters such as the power concentration ratio and the associated area ratio have been determined theoretically Some preliminary experimental data are included (Author)

A76-42526 * # **A systematic method for computer design of supercritical airfoils in cascade** P Garabedian and D Korn *Communications on Pure and Applied Mathematics,* vol 29, July 1976, p 369-382 12 refs Grants No NGR 33-016-167, No NGR-33-016-201, Contract No E(11 1)-3077

A computer code has been developed for the direct calculation of shockless transonic airfoils whose pressure distributions can be assigned within reasonable limits The partial differential equations of two-dimensional inviscid gas dynamics are solved by analytic continuation into the domain of two independent complex characteristic coordinates The domain of integration is mapped conformally onto the unit circle in the hodograph plane of one of these coordinates It is possible to formulate a boundary value problem on this circle for the stream function that is well posed in the case of transonic flow This enables the formulation of a procedure for the calculation of an airfoil on which the speed is prescribed as a function of the arc length B J

A76-42545 # **Calculation of the velocity distribution on a wing profile between two flat parallel walls (Calcolo della distribuzione di velocità su di un profilo alare tra due pareti piane e parallele)** G Chiocchia (Torino, Politecnico, Turin, Italy) *Associazione Italiana di Aeronautica e Astronautica, Congresso Nazionale, 3rd, Turin, Italy, Sept 30-Oct 3, 1975, Paper* 11 p In Italian

A numerical method developed by Muggia (1974) is used to calculate the velocity distribution on a wing profile - assumed thin and slightly curved - between two flat parallel walls in the undisturbed flow of an ideal incompressible fluid The method permits one to separate the effects of wing incidence, camber, and thickness on the velocity distribution, and is applied to cases of varying distances of walls from profile two distant walls, two near walls, and one near wall (ground effect) B J

A76-42547 # **Wind tunnel testing of motorized helicopter models - Determination of rotor attitude (Sperimentazione in galleria del vento di modelli motorizzati di elicottero - Rilievi di assetto del rotore)** S D'Angelo, R Malvano, and B Piombo (Torino, Politecnico, Turin, Italy) *Associazione Italiana di Aeronautica e Astronautica, Congresso Nazionale, 3rd, Turin, Italy, Sept 30-Oct 3, 1975, Paper* 11 p In Italian

A laser method was developed for determining the real values of the attitude of helicopter rotor blades in the wind tunnel simulation of a variety of flight conditions The method consists of determining the geometrical attitude and corresponding aerodynamic parameters of the rotor blades by reflecting a laser beam from the undersurface

of the blades In the tests reported, a motorized 1 9 scale model of the Bell 212 Twin Jet helicopter was used A complex procedure for determining blade attitudes from beam incidence and reflection characteristics is detailed B J

A76-42588 # **Engineering realizatıcn of electronic components of a combined control system (Realizace elektronicke casti kombinovaneho regulacniho systemu)** B Riha *Zpravodaj VZLU,* no 1, 1976, p 17-23 In Czech

Reliability and assembly problems in the design, testing, and use of control components and circuitry for aviation turbine engines are discussed, with emphasis on integrated circuits and printed circuits Operational reliability and on-shelf reliability of connections, circuit boards, and soldered joints, availability of spare parts, ways of coping with adverse operating conditions, mechanical stresses, and adverse climatic conditions are discussed, in addition to sizing of printed circuit boards, modularity in design, testing of circuit boards prior to assembly, assembly of components on boards, interference between subsystems, and ruggedized design Comparison with all-hydraulic engine control systems are presented R D V

A76-42589 # **Performance of the M 601 engine (Charakteristiky motoru M 601)** Z Pospisil and M Simer *Zpravodaj VZLU,* no 1, 1976, p 25-33 In Czech

Flight and throttling characteristics of the M 601A turboprop aviation engine are discussed, and analytical expressions are derived for approximating flight characteristics Principal operating con ditions, various turbine arrangements configurations, engine altitude and speed performance, test-stand measurements, engine start/stop and acceleration, pressure losses and heating in the intake and the effect of engine rpm, and the response to the engine to control signals are discussed, in addition to effects of air bleeds downstream of the compressor, loading of the instruments, and the effect of actuating the de icing system when air bleeds are at their peak R D V

A76-42590 # **Use of the MAP stochastical method for identifying aviation turbine engines (Pouziti stochasticke metody map pro identifikaci leteckych turbinovych motoru)** J John and J Salaba *Zpravodaj VZLU,* no 1, 1976, p 35-42 In Czech

Application of the extended Kalman filter, also known as the MAP (maximum a posteriori probability density) identification algorithm, for identification of aviation turbine engines is discussed The algorithm is applied here to twin-shaft turboprop engines, and specifically to the gas generator unit Results are comparable to those obtained in adaptive model identification An estimate is given of the second time constant Forced linearization, scattering matrices, and use of the algorithm in diagnostic and prediction problems are discussed R D V

A76-42591 # **A single-purpose adaptive analog model for in-process identification of a twin-shaft turboprop engine (Jednoucelovy adaptivni analogovy model pro prubeznou identifikaci dvouhrideloveho turbovrtuloveho motoru)** V Eck and J Salaba *Zpravodaj VZLU,* no 1, 1976, p 43-51 In Czech

The design of a custom-tailored adaptive model facilitating in-process identification of the gas generator unit of a twin-shaft turboprop engine is discussed A block diagram is set up for the identification process, and the basic structural components of the model are specified in detail, these include adaptive model, shaping of signals at the system input and output, shaping of signals at the output of the adaptive model, and filtration of signals to eliminate noise Attention is centered on the parallel adaptive model, with components commonly employed in existing analog computers and their peripherals Relationships between the model building blocks are analyzed, mutual amplitude transformations designed not to exceed limiting values for the components are presented, and an engineering solution of the adaptive model is presented R D V

A76-42592 # **Some experiments on in-process identification of the gas generator unit of a twin-shaft turboprop engine (Nektere zkusenosti z prubezne identifikace generatoru plynu dvouhrideloveho turbovrtuloveho motoru)** J Salaba and V Eck *Zpravodaj VZLU,* no 1, 1976, p 53-60 22 refs In Czech

An account is given of some experiments on in-process identification of the gas generator unit of a twin shaft turboprop engine, based on use of an adaptive model Models discussed include a series-parallel model, and a parallel adaptive model, both products of analog computation, and thirdly a model based on digitally programmed mathematical regression in recursive form Graphical displays of the results are included The effect of noise on adaptive identification, and ways of coping with noise, are indicated, in addition to the effect of input signals on the adaptive process Ways of accelerating the adaptive process with the aid of improved algorithms and alternate realizations of in-process identification are also indicated R D V

A76-42593 # **Procedure for calculating flight characteristics of turbofan engines (Program vypoctu letovych charakteristik dvouproudovych motoru)** A Malek and J Dostal *Zpravodaj VZLU,* no 2, 1976, p 83-94 In Czech

A new procedure is described for calculating the flight charac teristics of turbofan engines based on measured or calculated characteristics of the turbines and compressors Sources of error are analyzed The procedure is computer-coded in FORTRAN P T H

A76-42597 # **Survey of the development and current application of fluidics in control systems for aircraft gas turbine engines (Prehled vyvoje a soucasneho uplatneni fluidiky v ridicich systemech leteckych motoru se spalovaci turbinou)** V Tesar *Zpravodaj VZLU,* no 2, 1976, p 123-147 33 refs In Czech

After a review of the development of fluidics, some of the basic design features of second-generation fluidic amplifiers are examined A new laminar amplifier is described, with attention given to technological production considerations Characteristics of rpm sensors, temperature sensors, pump rate meters, and gas composition sensors are examined The possibility of realizing purely fluidic control systems for aircraft engines is discussed P T H

A76-42635 **An evaluation for the location and type of hand portable fire extinguisher used on board the AH-1 Army helicopter** J Jones (U S Army, Anniston Army Depot, Anniston, Ala) and R Morris (Texas A & M University, College Station, Tex) In Survival and Flight Equipment Association, Annual Conference and Trade Exhibit, 13th, San Antonio, Tex , September 21-26, 1975, Proceedings Canoga Park, Calif , Survival and Flight Equipment Association, 1975, p 62-65

A76-42740 **Aircraft energy needs** G J Schott (Boeing Commercial Airplane Co , Renton, Wash) In Energy and transportation, Proceedings of the Forum, Detroit, Mich , October 15, 1975 Warrendale, Pa , Society of Automotive Engineers, Inc , 1976, p 5-8

Aviation accounts for only a small fraction of the total annual consumption of petroleum based fuels for transportation Air transport fuels must be globally available, fluid at operational temperatures and pressures, and priced to allow profitable operations, and must have a high heating value, high density, and, preferably, a low vapor pressure Of the potential replacements for petroleum based fuels (liquid hydrogen, liquid methane, methanol, and synthetic kerosene), synthetic kerosene is judged most likely to satisfy these requirements A number of technological improvements, such as automatic flight management, advanced aerodynamics, laminar flow control, advanced engines, and advanced structural materials, could lead to significant reductions in fuel requirements, the development of new technologies is, however, dependent on the economic health of the aviation industry C K D

A76-42754 # **Experimental study of the effect of air suction through a slot on the development of a three-dimensional turbulent**

boundary layer (Eksperimental'noe issledovanie vliianiia otsosa vozdukha cherez shchel' na razvitie prostranstvennogo turbulentnogo pogranichnogo sloia) A V Kolesnikov and M O Frankfurt In Aerodynamics of ducts and fans Moscow, Izdatel'stvo Mashinostroenie, 1975, p 49 71 14 refs In Russian

The characteristics of the three-dimensional turbulent boundary layer on a slip wing of 0 6-m chord at slip angles of 0-40 deg were experimentally studied It was found that the change in the integrated characteristics of the layer caused by the suction was practically independent of slip angle The results permit evaluation of the effectiveness of suction through a slot of the turbulent boundary layer P T H

A76-42756 # **Selecting profile array density and angle of attack in axial fans (Vybor gustoty reshetki profilei i ugla ataki v osevykh ventiliatorakh)** I V Brusilovskii In Aerodynamics of ducts and fans Moscow, Izdatel'stvo Mashino stroenie, 1975, p 93 116 23 refs In Russian

A76-42758 # **Determining skin friction coefficients in the boundary layer with the aid of total pressure microtubes (K opredeleniiu koeffitsientov poverkhnostnogo treniia v pogranichnom sloe s ispol'zovaniem mikrotrubok polnogo davleniia)** A G Pro zorov In Aerodynamics of ducts and fans Moscow, Izdatel'stvo Mashinostroenie, 1975, p 197 204 In Russian

The feasibility of using Preston tubes for measuring skin friction in laminar boundary layers in the presence of strong pressure gradients at the wall is investigated Certain relations are given for experimentally determining skin friction, along with necessary calibration curves obtained in experiments on a plate P T H

A76-42848 Future development of radio and electronic aids for civil aviation in the USSR G A Pakholkov (Ministerstvo Radio Tekhnicheskoi Promyshlennosti SSSR, Moscow, USSR) and T Anodina (Ministerstvo Grazhdanskoi Aviatsii SSSR, Moscow, USSR) *Journal of Air Traffic Control,* vol 18, July Sept 1976, p 26 28, 30

The present state of the development of aircraft landing systems in the USSR is characterized by a wide use of Category I instrument landing systems, and by the putting into operation of Category II and III systems with gradual transition to principles of operation regulated by ICAO Short range radio navigation systems used in the USSR permit measurement of azimuth and distance on board the aircraft and the use of these data for area navigation by means of an airborne computer Air traffic control is provided by primary controller radar stations The improvement of automated ATC complexes by gradual transition from automated data acquisition systems to complexes which solve a number of logical tasks to help the controller is examined B J

A76-42901 Procedures before the Federal Aviation Administration J A Kovarik (FAA, Southwest Region, Fort Worth, Tex) *Journal of Air Law and Commerce,* vol 42, Winter 1976, p 11-37 43 refs

The development of the aeronautics federal regulation system which resulted in the establishment of the Federal Aviation Agency (FAA) in 1958 is outlined The structure of the FAA is described along with its statutory authority Detailed attention is given to the FAA activity in promoting aviation safety and efficiency, describing conventional and extraordinary enforcement procedures such as fact finding investigations, emergency cease and desist orders, seizure of aircraft, injunctions, etc Procedures of appealing to the National Transportation Safety Board (NTSB) and judicial reviewing of FAA orders are examined along with medical cases handling S N

A76-42902 Operational problems from the professional pilots perspective J J O'Donnell (Air Line Pilots Association, Washington, D C) *Journal of Air Law and Commerce,* vol 42, Winter 1976, p 39 45

The necessity of analyzing causes of pilot's actions in 'pilot error accidents' in order to improve air safety is stressed It is shown that most of the approach and landing phase accidents in commercial aviation happen because of a pilot's miscalculation or error in judgement induced by lack of information or the unavailability of adequate visual cues for successful transition from instrument to visual flight regime The following recommendations are set forth (1) the pilots should be more independent from the ground operators in the decision making process, particularly concerning the final 'go no go' decision, (2) there should be improvement in the information reporting system, the real time Runway Visual Range (RVR), wind, temperature and runway condition data should be reported directly to the cockpit, (3) the current aircraft and airport design requirements should be reviewed to insure aircraft landing safety, (4) the instrumentation in the cockpit should provide data on the real and proposed flight paths, true aircraft attitude and a measure of energy required versus energy available Areas to be investigated are indicated S N

A76-42903 The practical problems of approach and landing procedures from the perspective of the air traffic controller D A Trick (Professional Air Traffic Controllers Organization, Washington, D C) *Journal of Air Law and Commerce,* vol 42, Winter 1976, p 47 55

A variety of factors involved in the air traffic controller's decision making process during the approach and landing phases are discussed The problems encountered by controllers are divided into two categories those restricting a controller's flexibility and those providing an additional time consuming work From another point of view, these problems are defined as those brought on by the ATC system and those related to human factors The real cause of most errors and accidents might well be human factors, often ignored by the present accident investigation practices Studying the human factor in the ATC system and in accidents is considered a major condition for the air traffic control improvement The controversial question of whether the 'go no go' authority should remain with the pilots or the controllers is discussed S N

A76-42904 Aircraft crashworthiness - Plaintiff's viewpoint D Donnelly *Journal of Air Law and Commerce,* vol 42, Winter 1976, p 57 71 67 refs

An analysis of the aircraft crashworthiness concept and a summary of the crash survival design development are followed by a detailed consideration of the functions of the plaintiff's lawyer in a crashworthiness case which entailed death or injury The investiga tion procedures include identifying the crash as survivable, proving uncrashworthiness of the aircraft, establishing the existence of a technology which could have made the aircraft crashworthy at the time of the aircraft's production, and demonstrating the causual relationship between the failure to incorporate this technology and injury or death Conventional defense arguments are analyzed S N

A76-42905 Some comments on aircraft crashworthiness G I Whitehead, Jr (Piper Aircraft Corp , Lock Haven, Pa) *Journal of Air Law and Commerce,* vol 42, Winter 1976, p 73-83 42 refs

The paper analyzes the definition and uses of the terms 'crashworthiness' and 'survival crash' as applied to aircrafts The current federal airworthiness and crashworthiness standards are examined from the juridical point of view The Federal Aviation Administration (FAA) principles and activity concerning aviation safety are considered, special attention being paid to the FAA and aircraft manufacturers legal relationship Contradictions and compromises between economic, engineering and judicial approaches to the crashworthiness problems are pointed out S N

A76-42907 An introduction to the use of risk analysis methodology in accident litigation A S Tetelman (California, University, Los Angeles, Failure Analysis Associates, Palo Alto, Calif) and L Burack *Journal of Air Law and Commerce,* vol 42, Winter 1976, p 133 164 39 refs

A recently developed 'risk analysis' method for investigating failures and accidents can be applied in accident litigations to determine the most likely cause of the accident when the direct methods of finding technical defects are impossible (if there is no failed part to examine, etc) The basic concepts of risk analysis are discussed, including the fundamental notions of 'frequency' and 'severity' A way of measuring risk level is described Particular attention is given to the meaning of 'acceptable level of risk' Examples are presented of the application of risk analysis method in accident litigations, and some tactical and procedural considerations on the use of risk analysis in expert studies of failure processes are reviewed S N

A76-42908 Wind shear and clear air turbulence K R Hardy (Environmental Research and Technology, Inc , Lexington, Mass) *Journal of Air Law and Commerce,* vol 42, Winter 1976, p 165 183 27 refs

Wind shear has been an important factor in several aircraft accidents during the take offs and landings, particularly when using automatic landing systems The nature of the waves instabilities, weather conditions leading to strong wind shear and some of the features of vertical wind shear are discussed Three major shear regions are considered near the surface, in the free atmosphere and in the vicinity of thunderstorm, as well as their effect on aircraft Recent techniques for early detection of severe shear conditions are described, including acoustic, microwave and laser Doppler systems S N

A76-42909 An examination of traditional arguments on regulation of domestic air transport B Keplinger *Journal of Air Law and Commerce,* vol 42, Winter 1976, p 187-212 149 refs

The 1975 proposals to move toward economic deregulation of the commercial aviation, and in particular, the proposal to deregulate the powers of the Civil Aeronautics Board (CAB), have intensified the continuing discussion over airline industry economic bases The paper undertakes a careful consideration of the arguments for CAB regulation The background of the 1938 Civil Aeronautics Act is considered together with the effects of this Act and the CAB on competition in the commercial aviation industry It is demonstrated that the past arguments made by proponents of government regulation are not persuasive in present conditions It is concluded that unless new justifications are presented, a relaxation of economic regulation would appear to better serve the preservation of competition and free entry into the industry S N

A76-42910 Direct method for calculating sonic flow past a given wing profile Nonsymmetric flow F Grosjean and G Tournemine (Brest, Universite, Brest, France) *Journal de Mécanique,* vol 15, no 3, 1976, p 351-372 9 refs In French

The method for computing steady flows past a given wing airfoil with free stream Mach number one developed for symmetric flows by Euvrard and Tournemine (1973) is applied to nonsymmetric flows, to be able to compute lifting airfoils The shape of the limiting characteristics and the velocity distribution over the part of the airfoil imbedded in the transonic range is sought in terms of two families of functions depending on a small number of parameters such that the analytic continuation of these data should correspond to a uniform sonic flow at infinity The values of these parameters are found by means of an iterative method The continuation of the solution is performed by the method of characteristics Comparison with experimental data appears to be satisfactory (Author)

A76-42963 An optimization approach to routing aircraft R Richardson (Pfizer, Inc , New York, N Y) *Transportation Science,* vol 10, Feb 1976, p 52 71 21 refs

The optimal solution for an aircraft routing model is developed for use in the route construction process of an airline operating in long haul markets The problem is to determine the sequence of stops for each aircraft from one base through a network of cities terminating at the original or second base A mixed integer linear programming model is formulated to maximize the profit derived from each routing The special structure of the mixed integer model is solved by an application of Benders' Decomposition Method Methods to improve the computational efficiency of the technique are examined and tested Finally, an implementation plan for incorporating the routing model into the airline scheduling process is presented (Author)

A76-43048 Induced drag of a straight wing in a wind tunnel of circular cross section S Ando (Nagoya University, Nagoya, Japan) and Y Yamamoto (Gifu Technical College, Motosu, Gifu, Japan) *Ingenieur-Archiv,* vol 45, no 3, 1976, p 161-170 11 refs

The induced drag of a wing with optimum lift distributions is studied, which lies on a diameter of a closed wind tunnel of circular cross section Exact expressions of the spanwise lift distribution and the induced drag are obtained from the Trefftz plane flow field When the ratio b/d of wing span to tunnel diameter increases, the lift distribution changes gradually from elliptic to uniform ones, and the induced drag also gradually decreases until it becomes zero An alternative solution based on the method of matched asymptotic expansions confirms the exact theory to be valid Throughout this paper the flow is assumed inviscid and incompressible, whereas the viscous effects are briefly described (Author)

A76-43049 The problem of minimum drag of conical supersonic wings with subsonic leading edges (Zum Problem des Minimalwiderstandes konischer Uberschalltragflachen mit Unterschallvorderkanten) B Wagner (Darmstadt, Technische Hochschule, Darmstadt, West Germany) *Ingenieur-Archiv,* vol 45, no 3, 1976, p 179-191 15 refs In German

The approach used by Oswatitsch (1950) is extended to conical wings with an arbitrary camber The approach provides a formula already reported by Carafoli (1956) and, in addition, an alternate relation for the pressure distribution The obtained relations make it possible to derive for a given lift value a necessary condition for conical contours with minimum drag The relation is obtained in form of an integral equation for the angle-of-attack distribution G R

A76-43075 Aircraft engines Technology and function (Flugtriebwerke Ihre Technik und Funktion) K Hunecke Stuttgart, Motorbuch Verlag, 1976 255 p 21 refs In German $14 25

The use of gas turbine engines for aircraft propulsion applications is considered and the principles of engine operation are examined Questions of engine inlet development are discussed along with compressor characteristics, the combustion process, the design of the combustion chamber, turbine design characteristics, and propulsion-nozzle designs Attention is also given to the fuel system, aspects of lubrication, the electrical system, the system for starting the engine, and questions of engine supervision and maintenance Environmental effects of the engine are investigated and problems of engine airframe integration are studied G R

A76-43102 # Optimal flight-path-angle transitions in minimum time airplane climbs J V Breakwell (Stanford University, Stanford, Calif) *American Institute of Aeronautics and Astronautics and American Astronautical Society, Astrodynamics Conference, San Diego, Calif , Aug. 18-20, 1976, AIAA Paper 76-795* 7 p

The conventional methods of calculating the minimum-time climb path (energy state analysis, Green's theorem), neglecting the dependence of drag D on lift L, lead to discontinuities in the flight-path-angle The paper attempts therefore a different boundary-layer analysis, in which the flight-path-angle is assumed to vary more rapidly than the velocity and the height The study also includes an analysis of transitions to and from a singular arc and the time-loss evaluation, as compared with the ideal cornered trajectories It is shown that, if the reciprocal of maximum L/D is treated as a small parameter, dependent on Mach number, the discontinuities in the flight-path-angle are replaced by transitional 'boundary layers' The

analysis is most valid for low subsonic speeds, especially for a low-powered airplane with high L/D S N

A76-43142 # **Mean number of loads and acceleration in roll of an airplane flying in turbulence** G Coupry (ONERA, Châtillon sous-Bagneux, Hauts de Seine, France) *(International Union of Theoretical and Applied Mechanics, Symposium sur les Problemes Stochastiques en Dynamique, Southampton, England, July 19-23, 1976) ONERA, TP* no 1976 9, 1976 7 p

The paper deals with the effect of the spanwise distribution of isotropic turbulence on the mean number of loads and accelerations in roll of an airplane which is assumed to be perfectly rigid Attention is devoted to the derivation of a transverse coherence function of turbulence, associated with the usual spectra, which explains most of the discrepancies that appear in the comparison of measured and calculated transfer functions of aircraft to turbulence The use of this transverse coherence function, associated with unsteady aerodynamic theory, makes it possible to calculate the Rice's integrals related to the mean number of loads and roll acceleration without any further assumption Very simple approximate formulas are proposed, and comparisons of predicted and measured numbers of loads are presented for Caravelle flights (Author)

A76-43148 * # **Evaluation of ball and roller bearings restored by grinding** R J Parker, E V Zaretsky (NASA, Lewis Research Center, Cleveland, Ohio), and S M Chen (NASA, Lewis Research Center, Cleveland, Ohio, U S Army, Aviations Systems Command, St Louis, Mo) *U S Army and NASA Lewis Research Center, Bearing Restoration by Grinding Seminar, St Louis, Mo, May 20, 21, 1976, Paper* 35 p 18 refs

A joint program was undertaken to restore by grinding those rolling-element bearings which are currently being discarded at aircraft engine and transmission overhaul Three bearing types were selected from the UH 1 helicopter engine (T 53) and transmission for the pilot program Groups of each of these bearings were visually and dimensionally inspected for suitability for restoration A total of 250 bearings were restored by grinding Of this number, 30 bearings from each type were endurance tested to a TBO of 1600 hours No bearing failures occurred related to the restoration by grinding process The two bearing failures which occurred were due to defective rolling elements and were typical of those which may occur in new bearings The restorable component yield to the three groups was in excess of 90 percent (Author)

A76-43149 * # **Microeconomic analysis of military aircraft bearing restoration** G F Hein (NASA, Lewis Research Center, Cleveland, Ohio) *U S Army and NASA Lewis Research Center, Bearing Restoration by Grinding Seminar, St Louis, Mo, May 20, 21, 1976, Paper* 20 p

The risk and cost of a bearing restoration by grinding program was analyzed A microeconomic impact analysis was performed The annual cost savings to U S Army aviation is approximately $950,000 00 for three engines and three transmissions The capital value over an indefinite life is approximately ten million dollars The annual cost savings for U S Air Force engines is approximately $313,000 00 with a capital value of approximately 3 1 million dollars The program will result in the government obtaining bearings at lower costs at equivalent reliability The bearing industry can recover lost profits during a period of reduced demand and higher costs (Author)

A76-43153 **Suggested changes in current noise certification procedures for commercial transport aircraft** E B Fish, Jr and N L Haight (Douglas Aircraft Co, Long Beach, Calif) *Society of Automotive Engineers, West Coast Meeting, San Francisco, Calif, Aug 9-12, 1976, Paper 760615* 8 p 6 refs

It is pointed out that work related to the reduction of aircraft noise has made it possible to identify several opportunities for controlling certification costs without compromise of national noise abatement objectives The development of the noise certification requirements is discussed, taking into account the question of equivalent procedures and the effect of current certification requirements Suggested changes in the FAR Part 36 procedural requirements are related to the sound path relative humidity lower limit and the determination of maximum sideline noise levels G R

A76-43173 # **Digital techniques for aircraft automatic control systems.** B Williams (Smiths Industries, Ltd, London, England) *Aviation Review,* Aug 1976, p 8-10

Advantages of the digital flight control systems (DFCS) over conventional analog systems, particularly for maintenance of high-integrity, failure-survival systems (automatic landing, fly by wire) are pointed out The principles of the operation of digital computers in high-integrity control systems are discussed The multiplex system approach in which all lanes of redundancy are controlling continuously is preferred to the alternative duplicate redundancy approach Assuming that a digital computer cannot be completely self monitoring, it is shown that, in a multiplex system, the computers must monitor each other on a basis of cross-comparison of individual control lanes Design and operating principles of the developed triplex failure-survival automatic landing system, triplex autostabilization system and quadruplex full-time fly by wire system are discussed, along with the simplex digital flight guidance system S N

A76-43175 # **Digital engine control** E S Eccles *Aviation Review,* Aug 1976, p 17 19

The paper considers major problems of aircraft jet engine control, discussing comparatively the alternative techniques used in modern jet aircrafts (hydromechanical or electronic control systems, based on digital or analog computing technologies) It is pointed out that digital control is best suited for gas turbines due to its ability to handle without loss of accuracy more variables per function or more complex relationships between the same number of variables The increased capability of digital computer control makes it possible to provide continuous automatic correction, to increase the number of employed control modes, to introduce programmability and reprogrammability of the engine control system, i e , to change the control laws of the system without changing the equipment, and to adapt the same controller to different engines The basic design and operating features of current digital control systems are described, with special attention to failure techniques and various failure response approaches It is shown that digital control technology is the most cost-effective approach to all except very simple control applications S N

A76-43196 **A view of air freight developments in the next decade** M L Olason and A D Reynolds (Boeing Commercial Airplane Co, Renton, Wash) *Aeronautical Journal,* vol 80, July 1976, p 294-302

Developments in the air freight industry since 1961 are examined, taking into account average operating costs, revenue yield, and effects related to the use of jet freighters The influence of the fuel crisis is studied and an investigation is conducted concerning the air cargo operations for the period from 1976 to 1985 Attention is given to an intermodal air freight system concept, possibilities for the improvement of the 747 freighter, future market trends, and questions regarding the development of a new freighter designed entirely for cargo service G R

A76-43233 **Symposium on the Future of the Airship A Technical Appraisal, London, England, November 20, 1975, Proceedings** Symposium sponsored by the Royal Aeronautical Society and Airship Association London, Royal Aeronautical Society, 1976 168 p $6 25

General considerations and possible solutions with respect to airships are discussed along with rotors and gas bags, the optimization of airship structures, airworthiness and the large modern airship, and the economic realities of air transport Attention is also given to

the program of the Atlas airship, an airship project for heavy and cumbersome load transport, the airfloat HL project, the development of a natural gas transportation airship, present activities concerning the Skyship project, and the possibility to use airships for the transportation of wood products

G R

A76-43234 # **Airships - General considerations and possible solutions.** D Howe (Cranfield Institute of Technology, Cranfield, Beds , England) and A A Blythe (Airship Association, England) In Symposium on the Future of the Airship A Technical Appraisal, London, England, November 20, 1975, Proceedings London, Royal Aeronautical Society, 1976 18 p 9 refs

The fundamental characteristics of airships are examined as a basis for an evaluation of the approaches which may be used to overcome with the aid of modern technology the difficulties which currently prevent a wider use of the airship Attention is given to lifting gases, aspects of buoyancy control, the gas envelope shape, propulsion, loads, structural form, lowspeed handling, control forces, advantages of size in relation to drag and power, questions of structure, STOL hybrids, and the VTOL hybrid G R

A76-43235 # **Rotors and gas bags - A marriage of convenience** I C Cheeseman and D R Taylor (Southampton, University, Southampton, England) In Symposium on the Future of the Airship A Technical Appraisal, London, England, November 20, 1975, Proceedings London, Royal Aeronautical Society, 1976 34 p

The idea is considered to use gas bags to decrease the required rotor lift for a helicopter The characteristics of rotor and gas bags are viewed in isolation Problems with regard to the employment of gas bags in conventional forms lead to the development of a new and simple shape The 'Static Lifting Aerodynamic Body' obtained has the form of a right cylinder with a near elliptic cross section Advantages of this shape are related to the reduction of stresses produced by gusts, easy ground mooring and handling, and ease of maintenance G R

A76-43236 # **Airworthiness and the large modern airship** J G M Pardoe (Civil Aviation Authority, London, England) In Symposium on the Future of the Airship A Technical Appraisal, London, England, November 20, 1975, Proceedings London, Royal Aeronautical Society, 1976 8 p

Questions concerning the need for airworthiness certification are examined and the requirements which have to be satisfied for obtaining a certificate of airworthiness for an aircraft are considered The generation of corresponding requirements for an airship will not be an easy matter It is believed that the probability approach to safety used for automatic landing, which has been refined for assessing Concorde, will be a valuable tool Procedural requirements are discussed Attention is also given to the airworthiness/operations requirements interface G R

A76-43237 # **Optimisation of airship structures** D M Richards (Cranfield Institute of Technology, Cranfield, Beds , England) In Symposium on the Future of the Airship A Technical Appraisal, London, England, November 20, 1975, Proceedings London, Royal Aeronautical Society, 1976 10 p 15 refs

A description is presented of results that have been obtained in a study of the structural design of a large airship for the commercial transportation of heavy bulky loads The considered structure is 402 meters long and has a maximum diameter of 67 meters The available lift at sea level using helium is 970 tonnes Attention is given to structural functions, structural forms, and the primary quantities optimized in a computer-aided design procedure G R

A76-43238 # **The economic realities of air transport** J F Vittek, Jr (MIT, Cambridge, Mass) In Symposium on the Future of the Airship A Technical Appraisal, London, England, November 20, 1975, Proceedings London, Royal Aeronautical Society, 1976 7 p 26 refs

An economic analysis is conducted regarding the competitive position of an airship with respect to the established conventional means of transportation It is found that there are special applications for which only airships are suited However, the number of airships needed for these applications is generally too small to justify the development costs involved The possibility of a use of cargo airships is investigated, taking into account estimated airship costs It is concluded that a revival of the large airships of the past will not take place because of their high, noncompetitive costs in general transportation service However, a number of small airships and unmanned buoyant vehicles will be developed G R

A76-43239 # **Atlas dirigible programme** P Balaskovic (CNRS, Paris, France) In Symposium on the Future of the Airship A Technical Appraisal, London, England, November 20, 1975, Proceedings London, Royal Aeronautical Society, 1976 18 p

The Atlas dirigible program is the result of investigations concerning the possibility to build a stratospheric dirigible with a lenticular shape The characteristics of lenticular shaped dirigibles are discussed, taking into account aspects of aerodynamics, questions of propulsion, aerostatics, structure, maneuverability, and geometrical considerations A description of the Atlas dirigibles is presented, giving attention to three particularly promising vehicle types G R

A76-43240 # **Airship project for heavy and cumbersome load transport** G Vinas Espin (Societe Nationale Industrielle Aerospatiale, Suresnes, Hauts-de-Seine, France) In Symposium on the Future of the Airship A Technical Appraisal, London, England, November 20, 1975, Proceedings London, Royal Aeronautical Society, 1976 5 p

An airship structure with a length of 200 meters, a width of 170 meters and a height of 80 meters was initially investigated The structure comprised four internally partitioned helium-filled balloons, each having a capacity of 250,000 cubic meters Certain problems studied in connection with the first structures led to the development of an improved design, the elongated airship The elongated airship has a maximum cruising speed of 140 km per hour The range of the airship with a 500-ton payload at an altitude of 1500 meters under zero wind conditions is over 2000 km G R

A76-43241 # **The Airfloat HL project** E Mowforth (Airfloat Transport, Ltd , Surrey, University, Guildford, England) In Symposium on the Future of the Airship A Technical Appraisal, London, England, November 20, 1975, Proceedings London, Royal Aeronautical Society, 1976 9 p

The project reported was initiated late in 1970 as a design study for an airship which was to carry large indivisible loads over moderate distances The developed airship design has the advantage that it can be rapidly manufactured It offers immediate commercial effectiveness even if only one ship is built A general description of the airship is presented and details of airship performance are discussed Attention is given to questions of open site operation, module operation, problems of maintenance and construction, safety factors, and costs G R

A76-43242 # **Action rather than words** R Munk (Aerospace Developments, Ltd , London, England) In Symposium on the Future of the Airship A Technical Appraisal, London, England, November 20, 1975, Proceedings London, Royal Aeronautical Society, 1976 18 p

The development of relatively small nonrigid, advanced technology airships for general freight, surveying, and airborne jeep applications is briefly considered A description is also given of a

project concerned with the development of a natural gas transportation airship The idea to transport natural gas in gaseous form by an airship has been conceived in connection with the many problems associated with moving gas by conventional means Attention is given to questions of airship design, the construction method, the development program, and approaches for overcoming hazards presented by hail strike and lightning strike G R

A76-43243 # **Skyship - Present activities** J West (John West Associates) In Symposium on the Future of the Airship A Technical Appraisal, London, England, November 20, 1975, Proceedings London, Royal Aeronautical Society, 1976 18 p

Skyship is being developed to meet unfulfilled demand in remote or developing areas, to solve transport interface problems, and to provide a service in areas in which current arrangements are unsatisfactory Structural problems in the development of the cargo carrying airship were found to be serious and complex Considered solutions include radial webs and structural cells In both cases a ring beam is the key part of the structural design Attention is given to aspects of construction, experiments with a 30 ft diameter radio controlled model, Skyship costs, and operating costs G R

A76-43249 # **Lateral forces produced by leakage flows at the rotors of thermal turbomachines (Durch Spaltstromungen hervorgerufene Querkrafte an den Laufern thermischer Turbomaschinen)** K Urlichs Munchen, Technische Universitat, Fachbereich Maschinenwesen, Dr -Ing Dissertation, 1975 163 p 30 refs In German

Self-excited rotor whirl represents a serious hazard in the operation of turbomachines The reported investigation has, therefore, the objective to measure the lateral forces acting on the rotor and to determine the characteristic pressure distribution in the rotor clearance area A description is presented of an approach for calculating the leakage flow in the case of an eccentric rotor position on the basis of empirical loss coefficients The results are reported of an experimental investigation with a turbine stage, taking into account a variation of the clearance characteristics The pressure data measured are consistent with the theoretical considerations G R

A76-43323 **An investigation of directional solidification of Ni3Cb reinforced eutectics in complex shapes** P M Curran, L F Schulmeister, J S Erickson, and A F Giamei (United Technologies Corp , Pratt and Whitney Aircraft Group, East Hartford, Conn) In Conference on In Situ Composites, 2nd, Bolton Landing, N Y , September 2-5, 1975, Proceedings Lexington, Mass , Xerox Individualized Publishing, 1976, p 285-294, Discussion, p 294, 295 5 refs Navy-supported research

An investigation was conducted on the unidirectional solidification of delta (Ni3Cb) reinforced eutectic alloys in turbine blade form The liquid metal cooling process was utilized as the basic processing technique The investigation involved evaluating the influence of solidification conditions on microstructure formation in complex blade shapes as well as investigating experimental methods for improving process temperature gradient Heat transfer analysis was used as an aid in improving process thermal conditions (Author)

A76-43348 # **Study on the unsteady force on a blade due to a moving cylinder in an airstream** T Adachi and Y Murakami (Osaka University, Toyonaka, Japan) *JSME, Bulletin,* vol 19, July 1976, p 769-775 9 refs

A theoretical calculation is presented for the unsteady force induced on a turbomachine blade due to the wake of a 30 mm diam upstream cylinder moving perpendicular to the free stream Wake effect and circulation effect are considered The cylinder is represented by a doublet traveling in a free stream to predict the unsteady force on the blade due to the theoretical cylinder thickness effect The unsteady pressure and lift coefficients are determined for different values of the velocity of the cylinder and the distance between the blade and the cylinder Theoretical calculations are compared with experiment The results show a slight discrepancy in the range of small values of cylinder blade distance and cylinder velocity Reasons for observed discrepancies are discussed S D

A76-43523 # **Deflection curve of a rotary airfoil blade (Elastichna linija kraka obrtnikh uzgonskikh povrshina)** M Nenadovich *Srpska Akademija Nauka i Umetnosti, Glas, Odeljenje Tehnichkikh Nauka,* no 11, 1976, p 11-16 In Serbian

The shape of the deflection curve of a rotary airfoil blade for arbitrary external load is described by an integro-differential equation which can be solved analytically by the operator method For conventional blade designs, the integro-differential equation can be reduced to a simple differential equation whose solution is not difficult P T H

A76-43536 # **Calculation of gas-turbine-engine blades by the finite element method (K raschetu lopatok GTD metodom konechnykh elementov)** A L Kvitka, P P Voroshko, and L A Zaslotskaia (Akademiia Nauk Ukrainskoi SSR, Institut Problem Prochnosti, Kiev, Ukrainian SSR) *Problemy Prochnosti,* June 1976, p 60-64 5 refs In Russian

The method proposed for calculating blades is based on simplifying the Laplace variational equation on the basis of several assumptions, in particular, that the stress-strain state does not vary along the blade length Application of a finite element technique leads to a resolvent system of linear algebraic equations V P

A76-43551 # **Accuracy of solving systems of equations in the calculation of jet engine characteristics (Tochnost' reshenila sistem uravnenii pri raschete kharakteristik VRD)** A M Akhmedzianov, S Kh Aksel'rod, and Kh S Gumerov *Aviatsionnaia Tekhnika,* vol 19, no 1, 1976, p 5-10 5 refs In Russian

The calculation of engine characteristics is conventionally reduced to ensuring an accurate selection of the position of the operating point on the characteristic curve of the compressor In the present paper, a method is proposed for determining the accuracy to which the selection conditions are satisfied for solving a system of equations in the computation of the characteristics of a turbojet engine It is shown that to achieve convergence of the solution to this system of equations by computer-aided selection (at a prescribed accuracy of such output parameters as thrust and fuel consumption), a specific relation must be used to determine the error in the selection conditions This relation must be precisely satisfied in the computer-aided determination of the turbojet engine characteristics V P

A76-43552 # **Efficiency criterion for an air-cooled turbine blading (Kriterii effektivnosti turbinnoi reshetki s vozdushnym okhlazhdeniem)** E N Bogomolov *Aviatsionnaia Tekhnika,* vol 19, no 1, 1976, p 11-20 10 refs In Russian

It is proposed to use a parameter that indicates the possible relative increase in kinetic energy behind the blading caused by a blade-temperature drop as the efficiency criterion for an air-cooled turbine cascade The criterion takes into account the influence of cooling on the gasdynamic characteristics of the cascade Cascades with internal cooling and with film cooling of the blade trailing edge are compared, and methods of evaluating analytically the efficiency of such cascades are examined Relations are derived for calculating the efficiency of trailing-edge cooling with allowance for heat input from the butt end of the trailing edge V P

A76-43558 # **A thermal analysis method for aircraft compartment constructions (Metod teplovogo rascheta konstruktsii otseka letatel'nogo apparata)** N M Krutova, G B Petrazhitskii, and A M Pylaev *Aviatsionnaia Tekhnika,* vol 19, no 1, 1976, p 55-60 In Russian

A method is proposed for solving systems of heat conduction

problems that are interrelated solely by linear inclusion of a set of functional parameters The solution is reduced to obtaining independent particular solutions to each problem of the system and to subsequent treatment of algebraic equations or linear systems As an example, the method is applied to the analysis of a steady periodic mode, and also of a general regular mode of the first kind, for the case where N subsystems with strong thermal couplings interact with each other V P

A76-43562 # **Selecting the compression ratio of the compressor of small-scale gas-turbine engines mounted in the bypass duct of a turbojet engine (K vyboru stepeni povysheniia davleniia kompressora malorazmernykh GTD, ustanovlennykh v naruzhnom konture TRDD)** B D Fishbein *Aviatsionnaia Tekhnika*, vol 19, no 1, 1976, p 78-85 9 refs In Russian

The problem of determining the pressure ratio that is optimal with respect to thrust for the compressor for a small-scale gas-turbine engine in the bypass dust is analyzed The compressor pressure ratio is plotted against the pressure ratio of the fan, against the gas temperature in front of the turbine of the small-scale engine, and against the parameters of the engine inlet It is shown that a pressure ratio between 4 and 5 provides optimal thrust characteristics V P

A76-43564 # **Propagation and mixing of a fluid injected into the supersonic cross-flow of a gas (Rasprostranenie i smeshenie zhidkosti, vpryskivaemoi v sverkhzvukovoi snosiashchii potok gaza)** Z G Shaikhutdinov and V M Klevanskii *Aviatsionnaia Tekhnika*, vol 19, no 1, 1976, p 99 108 7 refs In Russian

Photographic methods do not yield correct quantitative relationships in studies of secondary flows propagating in a cross wind The 'thermometric' method proposed makes it possible to study the spatial dispersion boundaries of the injected fluid and the mixing characteristics of the injected stream The penetration depth, the shape of the cross section, and the mixing characteristics are plotted for water jets injected at pressures of 4 to 80 bars into gas flow of Mach number 2 5 and a temperature of 500 K V P

A76-43566 # **Investigation of heat transfer at the inlet section of a tube under conditions of initial swirl and transverse mass flow (Issledovanie teplootdachi v nachal'nom uchastke truby v usloviiakh nachal'noi zakrutki potoka i poperechnogo potoka veshchestva)** V K Shchukin, A A Khalatov, and A V Kozhevnikov *Aviatsionnaia Tekhnika*, vol 19, no 1, 1976, p 115-121 8 refs In Russian

A76-43571 # **Computational and experimental investigation of the thermal state of a turbine rotor blade (Raschetnoe i eksperimental'noe issledovanie temperaturnogo sostoianiia rabochei lopatki turbiny)** K M Iskakov, A A Panteleev, V A Trushin, and V N Fedorov *Aviatsionnaia Tekhnika*, vol 19, no 1, 1976, p 141-146 8 refs In Russian

A numerical finite-difference scheme is proposed for calculating the thermal state of turbine blades with a transverse cooling-air flow The technique can be used to determine the temperature distributions over the blade contour and over the wall thickness of the blade, and the behavior of the cooling-air temperature along the path from the leading edge to the exit slot at the trailing edge The theoretical results are found to correlate with thermocouple and pyrometer measurements V P

A76-43577 # **A gas-turbine-engine regenerator employing heat pipes (Regenerator gazoturbinnogo dvigatelia na teplovykh trubakh)** V K Shukin, I I Mosin, N V Lokai, and I I Fedorov *Aviatsionnaia Tekhnika*, vol 19, no 1, 1976, p 172 175 In Russian

The principles of operation of gas turbine-engine regenerator of a fundamentally new design are discussed The device is essentially a recuperative (fixed) heat exchanger which uses heat pipes to offset the intrinsic drawbacks of recuperative heat exchangers, such as a low recovery factor and high hydraulic pressure losses along the hot gas duct V P

A76-43794 **Theoretical gas dynamics /3rd revised and enlarged edition/ (Theoretische Gasdynamik /3rd revised and enlarged edition/).** J Zierep (Karlsruhe, Universitat, Karlsruhe, West Germany). Karlsruhe, Verlag G Braun, 1976 516 p. 86 refs. In German.

The book is a systematic exposition of the dynamics of gases from basic principles to descriptions of problems of current interest. After a review of thermodynamic concepts, the discussion covers the integral and differential forms of the conservation laws, the shock equation, steady-state stream filament theory with and without compression shock, linear wave propagation, nonlinear wave processes, linearized two-dimensional steady flows, nonlinear two-dimensional steady flows, linearized steady flow past slender bodies of revolution, nonlinear axisymmetric flows, supersonic airfoil flows, principles of gas dynamic similarity theory, equations of steady transonic flow, and steady hypersonic flows. P.T.H.

A76-43813 # **Endurance of steel 45 in the environment of some jet fuels at elevated temperatures (Vynoslivost' stali 45 v sredakh nekotorykh reaktivnykh topliv pri povyshennykh temperaturakh)** V T Sharai (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukrainian SSR) *Fiziko-Khimicheskaia Mekhanika Materialov*, vol 12, May June 1976, p 106, 107 5 refs In Russian

A76-43926 # **The method of successive approximations in the theory of electron-photon showers (Metod posledovatel'nykh priblizhenii v teorii elektronno-fotonnykh livnei)** E V Krokhin, Iu I Paskhalov, and V S Sushkov (Akademiia Nauk SSSR, Radiotekhnicheskii Institut, Moscow, USSR) *(Vsesoiuznaia Konferentsiia po Fizike Kosmicheskikh Luchei, Samarkand, Uzbek SSR, Oct 29-31, 1975) Akademiia Nauk SSSR, Izvestiia, Seriia Fizicheskaia*, vol 40, May 1976, p 976, 977 6 refs In Russian

The article attempts to develop an effective application of the method of successive approximations to the cascade theory of electron photon showers and to cosmic-ray physics, in particular to calculations of the characteristics of showers in the atmosphere at heights traversed by aircraft and balloons Integral equations evaluated as sums of successive approximations, with the initial particle distribution serving as the zero th approximation, are employed More exact cross sections of the processes, and approximations of higher order, are obtained than in the Landau approximation R D V

A76-44099 # **A case study evaluation of peripheral metropolitan STOL-VTOL development** L E Haefner, R W Meyer, L Hutchins, and D Lang (Washington University, St Louis, Mo) *Operations Research Society of America and Institute of Management Sciences, Joint National Meeting, Philadelphia, Pa, Mar 31-Apr 2, 1976, Paper* 38 p

An investigation is conducted concerning the feasibility to establish STOL or VTOL ports in strategic peripheral locations of a metropolitan region The investigation makes use of the approaches of Bayesian decision theory The Bayesian results for internal rate of return estimates and for two rank-based expected value estimates are considered Attention is given to aspects of case study location, data inputs, utility computational processes, and details of rate of return analysis It is found that the best criteria for judging feasibility are related to zoning change ability, national economic status, and fluidity of land development capital G R

A76-44100 # **Some elements of the airline fleet planning problem - Or, why human fleet planners /and not computers/ do airline fleet plans** M Pollack (Lockheed-California Co, Burbank, Calif) *Operations Research Society of America and Institute of Management Sciences, Joint National Meeting, Philadelphia, Pa, Mar 31-Apr 2, 1976, Paper* 14 p 9 refs

The considered problem is related to decisions concerning the number and the types of aircraft to be purchased or maintained by an airline The problem is examined in its proper context, taking into account planning studies which precede or follow a fleet planning study Attention is given to the problem study environment, various types of optimization approaches, the current use of fleet planning models, aircraft operational conditions and restraints, integer variables, seasonal variations, station restraints, city-pair service level, passenger flow, cargo flow and demand, passenger demand relationships, marketing continuity, fleet continuity, fixed and variable costs, and the relationship to other airlines G R

A76-44105 An aircraft gas turbine engine simulator test for evaluating lubricant deposition and degradation B B Baber, J C Tyler, and M L Valtierra (Southwest Research Institute, San Antonio, Tex) *American Society of Lubrication Engineers, Annual Meeting, 31st, Philadelphia, Pa , May 10-13, 1976, Preprint 76-AM-2E-2* 9 p 6 refs Contract No F33615-72-C-1097

An aircraft gas turbine engine simulator has been developed to evaluate the deposition and degradation characteristics of lubricants The No 4-5 bearing compartment areas of a J57 turbine engine are used as the basic section of the simulator The simulator is driven by a 74 6 kW (100-hp) variable speed drive system through the accessory drive gearbox Electrical resistance heaters are used to heat the air surrounding the oil wetted areas within the No 4 5 bearing compartment areas to controlled test temperatures Results obtained on seven lubricants, for which full scale engine data are available, show a good correlation between the deposit ratings obtained from the simulator test and the deposit ratings obtained for the No 4 5 bearing compartment areas from the full scale engine test Reasonable agreement of viscosity and neutralization number data from the simulator test and the full scale engine test is also indicated for most lubricants tested (Author)

A76-44109 Selectivity of the oxidative attack on a model ester lubricant P J Sniegoski (U S Navy, Naval Research Laboratory, Washington, D C) *American Society of Lubrication Engineers, Annual Meeting, 31st, Philadelphia, Pa , May 10-13, 1976, Preprint 76-AM-2A-1* 4 p 16 refs

The relative oxidative attack at the various carbon hydrogen bonds of the model ester lubricant neopentyl hexanoate at temperatures 150-200 C was determined by GLC analysis of appropriate derivatives Relative rates for single carbon hydrogen bonds were primary 1, 'normal' secondary 15, alpha acyl secondary 2, and alpha-alcohol secondary 4 These results may furnish valuable insight in the development of more oxidatively stable esters for use in high-temperature jet engine lubricants (Author)

A76-44110 Mineral oil lubrication of large gas turbines M J Den Herder (Amoco Oil Co , Naperville, Ill) *American Society of Lubrication Engineers, Annual Meeting, 31st, Philadelphia, Pa , May 10-13, 1976, Preprint 76-AM-4A-1* 5 p

High-severity heavy duty gas turbines are now running without oil changes for many thousands of hours by using a greatly improved mineral oil lubricant It is shown that common steam turbine oils containing volatile phenolic oxidation inhibitors do not have adequate oxidation resistance for use in these turbines Laboratory test results indicate that the new oil resists oxidation about ten times longer than common steam turbine oils The turbines are found to be free from the lubricant-associated problems due to oil oxidation that previously raised doubts about the suitability of mineral oils for this type of service Adherence to the recommended oil change practices should minimize failures and the resulting need for cleaning and repair of turbines S D

A76-44114 Rotary engine experimental measurements using telemetry P M Leucht (GM Research Laboratories, Warren, Mich) *American Society of Lubrication Engineers, Annual Meeting, 31st, Philadelphia, Pa , May 10-13, 1976, Preprint 76-AM-5B-4* 9 p

Experimental measurements were made to quantify the sealing environment of the rotary combustion engine Telemetry was used as the data link from sensors on the moving rotor to the stationary housing of a firing engine Specific data measured and discussed include the motion of the apex seal, apex seal and rotor tempera tures, and the pressure in the combustion chamber and under the apex seal Some of the numerous problems encountered and the limitations of the measurement system are discussed to illustrate implementation of this experimental technique (Author)

A76-44118 Performance of heavily-loaded oscillatory journal bearings W A Glaeser and K F Dufrane (Battelle Columbus Laboratories, Columbus, Ohio) *American Society of Lubrication Engineers, Annual Meeting, 31st, Philadelphia, Pa., May 10-13, 1976, Preprint 76-AM-1C-1* 5 p

Results of experimental work in which plain bearings of various materials were operated under oscillatory motion and heavy loads are described Bearing stress (based on projected area) covered the range 69 to 620 MN/per sq m The effect of different grease lubricants, temperature, bearing stress, and oscillatory mode on wear and friction characteristics was studied Maximum load capacity of a number of bronze and steel bearing materials has been determined Recommendations for selection of materials and design of bearings for oscillatory motion and heavy loads are given along with design charts and tables (Author)

A76-44123 Designing turbulent thrust bearings for reduced power loss D F Wilcock (Mechanical Technology, Inc , Latham, N Y) *American Society of Lubrication Engineers, Annual Meeting, 31st, Philadelphia, Pa , May 10-13, 1976, Preprint 76-AM 2C-1* 9 p 9 refs

Some of the options open to the designer for reducing turbulent thrust bearing losses in large turbine generators are examined It is mainly assumed that the short (narrow) bearing theory is applicable, that the influence of turbulence may be expressed as a coefficient greater than unity by which the oil viscosity may be multiplied to obtain the effective viscosity, and that a rectangular pad may be used to approximate the sector-shaped pad for the basic comparison While the study assumes pads of fixed inclination, the results may also be useful as a guide to the design of tilting pad bearings It is shown that high aspect ratio (pad width/pad length) have superior efficiency, that redesign for turbulence should employ fewer pads rather than narrower pads, and that temperatures in a rectangular pad are constant across the width Temperatures in a sector pad increase in both the radial direction and in the direction of runner motion S D

A76 44127 A study of parameters which affect corrosion between solid film lubricants and aircraft alloys M K Gabel (U S Naval Material Command, Naval Air Development Center, Warminster, Pa) and M B Peterson (Wear Sciences, Inc , Scotia, N Y) *American Society of Lubrication Engineers, Annual Meeting, 31st, Philadelphia, Pa , May 10-13, 1976, Preprint 76-AM-6C 2* 6 p 9 refs

The failure of mechanical components has frequently been attributed to the corrosion characteristics of solid film lubricants under the stringent operating conditions that constitute the per formance regime of contemporary flight vehicles The investigation of the corrosion mechanism is being accomplished by three pro cedures (1) Dynamic wear testing under various humidities with electron diffraction analysis of the debris (2) Static corrosion studies of lubricants' behavior in a SO2/salt spray environment when aircraft alloys, inhibitors, and pretreaments are varied (3) Electro-chemical testing in synthetic seawater solution using dissimilar metal and lubricant combinations This paper summarizes the findings of this program demonstrating how various parameters (humidity, surface pretreatment, inhibitors, SO2/salt, environment, etc) affect corrosion between solid-film-lubricants and various aircraft alloys (Author)

A76-44201 **Modern lead-acid battery designs for aircraft** N E Bagshaw, K P Bromelow, and J Kirkpatrick (Chloride Industrial Batteries, Ltd., Manchester, England) *International Power Sources Symposium Committee, International Power Sources Symposium, 10th, Brighton, England, Sept. 13-16, 1976, Paper* 9 p 12 refs

Batteries rated at 24 V, 34 A h and 24 V, 18 A h have been designed to meet the requirements of modern aircraft The batteries have a good performance at high discharge rates combined with reliability in service A ventilation system has been designed which enables gases to be piped outside the aircraft and ensures that all live connections are remote from the gases The batteries are assembled in flame-retardant acid-resistant fiberglass containers and covers The batteries are completely aerobatic and comply with all the electrical and environmental conditions of the latest British Standard for aircraft batteries (Author)

A76-44240 # **The performance of a high-speed ball thrust bearing using silicon nitride balls** J M Reddecliff (United Technologies Florida Research and Development Center, West Palm Beach, Fla.) and R Valori (U S Naval Air Propulsion Test Center, Trenton, N J.) *American Society of Mechanical Engineers, Lubrication Symposium, Atlanta, Ga., May 24-26, 1976, Paper 76-LubS 8* 6 p 9 refs Members, $1 50, nonmembers, $3 00 Contract No N00140 75-C-0382

A 35 mm bore angular contact ball bearing having M50 tool steel races and hot pressed silicon nitride balls was tested at speeds to 71,500 rpm (2 5 million DN) The bearing ran smoothly throughout 32 hr of accumulated time Heat generation was 10 to 20 percent lower than that of a comparable bearing with steel balls, and the silicon nitride bearing began to skid at lower axial loads The silicon nitride balls and steel raceways were in excellent condition after the test (Author)

A76-44246 * # **Endurance and failure characteristic of mainshaft jet engine bearing at 3 million DN** E N Bamberger (General Electric Co., Evendale, Ohio), E V Zaretsky (NASA, Lewis Research Center, Cleveland, Ohio), and H Signer (Industrial Tectonics, Inc., Compton, Calif.) *American Society of Mechanical Engineers, Lubrication Symposium, Atlanta, Ga., May 24-26, 1976, Paper 76-LubS-16* 6 p 21 refs Members, $1 50, nonmembers, $3 00

Groups of thirty 120-mm bore angular-contact ball bearings were endurance tested at a speed of 12,000 and 25,000 rpm (1 44 million and 3 0 million DN, where DN is the product of the bearing bore in mm and the shaft speed in rpm) and a thrust load of 66,721 N The bearings were manufactured from a single heat of VIM VAR AISI M-50 steel At 1 44 million and 3 0 million DN, 84,483 and 74,800 bearing test hours were accumulated, respectively Test results were compared with similar bearings made from CVM AISI M-50 steel run under the same conditions Bearing lives at speeds of 3 million DN with the VIM VAR AISI M 50 steel were nearly equivalent to those obtained at lower speeds A combined processing and material life factor of 44 was found for VIM VAR AISI M 50 steel Continuous running after a spall has occurred at 3 0 million DN can result in a destructive fracture of the bearing inner race (Author)

A76-44292 **CFM56 engine still looking for an aircraft** M Brown *Interavia,* vol 31, Sept 1976, p 847-849

Performance test data, development data, and costs data are presented on the CFM56 turbofan engine, six development prototypes of which have been built and are undergoing test stand operations Data on the six test programs are presented The NATO Boeing E-3A advance warning patrol craft (AWACS) is viewed as a potential user for the engine Revenue sharing and costs sharing arrangements between GE and SNECMA are discussed The CFM56 is rated to enter service delivering 22,000 lb thrust, with a step-up capability of 27,500 lb thrust in six years, given some engine modification Various other aircraft are considered as candidates for CFM56 turbofan propulsion R D V

A76-44293 **Ground proximity warning systems Will they survive the enthusiasm** D Boyle *Interavia,* vol 31, Sept 1976, p 852-854

Unwanted warnings sounded in ground proximity warning systems (GPWS) are acknowledged as a serious factor hindering eventual acceptance of GPWS, and types and sources of unwanted GPWS responses are discussed False warnings caused by defects in the GPWS or in the aircraft (flaps, undercarriage switches, altimeters), nuisance warnings sounded when no actual hazard exists, incompatibility between GPWS and ATC-governed descent profiles which are safe at the air terminal in question but which elicit GPWS responses, and cluttering of the flight deck with competing warning devices and systems are discussed Blindness of GPWS to some dead-ahead hazards, such as a vertical cliff face, is considered Libraries of flight profiles are being compiled for construction of reliable warning envelopes The projected effect of unwanted GPWS responses on aircraft crew acceptance of GPWS is viewed as a serious problem R D V

A76-44294 **Autoland starts to pay off for British Airways. II** D Craig (British Airways, European Div., London, England) *Interavia,* vol 31, Sept 1976, p 863-867

Problems in the implementation of Category III automatic landing and approach and landing capability in 15 years of practice in one airline (BAED) are reviewed The necessity for complex aircraft integrated data systems for Category III operations is emphasized Proper placarding on the display panel to indicate whether the aircraft is fitted for autoland operation, in which categories, and whether the equipment is serviceable as tested for that flight, is discussed, in addition to problems of qualification of pilots for Category III operations in the face of frequently changing procedures Proper design and equipment of runways for autoland operations is dealt with Integrity, performance, reliability, and the 'perfect' autoland system are defined R D V

A76-44307 **Theory of low-aspect ratio wing calculation using discrete-continuous analysis scheme /matrix differential equation of secondary displacements/** M B Vakhitov and N G Larionov *(Aviatsionnaia Tekhnika,* vol 18, no 4, 1975, p 44 51.) *Soviet Aeronautics,* vol 18, no 4, 1975, p 33 38 5 refs Translation

Additional tangential displacements lead to deformations of the wing ribs, leading to distortions of the wing cross section In the mathematical model proposed, the ribs within a wing section are treated as a continuously distributed medium whose rigidity is equivalent to the combined rigidity of the ribs The derived matrix differential equation for the additional displacements forms, together with a previously obtained equation (Vakhitov and Larinov, 1975), a closed system for calculating all unknown displacements The boundary conditions are obtained, along with conditions for joining the wing sections with respect to discrete ribs V P

A76-44308 **Calculation of free vibrations of thinwall aircraft structures** M B Vakhitov, M S Safariev, and A S Safonov *(Aviatsionnaia Tekhnika,* vol 18, no 4, 1975, p 52 57.) *Soviet Aeronautics,* vol 18, no 4, 1975, p 39 43 12 refs Translation

A method is proposed for calculating the natural vibrations of a reinforced slightly conical shell with rigid transverse diaphragms The method is developed on the basis of an extension of Odinokov's (1948) theory of thin-walled structures to the case of dynamic loading Numerical solutions are obtained with the aid of the formalism of integrating matrices The problem is reduced to the determination of the eigenvalues and eigenvectors of a dynamic matrix The equation obtained takes into account the deformational behavior of a thin-walled structure associated with irregularities, shear strains, etc V P

A76-44310 **Parametric study of three-element aft flap** Iu S Evdochenko *(Aviatsionnaia Tekhnika,* vol 18, no 4, 1975, p 63-68) *Soviet Aeronautics,* vol 18, no 4, 1975, p 49-53 5 refs Translation

Experimental data concerning the influence of the flap angle relation and the relation of the dimensions of the elements of a triple-slotted flap on the aerodynamic characteristics of a wing are reviewed The optimal flap angles are determined from the condition for attaining maximum lift The characteristic features of the influence of the chord and the flap dimensions on the aerodynamic characteristics of the wing are determined, and the aerodynamic characteristics of a wing with double-slotted and triple-slotted flaps are compared V P

A76-44311 Analog computer study of elastic helicopter blade flutter K D Egorov, V P Kandidov, and S A Pulinets *(Aviatsionnaia Tekhnika,* vol 18, no 4, 1975, p 69 76) *Soviet Aeronautics,* vol 18, no 4, 1975, p 54 59 11 refs Translation

The dynamics of a rotating rotor blade is analyzed by a finite element technique developed for one dimensional systems in a centrifugal force field The blade model (composed of finite elements) is studied by analog simulation A relation between the blade vibration frequencies and the rpm is derived, and the behavior of the system's eigenvalues during hover and during flight is studied The critical values of the flight parameters are determined V P

A76-44314 **Hypersonic flow around three-dimensional wing** V V Kravets and V K Khrushch *(Aviatsionnaia Tekhnika,* vol 18, no 4, 1975, p 94-100) *Soviet Aeronautics,* vol 18, no 4, 1975, p 74-79 6 refs Translation

The attached hypersonic flow at incidence past a thin-section wing with a leading edge of arbitrary planform is analyzed, using a generalized formulation of the problem A solution is obtained in the form of a series in powers of a small parameter The wave drag and lift coefficients are obtained in final form to within terms of second power in the small parameter The shape of the shock wave and the parameters within the shock layer are expressed in quadratures The calculations can be readily extended to flows past large-aspect ratio wings V P

A76-44316 **Application of the direct Lyapunov method to nonlinear problems of flight vehicle lateral motion stabilization** L G Romanenko and S V Krivosheev *(Aviatsionnaia Tekhnika,* vol 18, no 4, 1975, p 106-110) *Soviet Aeronautics,* vol 18, no 4, 1975, p 84-88 Translation

The absolute stability of the trivial solution of the equations of lateral motion of an aircraft employing an automatic bank regulator is analyzed, assuming that the actuator of the bank regulator has a nonlinear rate characteristic The conditions for absolute stability are obtained by applying Liapunov's direct method to the system of equations composed of the equations of perturbed motion of the aircraft and the equation the bank regulator V P

A76-44317 **Optimal trajectories of programmed stable flight vehicle motion** V A Sgilevskii *(Aviatsionnaia Tekhnika,* vol 18, no 4, 1975, p 111 115) *Soviet Aeronautics,* vol 18, no 4, 1975, p 89 93 5 refs Translation

The problem of optimizing stable programmed motion for an aircraft is compared with the more general problem for a heavy point of variable mass The problem for the case of an aircraft is complicated by the dependency of the control functions on the characteristics of the aircraft and its engines The elaboration of the two control functions, one of which ensures the condition of stable completion of the program and the other of which ensures optimal motion according to a selected criterion, permits the synthesis of the optimal controls for an aircraft with a known structure C K D

A76-44321 **Estimation of generalized geometric parameter of multi-element wing mechanization.** A I Matiazh, V A Popov, and V A Sterlin *(Aviatsionnaia Tekhnika,* vol 18, no 4, 1975, p 126-131) *Soviet Aeronautics,* vol 18, no 4, 1975, p 104-108 Translation

To evaluate the effectiveness of a trailing-edge triple-slotted flap, it is proposed to use a geometrical parameter in the form of the reduced flap angle that takes into account the chord length and the angles of the flap elements The feasibility of using the proposed parameter in practice is demonstrated by wind tunnel tests It is shown that the experimental diagrams can be satisfactorily approximated by analytical expressions whose form is defined by the reduced flap angle V P

A76-44322 **Design of empennage with distributed reaction.** V A Pavlov and V I Savinov *(Aviatsionnaia Tekhnika,* vol 18, no 4, 1975, p 131-134) *Soviet Aeronautics,* vol 18, no 4, 1975, p 109-111 Translation

The problem of determining the aerodynamic reaction distributed along the hinge of a horizontal control surface is solved with allowance for the pliability of the stabilizer and control-surface joints The equilibrium equations derived are reduced to a single resolvent linear differential equation An analytical solution is obtained for a tail unit of constant cross section Plots showing the distribution of the bending moment, the shearing force, and the distributed reaction over the control surface are presented V P

A76-44323 Influence of attachment nature on wing stress state and weight Iu I Popov *(Aviatsionnaia Tekhnika,* vol 18, no 4, 1975, p 134 137) *Soviet Aeronautics,* vol 18, no 4, 1975, p 112 114 Translation

The selection of the type of fitting for a three-spar straight wing is examined on the basis of strength and weight analyses Two variants are compared moment fitting at all three spars, and moment fitting of the center spar only, with hinge fitting at the two edge spars It is shown that moment fitting at all three spars gives better distribution of tangential forces and stress along the cord of the wing than that obtained with the single moment fitting The two variants are about equally desirable in terms of weight C K D

A76-44500 **Flying the flight deck of the future** R E Gillman. *Flight International,* vol 110, Sept 11, 1976, p 799-802

Responses of an experienced pilot to sensations and readings perceived in the use of automated flight deck, navigation, and landing approach systems are reported subjectively, and features of the system are described New flight decks with computer-generated symbology designed to exploit the possibilities of MLS, new navigation aid systems, and digital data links are described from the pilot's viewpoint The terminal configured vehicle program, electronic attitude director indicator, aft flight deck, and electronic horizontal situation indicator systems are dealt with The author-pilot's responses to computer-generated dynamic runway and landing approach displays are presented, with comparisons of responses to visual and automatic flight deck situations R D V

A76-44525 **Grumman VTOL aimed at small-ship use** C A Robinson, Jr *Aviation Week and Space Technology,* vol 105, Sept 20, 1976, p 15-20

A small VTOL designed by Grumman for operation off warships much smaller than conventional aircraft carriers, or even most vessels with helicopter launch pads, is described The twin fan engine Nutcracker VTOL features an articulated fuselage (inverted-L bent body) with fan engines abreast the aft body, and carrier-type foldable wings, and is launched and retrieved, in tail-sitting configuration, from a launch/retrieval boom on the mother ship, which may be as small as a destroyer escort or patrol frigate The Nutcracker mission envelope includes antisubmarine operation, surveillance, long-range target identification, cargo transfer, and surface attack Problems with engine bleed air, hot air ducting, reaction controls, engine cross-shafting, and single-engine-out control are minimized by the design Launch capability from tracked vehicles or flat bed

trailers is envisaged, and development work on a suitable conformal antenna array is in early stages R D V

A76-44576 Inter-noise 75, Proceedings of the International Conference on Noise Control Engineering, Sendai, Japan, August 27-29, 1975 Conference sponsored by the Acoustical Society of Japan, Institute of Noise Control Engineering, et al Edited by K Kido (Tohoku University, Sendai, Japan) Sendai, Japan, Tohoku University, 1975 784 p $28

The present collection of papers is concerned with relevant amendments to noise control regulations and prospects of environmental noise abatement Attention is focused on surface transportation noise, aircraft and industrial noise control, the so-called vibration pollution control as related to the detrimental effects of vibrational noise on the human organism, and ducts and silencers The methodology and instrumentation for noise and vibration measurements are discussed, along with noise problems associated with sound propagation under specific conditions Other areas of interest include noise control engineering in buildings, community noise and its assessment, and standards and legislation for noise and vibration

S D

A76-44577 The status of noise control regulations in the U S A W W Lang (IBM Acoustics Laboratory, Poughkeepsie, N Y) *In Inter-noise 75, Proceedings of the International Conference on* Noise Control Engineering, Sendai, Japan, August 27-29, 1975 Sendai, Japan, Tohoku University, 1975, p 1-12 20 refs

The paper assesses the progress that has been made in the regulatory area of noise control during the last decade and gives a brief description of some of the unresolved issues The discussion covers the Federal Noise laws, federal hearings on noise exposure standards, EPA programs, and aviation noise control programs Other topics include truck and highway noise programs, product noise and source emissions, regulations of other agencies, and regulations of state and local governments S D

A76-44578 Aircraft noise certification requirements which ensure use of available noise control technology A L McPike (Douglas Aircraft Co , Long Beach, Calif) In Inter-noise 75, Proceedings of the International Conference on Noise Control Engineering, Sendai, Japan, August 27-29, 1975 Sendai, Japan, Tohoku University, 1975, p 117-138

There are differences of opinion as to the basic purpose of aircraft noise certification requirements Most noise certification concepts which have been proposed represent an attempt to develop a compromise set of noise requirements which partly satisfy a variety of purposes This paper presents a noise certification concept which attempts to satisfy the single purpose of ensuring that a given level of noise control technology is incorporated in all CTOL transport aircraft powered by turbofan engines The key feature of the concept is the isolation of an aircraft's propulsion system as the basic noise source to be controlled The analysis presented in developing the concept helps to point out the necessity of properly accounting for aircraft climbout performance in any takeoff noise certification requirement (Author)

A76-44579 Aircraft operational procedures for community noise control N Shapiro (Lockheed California Co , Burbank, Calif) In Inter-noise 75, Proceedings of the International Conference on Noise Control Engineering, Sendai, Japan, August 27-29, 1975 Sendai, Japan, Tohoku University, 1975, p 139-145 7 refs

Noise received at the ground, and particularly noise exposure patterns, may be modified by varying airplane operational procedures A major improvement in aircraft flyover noise is achieved with the introduction of the wide bodied transports powered by the new technology high bypass ratio turbofan engines in acoustically treated nacelles Emphasis is placed on the study of takeoff and approach operational procedures for moderating community noise exposures An analysis is performed regarding the effect of variations in operational procedures on noise under the flight path as well as regarding the shapes and areas enclosed by noise contour 'footprints' in order to evaluate the use of these operational techniques for various noise situations Of the three takeoff and three approach procedures reviewed, thrust outback on takeoff and two segment approach appear to be most suitable for noise abatement, with delayed transition from approach to landing configuration also indicating some benefit S D

A76-44580 German Federal regulations for sound insulation against aircraft noise /Decree on sound insulation/ H Gummlich (Bundesministerium des Innern, Bonn, West Germany) and H Reich (Federal Ministry for Regional Planning, Building and Urban Development, Bonn, West Germany) In Inter noise 75, Proceedings of the International Conference on Noise Control Engineering, Sendai, Japan, August 27-29, 1975 Sendai, Japan, Tohoku University, 1975, p 147-150 9 refs

The paper discusses the contents and scope of the decree of the Federal Government of Germany on sound insulation against aircraft noise The key items discussed concern the adoption of the airborne sound insulation index established by ISO as a criterion for assessing airborne sound insulation of a structural shell, the requirement of a minimum airborne sound insulation index of 50 dB and 45 dB for the structural shell of rooms of leisure activities, and data on the properties of building elements meeting the requirements without individual certification The airborne sound insulation index combines the advantage of providing a set of reference values with a psychological merit of always giving positive figures S D

A76-44581 Noise zoning around airports in the Federal Republic of Germany according to the Air Traffic Noise Act A O Vogel (Bundesministerium des Innern, Bonn, West Germany) In Inter-noise 75, Proceedings of the International Conference on Noise Control Engineering, Sendai, Japan, August 27-29, 1975 Sendai, Japan, Tohoku University, 1975, p 151-153 6 refs

A76-44582 The role of EPA in regulating aircraft/airport noise H J Nozick and J C Schettino (U S Environmental Protection Agency, Office of Noise Abatement and Control, Arlington, Va) In Inter-noise 75, Proceedings of the International Conference on Noise Control Engineering, Sendai, Japan, August 27-29, 1975 Sendai, Japan, Tohoku University, 1975, p 155-158

The paper gives a brief overview of past and present activities of the EPA in its continuing effort to provide public health and welfare guidelines and specific proposals for abating aircraft noise Particular attention is given to the legislative history and current status for a long-range program of noise control and abatement While implementation of aircraft operational and source noise regulations will bring considerable relief to a large sector of noise-impacted population, they alone are incapable of eliminating the problem Promulgation of an airport regulation in conjunction with more reponsible land use planning around airports is expected to prevent aggravation of the problem Future regulatory actions are identified S D

A76-44583 Recent progress in the control of aircraft/airport noise for community relief A G Jhaveri In Inter-noise 75, Proceedings of the International Conference on Noise Control Engineering, Sendai, Japan, August 27-29, 1975 Sendai, Japan, Tohoku University, 1975, p 159-162 10 refs

Aircraft/airport noise and its impact on the residential community surrounding an airport has become one of the most important planning and abatement concerns of airport authorities, airlines, airframe and engine manufacturers, planning commissions, and government agencies The present study outlines the significant progress made in the technology, methodology, regulations, strategy, and abatement procedures related to aircraft/airport noise Emphasis

is on noise abatement activities for community relief in the Pacific Northwest region of the U S A with comparison to similar approaches used by other agencies S D

A76-44584 Prediction of noise exposure around an airbase. S Furukawa, F Sasaki, and G Nishinomiya (Japan Broadcasting Corp , Technical Research Laboratories, Tokyo, Japan) In Inter-noise 75, Proceedings of the International Conference on Noise Control Engineering, Sendai, Japan, August 27-29, 1975 Sendai, Japan, Tohoku University, 1975, p 163-166

A simple procedure to predict noise exposure around an airbase is developed by expanding the concepts applied in civil aviation The data necessary to predict noise exposure are obtained with an accuracy similar to that encountered in civil aviation from a limited sample Since the number of operations at an airbase is normalized over a long term of observations, it is therefore possible to evaluate total noise exposure as in civil aviation For irregular operations, the flight profiles and courses can be grouped with some regularity to calculate the number of operations in each group S D

A76-44585 Propeller noise of an aircraft flying in the U S standard atmosphere. R Stuff (Aerodynamische Versuchsanstalt, Gottingen, West Germany) In Inter-noise 75, Proceedings of the International Conference on Noise Control Engineering, Sendai, Japan, August 27-29, 1975 Sendai, Japan, Tohoku University, 1975, p 167-170 7 refs

An analytical solution is described for sound wave propagation *in an atmosphere with gravity stratification and vertical temperature* gradient A method of calculating propeller noise in the U S standard atmosphere is obtained by applying the analytical solution as an initial solution to a certain propeller noise theory Particular attention is given to solutions for acoustical monopoles and dipoles *As an example, the first harmonic of a two-blade propeller is* calculated The directional characteristic of a propeller at a 5000-m altitude in the U S standard atmosphere is assessed for the vertical plane beneath the aircraft S D

A76-44586 Run up silencer for F-4EJ Phantom H Kobayashi, A Nakano, and Y Kushiraha (Ishikawajima Harima Heavy Industries Co , Ltd , Tanashi, Tokyo, Japan) In Inter noise 75, Proceedings of the International Conference on Noise Control Engineering, Sendai, Japan, August 27-29, 1975 Sendai, Japan, Tohoku University, 1975, p 171 174

The paper discusses the required performance, design, and test results for a ground-runup silencer used for the F 4EJ Phantom aircraft The silencer is designed to reduce, to the prescribed level, the noise produced during the operation of the J79 17 engine installed in the aircraft The silencer consists of a reinforced structure, a control room, and a supplementary equipment incorporating a cooling unit and CO2 fire extinguishers Acoustics design is discussed along with noise from aircraft air intake ports, secondary air intake ports of silencer, exhaust stack, and soundproof door Test results for noise level at a point of 500 m from the silencer and for octave band noise level are plotted S D

A76-44587 * Fan noise reduction at subsonic and supersonic tip speeds with high Mach number inlets E Lumsdaine (Tennessee, University, Knoxville, Tenn) In Inter noise 75, Proceedings of the International Conference on Noise Control Engineering, Sendai, Japan, August 27-29, 1975 Sendai, Japan, Tohoku University, 1975, p 283-290 23 refs NSF Grant No GK 38342, Grant No NGR 43-001 081

Results are presented for an experimental study of two fixed geometry inlets and one translating centerbody type inlet tested in an anechoic-chamber transonic-compressor facility The test vehicle was a 12-inch tip diameter single-stage transonic compressor with 19 rotor blades and 30 stator blades located approximately two chord lengths downstream of the rotor It is shown that the translating centerbody-type-of-inlet-is-superior-to-the-collapsing-cowl-type-for noise reduction at high subsonic Mach numbers, both acoustically and aerodynamically The feasibility of using a high inlet Mach number depends largely on the maximum area ratio requirement (normally at landing) The high inlet Mach numbers are more effective in reducing high frequency noise than low frequencies and more effective in reducing the blade passage frequency than the overall noise level S D

A76-44588 Sound absorbing structures for engine noise reduction K Ishizwa, A Nakano (Ishikawajima Harima Heavy Industries Co , Ltd , Tanashi, Tokyo, Japan), and R Sasaki (Japan Defense Agency, Technical Research and Development Institute, Tokyo, Japan) In Inter noise 75, Proceedings of the International Conference on Noise Control Engineering, Sendai, Japan, August 27 29, 1975 Sendai, Japan, Tohoku University, 1975, p 299 301

The paper describes the economical design of an easily fabricated perforated sheet metal acoustic panel for absorbing the noise produced by a 4000 lb thrust type high bypass turbofan engine Preliminary calculations and field tests indicated that acoustic treatment should be applied to engine intake and fan bypass duct A honeycomb structure is made with slotted straight sheet metals that cross slotted arched sheet metals Perforated sheet and back sheet are bonded to this honeycomb structure and baked in a furnace Reduction of aftward and forward fan noise is discussed Maximum noise reduction took place at the resonant frequency of the acoustic panel designed with correction of Mach number effect S D

A76-44589 A new method suggested for estimating the psychological effect of the aircraft noise at an airport S Kondo (Hitachi, Ltd , Tokyo, Japan), C Hayashi (Institute of Statistical Mathematics, Tokyo, Japan), and H Kodama (Japan Women's University, Tokyo, Japan) In Inter-noise 75, Proceedings of the International Conference on Noise Control Engineering, Sendai, Japan, August 27-29, 1975 Sendai, Japan, Tohoku University, 1975, p 433-436

A76-44590 A study on TTS due to DC-8 aircraft noise. K Hiramatsu, K Takagi, T Yamamoto (Kyoto University, Kyoto, Japan), and K Yamano (Kobe Municipal Office, Kobe, Japan) In Inter-noise 75, Proceedings of the International Conference on Noise Control Engineering, Sendai, Japan, August 27 29, 1975 Sendai, Japan, Tohoku University, 1975, p 457-460

Results are presented for an experimental study of temporary threshold shift (TTS) in human hearing due to DC-8 aircraft noise in the vicinity of the Osaka International Airport Post-exposure thresholds at 4 kHz were determined after specified times of exposure to aircraft noise A regression equation for the growth of TTS at 4 kHz is determined as TTS = AlogT + B, where A and B are constants depending on the peak level of the noise and T is exposure time S D

A76-44591 Monitoring system of environmental noise M Okuda and H Fukuhara (Rion Co , Ltd , Kokubunji, Tokyo, Japan) In Inter-noise 75, Proceedings of the International Conference on Noise Control Engineering, Sendai, Japan, August 27 29, 1975 Sendai, Japan, Tohoku University, 1975, p 461-464

A system for monitoring traffic and factory noise is designed which can operate its integral function to statistically process the noise that varies greatly and irregularly and which can give processed data at the monitoring site For aircraft noise, the monitoring system yields a computerized record automatically for each aircraft flight, maximum noise level and time (month, day, hour and minute), and period of time during which the noise exceeds a prescribed level The microphone unit used is a condenser microphone with a wind screen of negligible effect on the acoustic characteristics of the microphone The system described for monitoring aircraft and traffic noise is simple-in-operation-than-the-conventional-method-and-is-capable-of yielding ample data S D

A76-44593 **Low noise level nozzles and exhaust silencers for quieting air discharge** C M Salerno (Tokyo, University, Tokyo, Japan) In Inter-noise 75, Proceedings of the International Conference on Noise Control Engineering, Sendai, Japan, August 27 29, 1975 Sendai, Japan, Tohoku University, 1975, p 675-678

Results are presented for an experimental study of simple bluff bodies in a quiet source of air with a view toward acquiring more information about the relevant Strouhal number regarded as a significant parameter for prediction of sound generated by bluff bodies in air flow An expression relating the normalized spectrum level using the Strouhal number as a parameter and the sound power spectrum level is obtained for predicting the aerodynamic sound generated by bluff bodies at a low velocity The exponent representing the velocity dependence of the sound for each system of bluff bodies is shown to be constant for all values of the Strouhal number and equal to 5 The size of a bluff body corresponding to the characteristic length in the formula for the Strouhal number is determined S D

A76-44594 **Design optimization of gas turbine silencers** I L Ver (Bolt Beranek and Newman, Inc , Cambridge, Mass) In Inter noise 75, Proceedings of the International Conference on Noise Control Engineering, Sendai, Japan, August 27 29, 1975 Sendai, Japan, Tohoku University, 1975, p 687 690 6 refs

Gas turbine silencers are almost always custom designed because of the large variation of turbine types and the noise criteria to be met Due to the high cost of silencers, it is imperative to optimize each design with respect to acoustical performance, pressure drop, and cost The present study deals with relevant aspects of the conceptual design of silencers, design evaluation, and selection of materials Particular attention is given to selection of silencer type, interactive silencers, effect of flow and temperature gradients, self-noise, and choice of lining material A formula is given to find the proper porous material to yield the needed flow resistance at design temperature S D

A76-44595 **Reduction of air flow noise by expanded barrel diffuser** J E Sneckenberger (West Virginia University, Morgantown, W Va) and J H Carpenter (Carborundum Co , Hagerstown, Md) In Inter noise 75, Proceedings of the International Conference on Noise Control Engineering, Sendai, Japan, August 27 29, 1975 Sendai, Japan, Tohoku University, 1975, p 691-694 5 refs

The research work for which an expanded barrel nozzle design was developed involved an investigation of noise abatement techniques for reducing the nozzle noise generated by operation of an abrasive blasting equipment The most significant noise attenuation for exhausted compressed air was achieved using a segmented expanded barrel diffuser type of nozzle modification This step change in barrel cross section permitted the flow to be partially expanded and subsequently slowed down before being discharged into the ambient air Test results indicated that barrel diffuser parameters for the expanded barrel nozzle can be selected to provide a reduction of as much as 20 dB for air flow noise generated at typical nozzle operating conditions Additional studies of this noise reduction technique are currently under way Further applications of this technique are noted S D

A76-44596 **Analysis of noise levels for existing and future airplanes in view of modifications to Federal Aviation Regulations Part 36** W C Sperry (U S Environmental Protection Agency, Office of Noise Abatement and Control, Washington, D C) In Inter-noise 75, Proceedings of the International Conference on Noise Control Engineering, Sendai, Japan, August 27-29, 1975
Sendai, Japan, Tohoku University, 1975, p 699-706 9 refs

The principal purpose of the United States Federal Aviation Regulations Part 36 (FAR 36) is to provide requirements which will influence the design of aircraft to include implementation of noise source control technology to the maximum extent feasible Feasibility means that the noise control technology must be consistent with the highest degree of safety, be economically reasonable, be technologically practicable, and be appropriate for the particular type of aircraft considered Current, available, and future technologies are discussed The proposed new compliance noise levels for FAR 36 are presented graphically, illustrating the capability of current, available, and future noise control technology Formulas are provided for the proposed compliance noise levels in terms of effective perceived noise level, applicable to airplane weights between 10,000 and 1,000,000 lb, along with their range of reductions from the levels of 1969 FAR 36 Modifications to FAR 36 must relate the compliance noise levels for each of the technology options to specific effective dates and be applicable to particular classes of airplanes S D

A76-44707 **The Jaguar program (Le programme Jaguar)** I R Yates (British Aircraft Corp , Ltd , Military Aircraft Div , Preston, Lancs , England) and M J Berjon (Societe Europeenne de Production de l'Avion d'Ecole, de Combat et d'Appui Tactique, Vélizy-Villacoublay, Yvelines, France) *L'Aeronautique et l'Astronautique,* no 59, 1976, p 3-20 In French

The history and scope of the Jaguar fighter project development program is reviewed The development of five distinct national variants in Jaguar design, and research and development work on engine and airframe are described, including in-flight tests, wind tunnel tests, and static bench tests Wake vortex interference, flutter, buffeting, handling and flying qualities, placement and jettisoning of outboard stores, and response to firing of projectiles from underwing or wing-top positions are discussed The article ends with a discussion of prospective future design developments in the Jaguar program R D V

A76-44712 **Ejectors for supersonic transport aircraft - A theoretical method (Ejecteur pour avion de transport supersonique - Methode de calcul theorique)** J M Hardy (SNECMA, Paris, France) *(International Symposium on Air Breathing Engine, 3rd, Munich, West Germany, Mar 7-12, 1976) L'Aeronautique et l'Astronautique,* no 59, 1976, p 43 49 7 refs In French

An account will be given of the basic principles for the calculation of three-dimensional axi symetric flows in choked or non-choked ejectors with internal venting The calculation requires an accurate theoretical determination of the transonic field, together with an appropriate thermodynamic formulation of the primary flow (Cp varying continuously) The proposed mathematical model is adapted to ejector design analysis of the optimum pattern, geometrical dimensioning The feasibility of the compromise between aerodynamics and mechanical design is studied by means of numerical tests in order to reduce wind tunnel testing (Author)

A76-44713 **New American development programs for small civil and military turbofan engines (Nouveaux programmes americains de petits moteurs a double flux civils et militaires)** A Bodemer (SNECMA, Moissy Cramayel, Seine et Marne, France) *L'Aeronautique et l'Astronautique,* no 59 1976, p 50 55 In French

A review is presented of the NASA sponsored quiet clean general aviation turbofan (QCGAT) program for developing a low noise nonpolluting turbofan engine Major sources of noise are pinpointed fan intake and exit noise, fan jet noise, compressor noise, gas generator noise, and gas generator jet noise Viable designs developed by competing concerns (Avco Lycoming, AiResearch Garrett, GE, Pratt and Whitney, Teledyne, and others) are compared Major pollutants are considered (nitrogen oxides, CO, partially combusted hydrocarbons) Performance data for some competing engines are tabulated, and data are presented on the low cost turbofan trainer program R D V

A76-44714 **Aspects of braking control (Aspects du contrôle des freins)** C Marcheron (Messier-Hispano, S A Montrouge,

Hautes-de Seine, France) *L'Aeronautique et l'Astronautique*, no 59, 1976, p 59 63 In French

Recent advances in electrohydraulic braking control at Messier and at Hispano-Suiza are surveyed The Ministop, Modistrop, SPAD, and Minimodulator electrohydraulically controlled braking mechanisms for landing gears of Concorde, Airbus, Mysteres, and Mirages are examined, with attention given to antiskid behavior, feedback from tire/runway drag to improve or reverse deceleration, and braking servomechanisms A minicomputer for calculating tire/runway drag continuously, calculating braking couples and braking pressure, is discussed Prospects for completely automated braking are considered R D V

Page intentionally left blank

Page intentionally left blank

STAR ENTRIES

N76-30148*# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif
PREDICTED DYNAMIC CHARACTERISTICS OF THE XV-15 TILTING PROPROTOR AIRCRAFT IN FLIGHT AND IN THE 40- BY 80-FT WIND TUNNEL
Wayne Johnson Jun 1976 56 p refs
(NASA-TM-X-73158 A-6700) Avail NTIS HC $4 50 CSCL 01A

Pretest predictions of the dynamic characteristics of the XV-15 tilting proprotor aircraft are presented The data for the aircraft in flight include trim conditions flight dynamics gust response aeroelastic stability and the wing response to control The data for the aircraft in the Ames 40- by 80-ft wind tunnel include aeroelastic stability and the wing response to control The calculations were made for pylon tilt angles of 0 deg (airplane mode) 0 1 deg (pylon unlocked) 30 60 and 90 deg (helicopter mode) Author

N76-30149 Ohio State Univ Columbus
SUBSONIC AND TRANSONIC FLOW OVER SHARP AND ROUND NOSED NONLIFTING AIRFOILS Ph D Thesis
James Joseph Olsen 1976 154 p
Avail Univ Microfilms Order No 76-18017

A theoretical and numerical investigation was conducted of the solution of the equations which govern the subsonic and transonic flow of a perfect gas over sharp and round nosed nonlifting airfoils The investigation was prompted by disagreements among three sources of airfoil pressure distributions experiment analytical solutions and numerical finite-difference solutions of the first order equations The investigation showed that commonly presented numerical solutions seem to agree with experiment but not with analytical solutions It was shown that the numerical solutions can be brought into agreement with the analytical solutions by very careful attention to the airfoil nose singularities however the consistent analytical and numerical solutions then disagreed with experiment Dissert Abstr

N76-30151 Washington Univ Seattle
TRANSITION TO TRANSONIC FLOW IN THE FAR FIELD FOR A SUPERSONIC AIRFOIL IN A STRATIFIED ATMOSPHERE Ph D Thesis
George Albert Pechuzal 1975 116 p
Avail Univ Microfilms Order No 76-17588

The flow field due to a thin airfoil in an atmosphere with a weak wind gradient is examined Because of this wind gradient which is assumed to increase linearly with altitude the flow gradually becomes transonic in the far field below the airfoil This transition phenomenon also occurs in an atmosphere where the temperature decreases with altitude and for certain cases of accelerating flights It is shown that a solution which describes both supersonic and transonic regimes can be derived by matching two expansions The flow field in the transonic region is then calculated numerically using the method of characteristics and incorporating the appropriate shock relations The problem considered here is restricted to be strictly hyperbolic by introducing a horizontal boundary the ground at an appropriate distance from the airfoil such that the lowest Mach number in the flow is strictly greater than one In addition to mapping the flow field in the transonic region the numerical solution is used to confirm the validity of the proposed asymptotic results Dissert Abstr

N76-30154*# National Aeronautics and Space Administration Langley Research Center Langley Station Va
AERODYNAMIC PERFORMANCE STUDIES FOR SUPERSONIC CRUISE AIRCRAFT
Vincent R Mascitti May 1976 21 p refs
(NASA-TM-X-73915) Avail NTIS HC $3 50 CSCL 01A

Technical progress made in each of the disciplinary research areas affecting the design of supersonic cruise aircraft is discussed The NASA Supersonic Cruise Aircraft Research program has supported an expanded research program in aerodynamics including an ever growing experimental data base methodology development across the Mach number range and sonic boom Progress in the aerodynamics area could facilitate the choice of the highly swept subsonic leading edge arrow wing known for superior supersonic cruise efficiency Author

N76-30156*# National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio
EFFECT OF EXTERNAL JET-FLOW DEFLECTOR GEOMETRY ON OTW AERO-ACOUSTIC CHARACTERISTICS
U VonGlahn and D Groesbeck 1976 33 p refs Presented at the 3d Aero-Acoustics Conf Palo Alto Calif 20-23 Jul 1976, sponsored by AIAA
(NASA-TM-X-73460 E-8823) Avail NTIS HC $4 00 CSCL 01A

The effect of geometry variations in the design of external deflectors for use with over-the-wing (OTW) configurations was studied at model scale and subsonic jet velocities Included in the variations were deflector size and angle as well as wing size and flap setting A conical nozzle (5 2-cm diameter) mounted at 0 1 chord above and downstream of the wing leading edges was used The data indicate that external deflectors provide satisfactory takeoff and approach aerodynamic performance and acoustic characteristics for OTW configurations These characteristics together with expected good cruise aerodynamics since external deflectors are storable may provide optimum OTW design configurations Author

N76-30157*# Virginia Polytechnic Inst and State Univ Blacksburg Coll of Engineering
AN INVESTIGATION OF AEROELASTIC PHENOMENA ASSOCIATED WITH AN OBLIQUE WINGED AIRCRAFT
Final Technical Report
Terry A Weisshaar 31 Aug 1976 44 p refs
(Grant NsG-2016)
(NASA-CR-148723) Avail NTIS HC $4 00 CSCL 01A

Oblique wing aeroelasticity studies are reviewed The static aeroelastic stability characteristics of oblique wing aircraft lateral trim requirements for 1-g flight and the dynamic aeroelastic stability behavior of oblique winged aircraft primarily flutter are among the topics studied The similarities and differences between oblique winged aircraft and conventional bilaterally symmetric swept wing aircraft are emphasized Author

N76-30158*# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif
PREDICTION OF STATIC AERODYNAMIC CHARACTERISTICS FOR SLENDER BODIES ALONE AND WITH LIFTING SURFACES TO VERY HIGH ANGLES OF ATTACK
Leland Howard Jorgensen Jul 1976 264 p refs
(NASA-TM-X-73123 A-6541) Avail NTIS HC $9 00 CSCL 01A

An engineering-type method is presented for computing normal-force and pitching-moment coefficients for slender bodies of circular and noncircular cross section alone and with lifting surfaces In this method a semi-empirical term representing viscous-separation crossflow is added to a term representing potential-theory crossflow For many bodies of revolution

computed aerodynamic characteristics are shown to agree with measured results for investigated free-stream Mach numbers from 0 6 to 2 9 For several bodies of elliptic cross section measured results are also predicted reasonably well over the investigated Mach number range from 0 6 to 2 0 and at angles of attack from 0 to 60 deg As for the bodies of revolution the predictions are best for supersonic Mach numbers For body-wing and body-wing-tail configurations with wings of aspect ratios 3 and 4 measured normal-force coefficients and centers are predicted reasonably well at the upper test Mach number of 2 0 However with a decrease in Mach number to 0 6 the agreement for C sub N rapidly deteriorates although the normal-force centers remain in close agreement Vapor-screen and oil-flow pictures are shown for many body body-wing and body-wing-tail configurations When separation and vortex patterns are asymmetric undesirable side forces are measured for the models even at zero sideslip angle Generally the side-force coefficients decrease or vanish with the following increase in Mach number decrease in nose fineness ratio change from sharp to blunt nose and flattening of body cross section (particularly the body nose) Author

N76-30159*# National Aeronautics and Space Administration Ames Research Center, Moffett Field Calif

AERODYNAMIC CHARACTERISTICS OF AN A-4B AIRCRAFT WITH SIMULATED AND ACTUAL GUNFIRE DAMAGE TO ONE WING

Mark D Betzina and David H Brown Jul 1976 174 p Prepared in cooperation with US Army Air Mobility R and D Lab (NASA-TM-X-73119 A-6519) Avail NTIS HC $6 75 CSCL 01A

The aerodynamic characteristics of a damaged McDonnell Douglas A-4B aircraft were studied in the Ames Research Center s 40- by 80-Foot Wind Tunnel A standard fuselage and three different wings were used The first wing tested was an undamaged one in which holes had been cut and detachable cover plates installed Removal of one or more cover plates gave one of fourteen different simulated damage cases The other two wings tested were damaged by actual gunfire at an Air Force range Author

N76-30160*# National Aeronautics and Space Administration Langley Research Center Langley Station, Va

AIRCRAFT MOTION AND PASSENGER COMFORT RESPONSE DATA FROM TIFS RIDE-QUALITY FLIGHT EXPERIMENTS

W Elliott Schoonover Jr Aug 1976 139 p (NASA-TM-X-73944) Avail NTIS HC $6 00 CSCL 01A

The aircraft motion data and passenger comfort response data obtained during ride-quality flight experiments using the USAD Total In-Flight Simulator (TIFS) are given During each of 40 test flights 10 passenger subjects individually assessed the ride comfort of various types of aircraft motions The 115 individuals who served as passenger subjects were selected to be representative of air travelers in general Aircraft motions tested consisted of both random and sinusoidal oscillations in various combinations of five degrees of freedom (transverse normal roll, pitch, and yaw) as well as of terminal-area flight maneuvers The data are sufficiently detailed to allow analysis of passenger reactions to flight environments evaluation of the use of a portable environment measuring/recording system and comparison of the in-flight simulator responses with input commands Author

N76-30163# Max-Planck-Institut fuer Stroemungsforschung Goettingen (West Germany)

ACOUSTIC MEASUREMENT OF THE CIRCULATION OF VORTICES AND THE CIRCULATION DISTRIBUTIONS IN WIND TUNNEL MODEL INVESTIGATIONS

D W Schmidt 1975 107 p refs In GERMAN ENGLISH summary (MPIS-Mitt-61) Avail NTIS HC $5 50, Max-Planck-Inst fuer Stroemungsforsch , Goettingen West Ger DM 25

Simple method for direct measurement of the circulation of vortices was deduced based on the influence of a vortex on the running time of ultrasonic pulses in flows and an acoustic circulation meter using this method developed This instrument was tested by performing measurements in the flow around models of a rectangular wing and of a swept wing in a 3 m x 3 m wind tunnel at velocities up to 30 m/s Using the rectangular wing measurements of the dependence of the circulation on the angle of incidence of the wing and on the main flow velocity and further of the circulation distribution along the wing span were made using the swept wing, the tip vortex was measured The results of measurements proved to be independent of practically all disturbing influences The smallest values of measured circulation were about 0 1 sqm/s It is advantageous that the flow region under test is not disturbed by measuring probes and that measuring times are short Thus the time needed to measure a circulation distribution depends only on the time needed to position the microphone system which is mounted on the traversing apparatus of the wind tunnel Author (ESA)

N76-30165# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Berlin (West Germany) Inst fuer Turbulenzforschung

TURBULENT PRESSURE DATA RELEVANT TO AIRFRAME NOISE SOURCES

Helmut V Fuchs 19 Jan 1976 26 p refs (DLR-FB-76-09) Avail, NTIS HC $4 00 DFVLR Cologne DM 11 30

Estimates of sound radiated from rigid surfaces interacting with a turbulent flow require a knowledge of at least the rms pressure fluctuation level p and the size of the respective correlation areas on the surface under consideration Since there is considerably more information available on velocity fluctuations in turbulent flow than there is on corresponding static pressure fluctuations it is convenient to replace p by an equivalent velocity expression It is shown that this assumption can result in misleading estimates of the relative importance of the various air frame noise source components The value of the dimensionless pressure coefficient varies from 1 to 1 000 depending on the local turbulence level and the particular flow configuration considered Author (ESA)

N76-30170# Royal Aircraft Establishment Farnborough (England) Aerodynamics Dept

INTERFERENCE PROBLEMS ON WING-FUSELAGE COMBINATIONS IN INVISCID, INCOMPRESSIBLE FLOW

J Weber and M GaynorJoyce London Aeron Res Council 1976 74 p refs Supersedes RAE-TR-74073 ARC-35588 (ARC-R/M-3781 RAE-TR-74073 ARC-35588) Avail NTIS HC $4 50 HMSO £ 4 50 PHI

Some interference effects between fuselage and wing are studied for two classes of configurations For the first class the report deals with the change of the pressure distribution caused by the body interference and for the second class with the change of the required shape of the mean surface The problems are solved by considering first the flow field past a single kinked infinite swept source line or a vortex in the presence of the fuselage and by computing some velocity components From the tabulated values of these velocity components the interference velocities for wings of given thickness distribution or load distribution can be derived by chordwise integration A few examples demonstrate how the interference effects can vary with the angle of sweep with the ratio between body radius and wing chord and with the spanwise distance from the wing-body junction Author (ESA)

N76-30171# Royal Aircraft Establishment Farnborough (England) Structures Dept

AN ASSESSMENT OF THE IMPORTANCE OF THE RESIDUAL FLEXIBILITY OF NEGLECTED MODES IN THE DYNAMICAL ANALYSIS OF DEFORMABLE AIRCRAFT

A S Taylor and M R Collyer London Aeron Res Council 1976 78 p refs Supersedes RAE-TR-73119, ARC-35085 (ARC-CP-1336 RAE-TR-73119 ARC-35085) Avail NTIS HC $5 00 HMSO £ 2 30 PHI

The mathematical framework for a unified approach to the dynamical problems of deformable aircraft is used as the basis

for a limited numerical investigation of the usefulness of the residual flexibility concept in truncated modal analyses A finite element model of a supersonic transport aircraft of slender delta configuration is the subject of stability and response calculations in which various representations of the structural deformability are used These comprise up to four natural modes both with and without the residual flexibility of the remaining modes It is concluded that the addition of residual flexibility to a structural model which comprises only one or two modes significantly improves the accuracy of estimates of low frequency characteristics However if a single model is to be used in an integrated approach to the aeroelastic problems of an aircraft it must incorporate a fairly large number of modes in order to deal with the higher-frequency problems In these circumstances the residual flexibility concept would seem to have little practical value
Author (ESA)

N76-30172# British Aircraft Corp Warton (England) Military Aircraft Div
EVALUATION OF A LOADING FORM FOR THE CALCULATION OF LINEARISED THEORY PRESSURE DISTRIBUTIONS ON WINGS WITH CONTROL SURFACES HAVING SWEPT HINGE LINES IN STEADY SUBSONIC FLOW
T G Wigley London Aeron Res Council 1976 58 p refs Supersedes ARC-35865
(Contract K43A/421/C B 43(A)2)
(ARC-CP-1340 ARC-35865) Avail NTIS HC $4 50 HMSO £2 60 PHI

Partially matched loadings are constructed to enable the accurate simulation of first order boundary conditions on wings with control surfaces having swept hinge lines in subsonic flow These loadings are assessed by observing the character of the difference between the induced downwash and the required boundary condition paying special attention to the neighborhoods of hinge line corners The regularized downwashes are used in lifting surface calculations to provide values for the fully matched loadings
Author (ESA)

N76-30175# European Space Agency Paris (France)
EXPERIMENTAL INVESTIGATION CONCERNING THE REDUCTION OF WAVE DRAG OF POINTED SYMMETRICAL WINGS OF EQUAL VOLUME WITH SUBSONIC LEADING EDGE AND BELL-SHAPED PLANFORM FOR DIFFERENT THICKNESS DISTRIBUTIONS IN THE SPANWISE AND CHORDWISE DIRECTIONS
Friedrich Keune et al Feb 1976 36 p refs Transl into ENGLISH of Exptl Untersuch zur Verringerung des Wellenwiderstands vorn spitzer symmetrischer Fluegel gleichen Volumens mit Unterschallvorderkante u glockenfoermiger Grundrissform bei verschiedenen Dickenverteilungen in Spannweiten- u Tiefenrichtung DFVLR, Cologne Report DLR-FB-75-62 15 Sep 1975 Original German report available from DFVLR Cologne DM 15 40
(ESA-TT-269 DLR-FB-75-62) Avail NTIS HC $4 00

For comparison with a theory developed by F Keune drag measurements were carried out on a family of wings in test section A sub H of the 30 x 30 sq cm supersonic wind tunnel of the DFVLR in Porz-Wahn for the Mach number range 1 57 to 4 15 The feasibility of the zero lift wave drag reduction for pointed symmetrical wings of finite thickness and equal volume by variation of the wing planform and of the thickness distribution in the spanwise and chordwise directions was studied Because of the unavoidable influence of the model support and the approximate estimate only of the skin friction necessary for determining the wave drag no agreement was found with the theory which is valid for the wave drag of wings only however from the flow behavior observed during the tests it was obvious that the shock wave-boundary layer interaction was important In addition to the drag measurement other important aerodynamic coefficients were experimentally determined for small angles of incidence
Author (ESA)

N76-30182*# National Aeronautics and Space Administration Langley Research Center Langley Station Va
THE PROMISE OF AIR CARGO SYSTEM ASPECTS AND VEHICLE DESIGN
Allen H Whitehead Jr 19 Jul 1976 39 p refs
(NASA-TM-X-71981) Avail NTIS HC $4 00 CSCL 01C

The current operation of the air cargo system is reviewed An assessment of the future of air cargo is provided by (1) analyzing statistics and trends (2) by noting system problems and inefficiencies (3) by analyzing characteristics of air eligible commodities and (4) by showing the promise of new technology for future cargo aircraft with significant improvements in costs and efficiency The following topics are discussed (1) air cargo demand forecasts (2) economics of air cargo transport (3) the integrated air cargo system (4) evolution of airfreighter design and (5) the span distributed load concept
Author

N76-30186# Teledyne/McCormick Selph Hollister Calif
INSTALLATION PROCEDURE OF BACKUP COVERS FOR THE AH-1 CANOPY REMOVAL SYSTEM
Donald R Duffy 9 Feb 1976 20 p
(Contract DAAJ01-75-C-0770)
(AD-A021434 USAAVSCOM-TR-75-48) Avail NTIS CSCL 01/3

This installation procedure was prepared as an aid in installing protective shells Teledyne McCormick Selph (TMc/S) part number 815478 over damaged Window Cutting Assemblies (WCA) in the AH-1 Helicopter Canopy Removal System The shells were designed to fit over WCA s with cracked retainers The segmented shell may be applied over the entire WCA or one or more shell sections may be utilized to cover only the cracked portion of the WCA A typical shell installation cross section is shown
GRA

N76-30187# Honeywell Inc Minneapolis Minn Systems and Research Center
FLUIDIC THRUST VECTOR CONTROL FOR THE STABILIZATION OF MAN/EJECTION SEAT SYSTEMS Final Report, 16 Dec 1974 - 1 Jul 1975
R B Beale Oct 1975 160 p refs
(Contract F33615-75-C-3031 AF Proj 6065)
(AD-A021223 F0350-FR AFFDL-TR-75-105) Avail NTIS CSCL 01/3

A 2-axis hydrofluidic thrust vector control (TVC) system was designed to improve the total trajectory of an ejection seat system during adverse conditions from 0 to 600 knots air speed A nonlinear model of the seat was derived and linearized to determine the best hardware components for meeting those requirements A vortex rate sensor fluidic resistance-capacitance (rc) compensation and a two stage servovalve using hot gas pressurized oil were chosen to drive a ball and socket nozzle with 20 degrees of thrust deflection This system controls seat attitude and rate in the pitch and yaw axes Of the many operating conditions analysed the worst case was 70 degrees nose down -250 degrees/sec pitch rate 2 inches cg offset in pitch and cg offset in yaw at 0 knots Recovery heights of 360 and 100 feet are achieved at 0 and 600 knots with a 5000 lb rocket burning 0 5 sec By stabilizing the escape system at its aerodynamics trim condition with the drogue chute out during rocket burn the remainder of the flight remained stable
GRA

N76-30196*# National Aeronautics and Space Administration Ames Research Center, Moffett Field Calif
THE KEYSTROKING ABILITY OF COMMERCIAL PILOTS
Douglas H Williams Jul 1976 9 p refs
(NASA-TM-X-73160 A-6713) Avail NTIS HC $3 50 CSCL 05E

A sample of airline and commercial pilots was tested on a standard computer keyboard (QWERTY) They were found to have a useful level of proficiency in operation of this keyboard Implications for the design of alphabetic keyboards for airborne use are discussed
Author

N76-30197# Pacific Missile Test Center Point Mugu Calif
TWO STUDIES OF PREDICTOR DISPLAYS FOR JET AIRCRAFT LANDINGS 1 OPTIMIZATION OF CONTROL STICK DYNAMICS AND PREDICTION SPAN PARAMETERS

2 A COMPARISON BETWEEN EXPERIENCED AND NOVICE NAVY F-4 PILOT SIMULATED LANDING PERFORMANCES

Robert S Kennedy Russell L Smith, Joseph W Wulfeck, John E Queen, and William J Burger 15 Oct 1975 29 p refs (AD-A021925 PMTC-TP-75-55) Avail NTIS CSCL 01/2

Two further studies are reported concerning the utility of a predictor display instrument in landing jet aircraft In the first study the length of prediction span and control stick dynamics were systematically varied and compared to baseline (no prediction and no stick/control response-delay) condition Performances on all predictor display conditions were superior to the baseline and the best performance was seen on the experimental condition with the longest prediction span and the longest stick/control response-delay In the second study a 6-degree of freedom F-4 night carrier landing simulation flown by pilots who were (N=6) or were not (N=6) experienced in that type aircraft Predictor display performances exceeded baseline conditions for both groups and as expected the results showed better performances on the baseline for the experienced F-4 pilots However predictor display performances were equivalent for both groups The letter finding suggests strongly that predictor displays also hold promise as training aids GRA

N76-30198*# McDonnell Aircraft Co St Louis Mo

STUDY OF A FAIL-SAFE ABORT SYSTEM FOR AN ACTIVELY COOLED HYPERSONIC AIRCRAFT VOLUME 1 TECHNICAL SUMMARY Final Report

C J Pirello and R L Herring Washington NASA Aug 1976 84 p refs

(Contract NAS1-13631)

(NASA-CR-2652 MDC-A3313-Vol-1) Avail NTIS HC $5 00 CSCL 01C

Conceptual designs of a fail-safe abort system for hydrogen fueled actively cooled high speed aircraft are examined The fail-safe concept depends on basically three factors (1) a reliable method of detecting a failure or malfunction in the active cooling system (2) the optimization of abort trajectories which minimize the descent heat load to the aircraft and (3) fail-safe thermostructural concepts to minimize both the weight and the maximum temperature the structure will reach during descent These factors are examined and promising approaches are evaluated based on weight reliability ease of manufacture and cost Author

N76-30199*# National Aeronautics and Space Administration Langley Research Center Langley Station Va

APPLICATION OF A HELICOPTER MATHEMATICAL MODEL TO THE LANGLEY DIFFERENTIAL MANEUVERING SIMULATOR FOR USE IN A HELICOPTER/FIGHTER EVASIVE MANEUVER STUDY

Jacob A Houck Billy R Ashworth and Dewey R Baker (Sperry Support Services Sperry Rand Corp) Aug 1976 18 p refs (NASA-TM-X-73935) Avail NTIS HC $3 50 CSCL 01C

A real time simulation study was conducted using a differential maneuvering simulator to determine and evaluate helicopter evasive maneuvers when attacked by fighter aircraft A general helicopter mathematical model was modified to represent an H-53 helicopter The helicopter model was compared to H-53 flight test data to determine any differences between the simulated and actual vehicles The simulated helicopter was also subjectively validated by participating pilots Two fighter mathematical models validated in previous studies were utilized for the attacking aircraft The results of this simulation study have been verified in a flight test program conducted by the U S Air Force and were found to closely match the flight results Author

N76-30200*# National Aeronautics and Space Administration Ames Research Center Moffett Field Calif

PROGRESS TOWARD DEVELOPMENT OF CIVIL AIR WORTHINESS CRITERIA FOR POWERED-LIFT AIRCRAFT Final Report

Barry C Scott Paul W Martin (FAA Los Angeles) Charles S Hynes and Ralph B Bryder (Civil Aviation Authority Airworthiness Div U K) May 1976 74 p refs Sponsored in part by DOT (NASA-TM-X-73124 FAA-RD-76-100) Avail NTIS HC $4 50 CSCL 01C

The results of a joint research program directed toward development of civil airworthiness flight criteria for power lift transports are summarized Tentative criteria are proposed for performance and handling characteristics for powered lift transport aircraft in commercial service The aircraft considered are primarily wing supported vehicles which rely upon the propulsion system for a significant portion of lift and control VTOL aircraft are excluded The flight criteria treat primarily the approach and landing flight phases Author

N76-30201*# National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio

INVESTIGATION OF UPPER-SURFACE-BLOWING NACELLE INTEGRATION AT CRUISE SPEEDS UTILIZING POWERED ENGINE SIMULATORS

E T Meleason and O D Wells (McDonnell-Douglas Corp Long Beach Calif) 1976 23 p refs Presented at the 12th Propulsion Conf Palo Alto Calif 26-29 Jul 1976 sponsored by AIAA and SAE

(NASA-TM-X-73447 E-8806) Avail NTIS HC $3 50 CSCL 01C

Various overwing nacelle designs were investigated on a representative four engine short haul aircraft configuration during a combined analytical and experimental program Design conditions were M sub o = 0 7 and C sub L = 0 4 All nacelles had D shaped nozzle exits and included a streamline contoured design a low boattail angle reference configuration and a high boattail angle powered lift design Testing was done with the design four engine airplane configuration as well as with only inboard nacelles installed Turbopowered engine simulators were used to provide realistic representation of nacelle flows Performance trends are compared for the various nacelle designs In addition comparisons are presented between analytical and experimental pressure distributions and between flow through and powered simulator results Author

N76-30203# European Space Agency Paris (France)

AERODYNAMIC RESEARCH ON THE SUITABILITY OF A HELICOPTER FOR SIMULATING V/STOL AIRCRAFT

Martin Marchand et al Feb 1976 58 p refs Transl into ENGLISH of Flugmechanische Untersuch ueber die Einsetzbarkeit eines Hubschraubers zur Simulation von V/STOL-Flugzeugen DFVLR Brunswick Report DLR-FB-75-59 27 Aug 1975 Original German report available from DFVLR Cologne DM 22 80

(ESA-TT-256 DLR FB-75-59) Avail NTIS HC $4 50

The possibility of using a BO 105 type helicopter as an experimental aircraft with variable flight characteristics for simulating V/STOL aircraft was investigated The control deflections required for the simulation of given natural motions and acceleration maneuvers are indicated and the maximum simulation amplitudes estimated Since by means of the four control deflections of the helicopter only four of the six degrees of freedom of an aircraft can be simulated simultaneously the behavior and stability of the helicopter were also investigated in the two degrees of freedom not simulated Author (ESA)

N76-30204# Air Force Flight Dynamics Lab Wright-Patterson AFB Ohio

INVESTIGATION OF A DOUBLE SLOTTED RUDDER FOR APPLICATION ON ADVANCED TACTICAL TRANSPORT AIRCRAFT Final Report, 1 Jun 1972 - 1 Jan 1975

Russell F Osborn Jr Dec 1975 56 p refs

(AF Proj 1476)

(AD-A022481 AFFDL-TR-75-94) Avail NTIS CSCL 01/3

The aerodynamic and mechanical design of a double slotted rudder (DSR) system for possible use on the next generation STOL transport aircraft has been synthesized and the aerodynamic configuration tested in the Wichita State University low speed wind tunnel Data collected during the Phase I wind tunnel program shows the double slotted rudder in combination with a typical transport aircraft vertical tail produces sixty percent greater side force than a comparable double hinged rudder design Adjustment in slotted rudder geometry directed toward actuation mechanism simplification was made and tested in the second phase of the program The changes investigated had minimal impact on slotted rudder aerodynamic performance Further design

analysis of the mechanically simplified DSR configuration and wind tunnel testing of a completely operable double slotted rudder are recommended before making a final assessment of the concept Author (GRA)

N76-30205# Army Aviation Engineering Flight Activity Edwards AFB Calif

VIBRATION AND TEMPERATURE SURVEY PRODUCTION CH-47C HELICOPTER Final Report, 18 Jul - 20 Sep 1974

Sep 1975 218 p refs

(AD-A022348 USAAEFA-70-15 6) Avail NTIS CSCL 01/3

Vibration and temperature measurement tests were conducted on a production model CH-47C helicopter to define the vibration and temperature environment for the instruments avionics pilot station and selected component parts for representative flight conditions Testing was performed by the United States Army Aviation Engineering Flight Activity at Edwards Air Force Base California between 18 July 1974 and 20 September 1974 The testing consisted of 16 flights totaling 19 3 productive test hours Vibration data were recorded from 63 accelerometer locations for 55 flight conditions and narrow band spectral analyses were performed on the vibration data The results of the spectral analyses were summarized by use of statistical methods GRA

N76-30206# Army Air Mobility Research and Development Lab Fort Eustis Va

MODEL 540 MAIN ROTOR BLADE FATIGUE TEST

Arthur J Gustafson and Nicholas J Calapodas Jan 1976 42 p

(DA Proj 1F2-63211-DB-41)

(AD-A021472 USAAMRDL-TN-22) Avail NTIS CSCL 01/3

The occurrence of catastrophic helicopter accidents due to Bell Model 540-11-250-1 main rotor blade structural failure triggered an Army-wide inspection to determine the condition of the existing 540 blade and full-scale testing to verify the 1100-hour fatigue life of the Model 540 main rotor blade was conducted at the Eustis Directorate Three Model 540 blades each having varying bond/debond conditions and numbers of accumulated flight hours were fatigue tested Existing inspection techniques for bond/debond detection were used and evaluated with emphasis placed on nondestructive test techniques GRA

N76-30207# Advisory Group for Aerospace Research and Development Paris (France)

HELICOPTER DESIGN MISSION LOAD SPECTRA

Aug 1976 71 p refs In ENGLISH partly in FRENCH Presented at 42d Meeting of the Structures and Mater Panel Ottawa Canada 8 Apr 1976

(AGARD-CP-206) Avail NTIS HC $4 50

Mission related load spectra are applied to component fatigue life predictions for helicopter design criteria

N76-30208 Advisory Group for Aerospace Research and Development Paris (France)

MISSION SPECTRA FOR THE COMPUTATION OF LIFE EXPECTANCIES [SPECTRES DE MISSION POUR LE CALCUL DES DUREES DE VIE]

F Liard *In its* Helicopter Design Mission Load Spectra Aug 1976 10 p In FRENCH

The computation of the life expectancies for helicopter parts was shown to be strongly affected by the assumptions made in the type of missions to be performed It appears preferable to restrict oneself to the most important flight characteristics such as speed and load factor instead of including more elaborate data (such as constraints) which cannot be carried over to the design of new helicopters The choice of helicopters selected should be based on a statistical sampling of the air fleet considered to give reliable information on the average mission spectra of these helicopters rather than to focus the attention on the single helicopter with the most severe utilization the reason for this is that it is extremely unlikely that the weakest part would be found on the most highly stressed machine Transl by Y J A

N76-30209 Messerschmitt-Boelkow-Blohm G m b H Munich (West Germany)

THE IMPACT OF HELICOPTER MISSION SPECTRA ON FATIGUE

G Reichert *In* AGARD Helicopter Design Mission Load Spectra Aug 1976 17 p refs

Helicopter components are requested to have long service lives, coming close to unlimited lifetimes However there are still real problems in the accurate prediction of the resulting component lives because this requires the availability of adequate mission load spectra The nature of the typical fatigue loading situation in combination with the requested long lifetimes raises the question of the sensitivity to variations in mission requirements and load spectra For a light helicopter with a hingeless rotor system using fiberglass rotor blades - in commercial as well as in military application - the influence of different mission requirements on load spectra and fatigue is discussed Normally only a small portion of the complete mission is of importance for fatigue Therefore the impact of modified mission spectra on fatigue is assessed Author

N76-30210 Westland Helicopters Ltd Yeovil (England)

HELICOPTER DESIGN MISSION LOAD SPECTRA

A D Hall *In* AGARD Helicopter Design Mission Load Spectra Aug 1976 5 p

The various stages of helicopter design are related to projected flight mission fatigue load magnitudes and occurrences The latter were expressed as a percentage of total flying time or as a number of occurrences per hour of flight Magnitude of loading was derived for the design stage from calculation or by parametric readout from similar aircraft types The assumed maneuver spectrum was the critical link in developing the design stage throughout prototype development and model fatigue testing G G

N76-30211 Technology Inc Dayton Ohio

US AIR FORCE HELICOPTER OPERATIONAL FLIGHT SPECTRA SURVEY PROGRAM PAST AND PRESENT

G L Martin and R B Johnson Jr *In* AGARD Helicopter Design Mission Load Spectrum Aug 1976 16 p refs

Development and application of the Flight Condition Recognition (FCR) technique for the processing of helicopter operational data are elaborated The FCR technique identifies aircraft operations and transitions which are called flight conditions and flight phases which are called mission segments Each identification is based on the characteristic behavior of the in-flight parameters With such identifications, the data processing consists basically of determining the occurrences and durations of the flight conditions and mission segments of measuring the in-flight parameters and accordingly of presenting these data so that the flight condition and mission segment time and frequency distributions are quantitatively defined by selected ranges of the flight parameters This application of the FCR technique permits the fatigue analyst to comprehend and apply more effectively the operational usage spectrum to the calculation of the fatigue life of critical helicopter components Author

N76-30212 Naval Air Systems Command Washington D C

US NAVY HELICOPTER OPERATIONAL FLIGHT SPECTRUM SURVEY PROGRAM PAST AND PRESENT

R E Malatino *In* AGARD Helicopter Design Mission Load Spectrum Aug 1976 13 p refs

In-flight load spectra surveys have been performed on the SH-3A CH-53A CH-46D UH-1E TH-1L and HH-2D helicopters Data from these surveys have been used to establish a more rational basis for static and fatigue structural design criteria as well as to more realistically establish the service lives of existing critically loaded structural components In addition to these in-flight load surveys, data have been obtained during operational landing surveys performed on the HUP-1 HTL-3 HTL-4 HTL-5 HO3S and HRS-1 helicopters These surveys were performed during the early 1950 s In the late 1960 s data were obtained in confined area landing operations with the CH-53A and CH-46F

helicopters Recently surveys were made during landing operations with the HH-2D and SH-2F aircraft on the landing platforms of small ships at sea These data have been used to up-date the Navy s design and test criteria for structural strength for landing Results and details of these surveys as well as the Navy s current plans for future surveys such as flight surveys in mine countermeasures operations with the RH-53D helicopter and at-sea hauldown landing operations with the SH-2F helicopter are discussed
Author

N76-30213 Army Air Mobility Research and Development Lab Moffett Field Calif
CRITIQUE AND SUMMARY OF THE SPECIALISTS MEETING ON HELICOPTER DESIGN MISSION LOAD SPECTRA
Frederick H Immen *In* AGARD Helicopter Design Mission Load Spectra Aug 1976 4 p

A low cost structural integrity monitoring system is reported that permits the determination of in-service fatigue damage of helicopter structural components The parameteric data recording system indicates airspeed static pressure outside air temperature main rotor RPM roll attitude vertical acceleration landing gear touchdown and engine torque In addition to measuring mission load spectra in actual service the use of a highly truncated fatigue load spectrum during initial design is advocated that assumes aircraft operation in the worst loading regime within G load power vibration performance or stability limits 100% of the time
G G

N76-30214*# Honeywell Inc St Louis Park Minn Government and Aeronautical Products Div
COMPUTER TECHNOLOGY FORECAST STUDY FOR GENERAL AVIATION
Charles L Seacord and Darrel Vaughn 30 Jun 1976 346 p refs
(Contract NAS2-8971)
(NASA-CR-137889) Avail NTIS HC $10 00 CSCL 01D

A multi-year multi-faceted program is underway to investigate and develop potential improvements in airframes engines and avionics for general aviation aircraft The objective of this study was to assemble information that will allow the government to assess the trends in computer and computer/operator interface technology that may have application to general aviation in the 1980 s and beyond The current state of the art of computer hardware is assessed technical developments in computer hardware are predicted and nonaviation large volume users of computer hardware are identified
S M

N76-30215# Air Force Inst of Tech Wright-Patterson AFB Ohio School of Engineering
AN EXPERIMENTAL INVESTIGATION OF METHODS OF SUPPRESSING THE UNSTEADY TORQUE EXERTED ON THE UPPER TURNING MIRROR OF AN AIRCRAFT MOUNTED COELOSTAT TURRET M S Thesis
R M Mullane Jun 1975 130 p refs
(AD-A021876 GAE/AE/75J-6) Avail NTIS CSCL 01/3

Various methods of reducing the unsteady torque exerted on the upper turning mirror (UTM) of a coelostat turret were experimentally evaluated The effect of an aft fairing and the turret aperture on the pressure distribution across the turret was also measured Areas of flow separation were determined from oil flow patterns A coelostat model with a turret diameter of five inches and capable of rotating 120 degrees in azimuth was wall mounted in a transonic wind tunnel Data were collected for Mach numbers of 7 85 and 95 Passive methods consisting of external fairings and active methods consisting of blowing and suction were employed to reduce UTM torque
GRA

N76-30216*# *National Aeronautics and Space Administration* Lewis Research Center Cleveland Ohio
ACOUSTIC, PERFORMANCE, AND WAKE SURVEY MEASUREMENTS OF A LOBED VELOCITY-DECAYER NOZZLE INSTALLED ON A QUIETED TF-34 TURBOFAN ENGINE
Nick E Samanich and Laurence J Heidelberg Washington Aug 1976 47 p refs
(NASA-TM-X-3413 E-8676) Avail NTIS HC $4 00 CSCL 21E

Results for three velocity decayer nozzle configurations are compared with those obtained with a separate flow coannular nozzle tested on the same quieted turbofan engine Peak sideline noise which occurred 110 degrees from the inlet was 2 to 4 db louder than with the coannular nozzle at the same ideal effective exhaust velocity and 8 to 11 db louder at the same thrust level The decayer nozzles produced an increase in loss equivalent to about 4 percent of the engine thrust and also increased the effective exhaust velocity of the engine The exhaust decayed to 0 35 of its peak velocity compared with no decay for the coannular nozzle within 3 equivalent nozzle diameters of the exit The peak exhaust gas temperature was 400 K lower for the decayer configuration at the same location The increase in perceived noise level for the decayer nozzles as compared with the coannular nozzle was attributed to the increase in exhaust velocity and the shift in peak spectrum frequency produced by these nozzles
Author

N76-30217*# National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio
VARIABLE-CYCLE ENGINES FOR SUPERSONIC CRUISE AIRCRAFT
Edward Willis 1976 21 p refs Presented at AGARD Propulsion Conf , Paris 6-9 Sep 1976
(NASA-TM-X-73463 E-8826) Avail NTIS HC $3 50 CSCL 21E

Progress and the current status of the Variable Cycle Engine (VCE) study are reviewed with emphasis placed on the impact of technology advancements and design specifications A large variety of VCE concepts are also examined
B B

N76-30218*# General Electric Co Cincinnati Ohio Aircraft Engine Group
STUDY OF TURBOFAN ENGINES DESIGNED FOR LOW ENERY CONSUMPTION
R E Neitzel R Hirschkron and R P Johnston Aug 1976 144 p refs
(Contract NAS3-19201)
(NASA-CR-135053 R76AEG432) Avail NTIS HC $6 00 CSCL 21E

Subsonic transport turbofan engine design and technology features which have promise of improving aircraft energy consumption are described Task I addressed the selection and evaluation of features for the CF6 family of engines in current aircraft and growth models of these aircraft Task II involved cycle studies and the evaluation of technology features for advanced technology turbofans consistent with initial service in 1985 Task III pursued the refined analysis of a specific design of an advanced technology turbofan engine selected as the result of Task II studies In all of the above, the impact upon aircraft economics as well as energy consumption, was evaluated Task IV summarized recommendations for technology developments which would be necessary to achieve the improvements in energy consumption identified
Author

N76-30220 Virginia Polytechnic Inst and State Univ Blacksburg
AEROELASTIC STABILITY BEHAVIOR OF OBLIQUE-WINGED AIRCRAFT Ph D Thesis
John Barrett Crittenden 1976 136 p
Avail Univ Microfilms Order No 76-17095

Aeroelastic instability characteristics of oblique-winged aircraft were determined using the finite element method of analysis Elastic and inertial properties of all planforms are modeled by using an assemblage of twenty beam elements (ten per semispan) each having plunging twisting and bending degrees of freedom The aerodynamic model consists of twenty trapezoidal strips arranged parallel to the free-stream flow direction Unsteady aerodynamic influence coefficients were calculated using a doublet-lattice technique applicable to the subsonic flow regime only The V-g method of flutter analysis was used to calculate wing divergence and flutter speeds for a variety of parameter combinations The wing parameter variations included changes

in geometry stiffness and inertial properties and root or fuselage freedom Flutter and divergence characteristics of the oblique-wing configurations were found to be similar to those of bilaterally symmetric aircraft in most cases Dissert Abstr

N76-30221 Michigan Univ Ann Arbor
TERRAIN FOLLOWING CONTROL BASED ON AN OPTIMIZED SPLINE MODEL OF AIRCRAFT MOTION Ph D Thesis
James Everett Funk 1976 189 p
Avail Univ Microfilms Order No 76-19139

The computational processing of information in aircraft terrain following systems is discussed A scheme is presented to incorporate the major portion of the computation into an optimization problem that considers all of the major constraints (1) a lower bound on the clearance height above the terrain (2) normal acceleration limits on the aircraft (3) jerk (time rate of change of acceleration) limits, and (4) flight path slope constraints Criteria for maintaining the flight path close to the terrain is investigated A general performance measure is considered with linear quadratic and min max options
Dissert Abstr

N76-30222*# Stanford Univ Calif Guidance and Control Lab
AIRCRAFT DIGITAL CONTROL DESIGN METHODS Final Report
J David Powell Eric Parsons and Michael G Tashker Feb 1976 80 p refs
(Grant NsG-1137)
(NASA-CR-148604 SU-DAAR-500) Avail NTIS HC $5 00 CSCL 01C

Variations in design methods for aircraft digital flight control are evaluated and compared The methods fall into two categories those where the design is done in the continuous domain (or s plane) and those where the design is done in the discrete domain (or z plane) Design method fidelity is evaluated by examining closed loop root movement and the frequency response of the discretely controlled continuous aircraft It was found that all methods provided acceptable performance for sample rates greater than 10 cps except the uncompensated s plane design method which was acceptable above 20 cps A design procedure based on optimal control methods was proposed that provided the best fidelity at very slow sample rates and required no design iterations for changing sample rates Author

N76-30224*# Virginia Military Inst Lexington
DIGITAL ADAPTIVE CONTROL OF A VTOL AIRCRAFT Final Report, Nov 1973 - Aug 1976
Gerald F Reid Aug 1976 59 p refs
(Grant NGR-47-018-005)
(NASA-CR-148778) Avail NTIS HC $4 50 CSCL 01C

A technique has been developed for calculating feedback and feedforward gain matrices that stabilize a VTOL aircraft while enabling it to track input commands of forward and vertical velocity Leverrier s algorithm is used in a procedure for determining a set of state variable feedback gains that force the closed loop poles and zeroes of one pilot input transfer function to be at preselected positions in the s plane This set of feedback gains is then used to calculate the feedback and feedforward gains for the velocity command controller The method is computationally attractive since the gains are determined by solving systems of linear simultaneous equations Responses obtained using a digital simulation of the longitudinal dynamics of the CH-47 helicopter are presented Author

N76-30225# Lockheed-California Co Burbank
ACTIVE SHIMMY CONTROL SYSTEM Final Report, Oct 1974 - Dec 1975
Max Gamon and Tom Mahone Wright-Patterson AFB Ohio AFFDL Dec 1975 172 p
(Contract F33615-75-C-3005 AF Proj 1369)
(AD-A022146 AFFDL-TR-75-136) Avail NTIS CSCL 01/2

A T-37 nose gear is modeled as a multiple lumped mass system with four torsional-degrees-of-freedom and one lateral-degree-of-freedom Fuselage flexibility is incorporated and a Von Schlippe tire model is used The equations of motion for various input conditions are solved using measured gear properties An Active Shimmy Control System is incorporated in the analytical model A feedback signal proportional to angular velocity is used to control the hydraulic actuator pressure The equations of motion for the gear with active control are solved for the same inputs as for the passive gear and their responses are compared System parameter values were varied about the nominal measured values to determine their effects for both active and passive systems A breadboard Active Shimmy Control System was built based on the model results A test program was performed establishing regions of shimmy for the passive gear The same conditions were repeated with the active system Substantial improvement was seen A comparison with the theoretical predictions showed good correlation Author (GRA)

N76-30226# City Univ , London (England)
AN INTRODUCTION TO HELICOPTER AIR RESONANCE
A R S Bramwell Aeron Res Council 1975 31 p refs Supersedes ARC-33886 Sponsored in part by Min of Defence
(ARC-R/M-3777 ARC-33886) Avail NTIS HC $4 00 HMSO £2 20 PHI

The phenomenon known as air resonance peculiar to helicopters with hingeless rotors is analyzed and presented In the air resonance case the body mode with frequency close to the whirling frequency of the rotor C G is much more heavily damped than in ground resonance and the damping of the modes of motion is apparently unaffected by coincidence of the body and whirl frequencies The slower of the two C G whirl modes is unstable if only the aerodynamic lag damping is present and it appears that at least 4 percent of critical damping is required for all the modes to be stable A resonant situation may occur if the lag stiffness is so high that the blade lag frequency coincides with the flapping frequency With low damping large lag amplitudes may be excited by Coriolis forces when blade flapping occurs Author (ESA)

N76-30227# European Space Agency Paris (France)
MAXIMUM LIKELIHOOD IDENTIFICATION USING KALMAN FILTERING LEAST SQUARES ESTIMATION A COMPARISON FOR THE ESTIMATION OF STABILITY DERIVATIVES CONSIDERING GUST DISTURBANCES
Gerd Schulz Feb 1976 54 p refs Transl into ENGLISH of Maximum-Likelihood-Identifizierung mittels Kalman-Filterung Kleinste-Quadrate-Schaetzung Ein Vergleich bei der Bestimmung von Stabilitaetsderivativa unter Beruecksichtigung von Boeenstoerungen DFVLR Oberpfaffenhofen West Ger Report DLR-FB-75-54 12 Aug 1975 Original German report available from DFVLR Cologne DM 21 80
(ESA-TT-258 DLR-FB-75-54) Avail NTIS HC $4 50

Starting from the force and moment equations of the longitudinal motion of an aircraft a state space model was derived which allows bias gust disturbances and nonlinear effects to be taken into account A description of the maximum likelihood identification procedure including the corresponding linear state estimation according to Kalman is given A least squares estimation procedure is also presented A comparison of the above estimation methods when used for identification of the stability derivatives of the longitudinal motion of an aircraft shows the maximum likelihood procedure to be superior It is also shown that the identification of the nondimensional derivatives improves the speed of convergence Author (ESA)

N76-30296*# Hamilton Standard Div United Aircraft Corp Windsor Locks Conn
FIBER COMPOSITE FAN BLADE IMPACT IMPROVEMENT Final Report
J Graff L Stoltze and E M Varholak Feb 1976 77 p refs
(Contract NAS3-17837)
(NASA-CR-135001 HSER-6968) Avail NTIS HC $5 00 CSCL 11D

The improved foreign object damage resistance of a metal matrix advanced composite fan blade was demonstrated The

fabrication whirl impact test and subsequent evaluation of nine advanced composite fan blades of the QCSEE type design were performed The blades were designed to operate at a tip speed of 282 m/sec The blade design was the spar/shell type consisting of a titanium spar and boron/aluminum composite airfoils The blade retention was designed to rock on impact with large birds thereby reducing the blade bending stresses The program demonstrated the ability of the blades to sustain impacts with up to 681 g slices of birds at 0 38 rad with little damage (only 1 4 percent max weight loss) and 788 g slices of birds at 0 56 rad with only 3 2 percent max weight loss Unbonding did not exceed 1 1 percent of the post-test blade area during any of the tests All blades in the post-test condition were judged capable of operation in accordance with the FAA guidelines for medium and large bird impacts Author

N76-30565*# National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio
CERAMIC THERMAL-BARRIER COATINGS FOR COOLED TURBINES
Curt H Liebert and Francis S Stepka 1976 14 p refs Presented at 12th Propulsion Conf Palo Alto Calif 26-29 Jul 1976 sponsored by AIAA and SAE
(NASA-TM-X-73426 E-8766) Avail NTIS HC $3 50 CSCL 21E

Coating systems consisting of a plasma sprayed layer of zirconia stabilized with either yttria magnesia or calcia over a thin alloy bond coat have been developed their potential was analyzed and their durability and benefits evaluated in a turbojet engine The coatings on air cooled rotating blades were in good condition after completing as many as 500 two-minute cycles of engine operation between full power at a gas temperature of 1644 K and flameout or as much as 150 hours of steady state operation on cooled vanes and blades at gas temperatures as high as 1644 K with 35 start and stop cycles On the basis of durability and processing cost, the yttria stabilized zirconia was considered the best of the three coatings investigated Author

N76-30568# Oxford Univ (England) Dept of Engineering Science
A REGENERATIVE COMPRESSOR
H Sixsmith and H Altmann Oct 1975 95 p refs Sponsored by Sci Res Council
(OUEL-1139/75) Avail NTIS HC $5 00

A regenerative of peripheral compressor was developed with aerodynamic blading in place of the usual straight radial vanes on the rotor The blades are shrouded by a core around which a helical toroidal flow path is established Two compressors were constructed the first with a single row of blades and the second with two rows side by side to provide parallel counter-rotating flow paths The steep output characteristics resemble those of a Roots blower with isothermal efficiency reaching a maximum of 58 % at a low pressure ratio and falling as the pressure ratio increases Suggestions based on the experience gained from these compressors are aimed at improving the efficiency of the machine especially at high pressure ratios Author (ESA)

N76-30575# Sikorsky Aircraft Stratford Conn
THE 3,000-HP ROLLER GEAR TRANSMISSION DEVELOPMENT PROGRAM VOLUME 2 DESIGN REPORT Final Report
G F Gardner and J Kish Dec 1975 379 p refs
(Contract DAAJ02-69-C-0042 DA Proj 1G1-62207-AA-72)
(AD-A020327 UTRC/S611675-Vol-2
USAAMRDL-TR-73-98-Vol-2) Avail NTIS CSCL 13/9

The development of the roller gear drive indicated potential gains in the overall operational efficiency of turbine-powered helicopters This report presents the design effort involved in the development of the Sikorsky S-61 roller gear transmission The roller gear drive is a combination of the roller transmission which transmits power through friction and a conventional geared planetary arrangement This report covers the initial design of the S-61 roller gear transmission wherein the number of reduction stages their locations and the reduction ratio of the roller gear unit are determined Various types and layouts of transmissions are discussed The finalized layout which receives 3 700 hp from twin turbines and transmits 3 000 hp to the main rotor incorporates a 19 85 L roller gear unit as the final stage in a three-stage reduction transmission The detail design of the major components is discussed and a stress analysis is presented in the appendixes A calculated efficiency of 98 9% for the roller gear unit and 96 5% for the transmission is comparable to high-reduction-ratio transmissions of conventional design Dynamic testing of the transmission will be conducted during later phases of the program whereby the efficiency of the transmission will be measured Author (GRA)

N76-30581# Pratt and Whitney Aircraft West Palm Beach, Fla Research and Development Center
DESIGN, FABRICATION, AND EVALUATION OF GATORIZED (TM) CERAMIC-WROUGHT ALLOY ATTACHMENT CONCEPTS Status Report, 1 Jul 1974 - 31 Dec 1975
W D Carruthers and Bryant H Walker 31 Dec 1975 94 p (Contract N00019-74-C-0484)
(AD-A022158 PWA-FR-7419 SR-6) Avail NTIS CSCL 13/8

Pratt and Whitney Aircraft (P and WA) has devised an attachment approach using P and WA s GATORIZING (TM) forging process which uses the superplastic characteristics induced during the GATORIZING process on selected nickel base superalloys to forge a disk around a ceramic blade root With this attachment approach localized stress concentrations on the ceramic are minimized by the low flow stress during forging inherent in the GATORIZING process The program was devised to develop and demonstrate the feasibility of a small gas turbine engine hybrid rotor with a superalloy disk and ceramic simulated blades using the aforementioned attachment concept The first task was to conduct a design study of selected candidate attachment concepts Primary candidates were then reduced to practice on a sample basis to establish optimum fabrication techniques process parameters ceramic stability during fabrication and the load carrying capability of the attachment Attachment concepts were evaluated in an iterative manner until one GATORIZED (TM) ceramic-wrought superalloy attachment was successfully fabricated and demonstrated an ability to carry acceptable tensile loads GRA

N76-30649# Committee on Commerce (U S Senate)
FUEL PROBLEMS OF THE NATION'S PUBLIC TRANSPORTATION SYSTEM RESULTING FROM THE CURRENT ENERGY SHORTAGE
Washington GPO 1974 207 p Hearings before Comm on Commerce 93d Congr 2d Sess 4-5 and 7 Mar 1974
(GPO-48-894) Avail Comm on Commerce

Testimony regarding the adverse effects on the airline industry and the public of fuel shortages and fuel price escalation created by the Arab oil embargo is presented The adequacy of fuel allocation regulations and the necessity of further legislative action in this area were considered D M L

N76-30678# RMC Research Corp Bethesda Md
INTERCITY PASSENGER TRANSPORTATION MODE/ENERGY CONSERVATION VOLUME 1 EXECUTIVE SUMMARY Final Report
George Roche and Armando M Lago Dec 1975 32 p refs Sponsored in part by FEA
(Contract EQ4AC028)
(PB-250883/6 RMC-UR-286-Vol-1 EQ5174130281-Vol-1) Avail NTIS HC $4 00 CSCL 10A

The energy conservation potential for 1980 and 1985 of alternative intercity passenger transportation policies for the United States is summarized A national intercity passenger transportation model was developed and used to simulate alternative energy conservation policies The model predicts household trip rates by mode and purpose of travel for five income groups four distance markets and three sizes of groups GRA

N76-30919*# Virginia Univ Charlottesville School of Engineering and Applied Science
USE OF STEEPEST DESCENT AND VARIOUS APPROXIMATIONS FOR EFFICIENT COMPUTATION OF MINIMUM NOISE AIRCRAFT LANDING TRAJECTORIES Annual Report
G Cook and R M Witt Aug 1976 85 p refs
(Contract NsG-1101)
(NASA-CR-148718 UVA/528075/EE76/103) Avail NTIS HC $5 00 CSCL 20A

The following areas related to landing trajectory optimization research were discussed (1) programming and modifying the steepest descent optimization procedure (2) successfully iterating toward the optimum for a four-mile trajectory, (3) beginning optimization runs for a twenty-mile trajectory and (4) adapt wind tunnel data for computer usage Other related areas were discussed in detail in the two previous annual reports Author

N76-30921*# Flow Research Inc Kent Wash
NUMERICAL SIMULATION OF TURBULENT JET NOISE, PART 2
Ralph W Metcalfe and Steven A Orszag Feb 1976 25 p refs
(Contract NAS1-12870)
(NASA-CR-144978 Rept-62-Pt-2) Avail NTIS HC $3 50 CSCL 20A

Results on the numerical simulation of jet flow fields were used to study the radiated sound field and in addition to extend and test the capabilities of the turbulent jet simulation codes The principal result of the investigation was the computation of the radiated sound field from a turbulent jet In addition, the computer codes were extended to account for the effects of compressibility and eddy viscosity, and the treatment of the nonlinear terms of the Navier-Stokes equations was modified so that they can be computed in a semi-implicit way A summary of the flow model and a description of the numerical methods used for its solution are presented Calculations of the radiated sound field are reported In addition the extensions that were made to the fundamental dynamical codes are described Finally the current state-of-the-art for computer simulation of turbulent jet noise is summarized Author

N76-30922*# National Aeronautics and Space Administration Lewis Research Center, Cleveland, Ohio
NOISE GENERATED BY IMPINGEMENT OF TURBULENT FLOW ON AIRFOILS OF VARIED CHORD, CYLINDERS, AND OTHER FLOW OBSTRUCTIONS
W A Olsen 1976 36 p refs Presented at the 3d Aero-Acoustic Conf Palo Alto Calif 20-22 Jul 1976 sponsored by AIAA
(NASA-TM-X-73464 E-8829 AIAA-Paper-76-504) Avail NTIS HC $4 00 CSCL 20A

Noise spectra were measured in three dimensions for several surfaces immersed in turbulent flow from a jet and over a range of flow conditions The data are free field and were corrected to remove the small contributions of jet noise atmospheric attenuation and feedback tones These broadband data were compared with the results of available theories which are only strictly applicable to simple geometries over a limited range of conditions The available theories proved to be accurate over the range of flow chord length thickness, angle of attack and surface geometries defined by the experiments These results apply to the noise generated by fixed surfaces in engine passages the lifting surfaces of aircraft and also to fan noise Author

N76-31079*# United Air Lines Inc San Francisco Calif
STUDY OF COST/BENEFIT TRADEOFFS FOR REDUCING THE ENERGY CONSUMPTION OF THE COMMERCIAL AIR TRANSPORTATION SYSTEM
Richard E Coykendall John K Curry Albert E Domke and Sven E Madsen Jun 1976 194 p refs
(Contract NAS2-8625)
(NASA-CR-137891) Avail NTIS HC $7 50 CSCL 05C

Economic studies were conducted for three general fuel conserving options (1) improving fuel consumption characteristics of existing aircraft via retrofit modifications (2) introducing fuel efficient derivations of existing production aircraft and/or introducing fuel efficient current state-of-the-art new aircraft, and (3) introducing an advanced state-of-the-art turboprop airplane These studies were designed to produce an optimum airline fleet mix for the years 1980 1985 and 1990 The fleet selected accommodated a normal growth market by introducing somewhat larger aircraft while solving for maximum departure frequencies and a minimum load factor corresponding to a 15% investment hurdle rate Fuel burnt per available-seat-mile flown would drop 22% from 1980 to 1990 due to the use of more fuel efficient aircraft designs larger average aircraft size and increased seating density An inflight survey was taken to determine air traveler attitudes towards a new generation of advanced turboprops Author

N76-31081# Naval Postgraduate School Monterey Calif
THE A-7 ALOFT COST MODEL A STUDY OF HIGH TECHNOLOGY COST ESTIMATING M S Thesis
Ronald Lloyd Johnson and Earle William Knobloch Dec 1975 274 p refs
(AD-A021913) Avail NTIS CSCL 14/1

This analytical study contains the development of an appropriate life cycle cost (LCC) model for the A-7 Airborne Light Optical Fiber Technology (ALOFT) system The model was developed to support an A-7 ALOFT economic analysis which will compare the total systems costs and performance benefits of an A-7 fiber optic linked navigation and weapons delivery system to existing or proposed wire interconnect designs Major features of this study include the development of (1) a process to derive cost estimates of a high technological development in the early conceptual stage (2) an appropriate LCC model for the A-7 ALOFT economic analysis, and (3) fiber optic costing methodology to support the LCC analysis This analysis is a follow-on study to An Approach to the Estimation of Life Cycle Costs of a Fiber Optic Application in Military Aircraft AD-A019 379 GRA

N76-31085# Committee on Science and Technology (U S House)
NASA AUTHORIZATION, 1977, VOLUME 2, PART 2
Washington GPO 1976 579 p Hearings on H R 11573 (superseded by H R 12453) before subcomm on Aviation and Transportation R and D of Comm on Sci and Technol 94th Congr 2d Sess 10-11 Feb 1976
(GPO-69-739) Avail Subcomm on Aviation and Transportation R and D

Testimony is given on NASA programs for FY 1977 as they relate to the proposed budget Specific topics discussed include technology for the long-range flight regime technology for the high speed flight regime technology for the low-speed flight regime aircraft environmental minimization program aircraft operations and safety and general aviation J M S

N76-31086# Committee on Science and Technology (U S House)
NASA AUTHORIZATION, 1977, VOLUME 3
Washington GPO 1976 433 p Hearing on H R 11573 (superseded by H R 12453) before Comm on Sci and Technol 94th Congr 2d Sess 27 Jan 1976
(GPO-69-812) Avail Comm on Sci and Technol

Various NASA programs are discussed in terms of the proposed budget for FY 1977 These include space shuttles science and applications energy efficient aircraft development of energy technology in the areas of solar heating and cooling electric power generation by wind power applications of photovoltaic cells application of NASA technology to national problems tracking and data relay satellite system thematic mapping MAGSAT the solar maximum mission and the national transonic facility J M S

N76-31090*# Aerospace Corp El Segundo Calif Energy and Transportation Div
EFFECT OF AIRCRAFT TECHNOLOGY IMPROVEMENTS ON

INTERCITY ENERGY USE Final Report
May 1976 108 p
(Contract NAS2-6473)
(NASA-CR-137940 ATR-76(7310)-1) Avail NTIS HC $5 50 CSCL 13F

An examination of the growth or decline in energy consumption in short haul high density intercity transportation is made in relation to changes in aeronautical technology Improvements or changes in the technology of competitive modes are also included Certain improvements in air traffic control procedures were included to determine their effectiveness in saving energy along with a fuel efficient turboprop short haul aircraft concept Author

N76-31091# Verve Research Corp Bethesda Md
FORECAST OF LANDSIDE AIRPORT ACCESS TRAFFIC AT 211 MAJOR US AIRPORTS TO 1990 VOLUME 1 THE FORECASTS Final Report
William W Ellis Naomi C Booker and Irene S Feldstein Feb 1976 243 p refs
(Contract DOT-FA74WAI-449)
(AD-A025401/1 FAA-RD-75-124-Vol-1 VR-19-5) Avail NTIS HC $8 00 CSCL 01/5

Landside airport access traffic is forecast for 211 major U S airports for 1975 1980 1985 and 1990 The 1973 traffic is estimated Aspects of access traffic fo ecast are average daily total vehicular volume peak hour volume per lane of principal access roadway congestion status modal split (including auto taxi/limousine bus rail and other) and annual access traveler volume Author

N76-31092# *Verve Research Corp Bethesda Md*
FORECAST OF LANDSIDE AIRPORT ACCESS TRAFFIC AT MAJOR US AIRPORTS TO 1990 VOLUME 2 DETAILED TECHNICAL DESCRIPTION OF FORECASTING METHODS Final Report
William W Ellis Naomi C Booker and Irene S Feldstein Feb 1976 76 p refs
(Contract DOT-FA74WAI-449)
(AD-A025246/0 VR-19-5-Vol-2 FAA-RD-75-124-Vol-2) Avail NTIS HC $5 00 CSCL 01/5

The methods used to forecast key aspects of landside access traffic are described The volume includes an overview of the work, a detailed description of the forecasting procedures a synopsis of earlier unpublished project reports and an annotated bibliography of relevant works Author

N76-31134*# National Aeronautics and Space Administration Langley Research Center Langley Station Va
AN ANALYTICAL STUDY AND WIND TUNNEL TESTS OF AN AEROMECHANICAL GUST-ALLEVIATION SYSTEM FOR A LIGHT AIRPLANE
Eric C Stewart Washington Aug 1976 82 p refs
(NASA-TN-D-8234 L-10635) Avail NTIS HC $5 00 CSCL 01C

The results of an analytical study of a system using stability derivatives determined in static wind tunnel tests of a 1/6 scale model of a popular high wing light airplane equipped with the gust alleviation system are reported The longitudinal short period mode dynamics of the system are analyzed and include the following (1) root loci (2) airplane frequency responses to vertical gusts (3) power spectra of the airplane responses in a gust spectrum (4) time history responses to vertical gusts and (5) handling characteristics The system reduces the airplane s normal acceleration response to vertical gusts while simultaneously increasing the pitching response and reducing the damping of the longitudinal short period mode The normal acceleration response can be minimized by using the proper amount of static alleviation and a fast response system with a moderate amount of damping The addition of a flap elevator interconnect or a pitch damper system further increases the alleviation while moderating the simultaneous increase in pitching response The system provides direct lift control and may reduce the stick fixed longitudinal static stability Author

N76-31144* *National Aeronautics and Space Administration*
Hugh L Dryden Flight Research Center Edwards Calif
FLIGHT TEST EXPERIENCE WITH THE F-8 DIGITAL FLY-BY-WIRE SYSTEM
Kenneth J Szalai *In its* Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 199-252 refs
CSCL 01C

Flight test results of the F-8 digital fly by wire control system are presented and the implications for application to active control technology are discussed The F-8 DFBW system has several of the attributes of proposed ACT systems so the flight test experience is helpful in assessing the capabilities of those systems Topics of discussion include the predicted and actual flight performance of the control system assessments of aircraft flying qualities and other piloting factors software management and control and operational experience Author

N76-31145* National Aeronautics and Space Administration
Hugh L Dryden Flight Research Center Edwards Calif
A PILOT'S OPINION OF THE F-8 DIGITAL FLY-BY-WIRE AIRPLANE
Gary E Krier *In its* Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 253-267 ref

CSCL 01C

The handling qualities of the F-8 digital fly by wire airplane are evaluated by using the Cooper-Harper rating scale The reasons for the ratings are given as well as a short description of the flying tasks It was concluded that the handling qualities of the airplane were good in most situations although occasional ratings of unsatisfactory were given Author

N76-31147* Lockheed Aircraft Corp Marietta Ga
HISTORICAL REVIEW OF C-5A LIFT DISTRIBUTION CONTROL SYSTEMS
T E Disney and D C Eckholdt (Wright-Patterson AFB Ohio) *In* NASA Dryden Flight Res Center Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 295-323 refs
CSCL 01C

Analytical and experimental development work on various load alleviation systems for the C-5A is reviewed to trace the development of the technical and hardware concepts to the present time Variations in system objectives means of implementation and effects on loads and airplane performance stability and control are discussed Author

N76 31148* Lockheed Aircraft Corp Marietta Ga
THE C-5A ACTIVE LIFT DISTRIBUTION CONTROL SYSTEM
William J Hargrove *In* NASA Dryden Flight Res Center Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 295-351

CSCL 01C

The ALDCS development and design tasks ALDCS functional configuration and resulting challenges encountered while accomplishing the first phase of the program are described These tasks are establishing system requirements and criteria and synthesizing a system mechanization to meet the desired load alleviation stability margins flight safety and flying qualities performance Results of the ALDCS development and prototype system flight simulation programs and control law optimization including system stability handling qualities and structural load analyses are presented along with concluding remarks relative to the system design integration Author

N76-31150* Boeing Commercial Airplane Co Seattle Wash
USE OF ACTIVE CONTROL TECHNOLOGY TO IMPROVE RIDE QUALITIES OF LARGE TRANSPORT AIRCRAFT

Gerald C Cohen Clifford J Cotter and Donald L Taylor *In* NASA Dryden Flight Res Center Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 373-407 refs
CSCL 01C

Analyses construction and flight testing of two systems Beta-vane and Modal Suppression Augmentation System (MSAS) which were developed to suppress gust induced lateral accelerations of large aircraft are described The 747 transport was used as the test vehicle The purpose of the Beta-vane system is to reduce acceleration levels at the dutch roll frequency whereas the function of the MSAS system is to reduce accelerations due to flexible body motions caused by turbulence Data from flight test with both systems engaged shows a 50 to 70 percent reduction in lateral aft body acceleration levels Furthermore it is suggested that present day techniques used for developing dynamic equations of motion in the flexible mode region are limited Author

N76-31151* Air Force Flight Dynamics Lab Wright-Patterson AFB Ohio
DECOUPLING CONTROL TECHNOLOGY FOR MEDIUM STOL TRANSPORTS
Daniel K Bird and Terry L Neighbor *In* NASA Dryden Flight Res Center Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 409-429 refs

CSCL 01C

The advanced control technology is considered that is necessary to cope with the medium STOL transport landing problem and in particular the necessity to decouple with active control techniques It is shown that the need to decouple is independent of the powered lift concept but that the provisioning for decoupling is most greatly dependent on the preassumed piloting technique The implications of decoupling and active control techniques with respect to pilot technique options handling quality criteria flight control mechanization and the use of piloted simulation as a design tool are also discussed Author

N76-31152* National Aeronautics and Space Administration Hugh L Dryden Flight Research Center Edwards Calif
POTENTIAL BENEFITS OF PROPULSION AND FLIGHT CONTROL INTEGRATION FOR SUPERSONIC CRUISE VEHICLES
Donald T Berry and William G Schweikhard *In its* Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 433-452 refs

CSCL 01C

Typical airframe/propulsion interactions such as Mach/altitude excursions and inlet unstarts are reviewed The improvements in airplane performance and flight control that can be achieved by improving the interfaces between propulsion and flight control are estimated A research program to determine the feasibility of integrating propulsion and flight control is described This program includes analytical studies and YF-12 flight tests Author

N76-31155* National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio
DESCRIPTION AND TEST RESULTS OF A DIGITAL SUPERSONIC PROPULSION SYSTEM INTEGRATED CONTROL
Peter G Batterton Dale J Arpasi and Robert J Baumbick *In its* Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 503-524 refs

CSCL 01C

A digitally implemented integrated inlet/engine control system was developed and tested on a mixed compression Mach 2 5 supersonic inlet and augmented turbofan engine The control matched engine airflow to available inlet airflow so that in steady state the shock would be at the desired location and the overboard bypass doors would be closed During engine induced transients such as augmentor lights and cutoffs the inlet operating point was momentarily changed to a more supercritical point to minimize unstarts The digital control also provided automatic inlet restart Author

N76-31158* Aeronautical Systems Div Wright-Patterson AFB Ohio
DESIGN OF A CONTROL CONFIGURED TANKER AIRCRAFT
Stephen A Walker *In* NASA Dryden Flight Res Center Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 3-35 refs
CSCL 01C

The benefits that accrue from using control configured vehicle (CCV) concepts were examined along with the techniques for applying these concepts to an advanced tanker aircraft design Reduced static stability (RSS) and flutter mode control (FMC) were the two primary CCV concepts used in the design The CCV tanker was designed to the same mission requirements specified for a conventional tanker design A seven degree of freedom mathematical model of the flexible aircraft was derived and used to synthesize a lateral stability augmentation system (SAS) a longitudinal control augmentation system (CAS) and a FMC system Fatigue life and cost analyses followed the control system synthesis after which a comparative evaluation of the CCV and conventional tankers was made This comparison indicated that the CCV weight and cost were lower but that for this design iteration the CCV fatigue life was shorter Also the CCV crew station acceleration was lower but the acceleration at the boom operator station was higher relative to the corresponding conventional tanker Comparison of the design processes used in the CCV and conventional design studies revealed that they were basically the same Author

N76-31159* National Aeronautics and Space Administration Hugh L Dryden Flight Research Center Edwards Calif
STUDY OF AN ACT DEMONSTRATOR WITH SUBSTANTIAL PERFORMANCE IMPROVEMENTS USING A REDESIGNED JETSTAR
Roy H Lange (Lockheed-Georgia Co) and Dwain A Deets *In its* Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 3-35 refs

CSCL 01C

The feasibility was studied of modifying a JetStar airplane into a demonstrator of benefits to be achieved from incorporating active control concepts in the preliminary design of transport type aircraft Substantial benefits are shown in terms of fuel economy and community noise by virtue of reduction in induced drag through use of a high aspect ratio wing which is made possible by a gust alleviation system An intermediate configuration was defined which helps to isolate the benefits produced by active controls technology from those due to other configuration variables Author

N76-31160* National Aeronautics and Space Administration Langley Research Center Langley Station Va
A SUMMARY OF THE APPLICATION OF ACTIVE CONTROLS TECHNOLOGY IN THE ATT SYSTEM STUDIES

R V Hood *In its* Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 3-35 refs

CSCL 01C

The application of active controls technology to subsonic, long-range transport aircraft was investigated in three Advanced Transport Technology system studies Relaxed stability requirements maneuver and gust load alleviation and active flutter suppression were the concepts considered A different configuration was investigated for each of the three airframe manufacturers and each had a somewhat different approach to the application of active controls technology Consequently the results varied in magnitude between the contractors but several trends were noted Relaxed stability requirements resulted in the largest benefits - reduced weight increased return on investment and decreased direct operating costs Maneuver load alleviation,

gust load alleviation and flutter suppression resulted in much smaller benefits Prior to application of active controls technology a research and development program directed toward fulfilling data base requirements establishing effective design techniques and criteria improving systems maintainability and reliability and demonstrating technology readiness must be completed Author

N76-31161* National Aeronautics and Space Administration Langley Research Center Langley Station Va
A SURVEY OF ACTIVE CONTROLS BENEFITS TO SUPERSONIC TRANSPORTS
Kermit G Pratt *In its* Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 3-35 ref

CSCL 01C
Results are drawn from studies of the impact of advanced technologies on the design of an arrow-wing configuration Information presented includes estimated benefits effects of combinations of active control concepts and constraints Emphasis is placed on characteristics that are uniquely related to a large airframe featuring a slender body with a fixed wing of low aspect ratio high sweep and small thickness ratio Author

N76-31162* Boeing Commercial Airplane Co Seattle, Wash
ESTABLISHING CONFIDENCE IN CCV/ACT TECHNOLOGY
Richard B Holloway and Henry A Shomber *In its* Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 3-35 refs
CSCL 01C
Despite significant advancements in controls configured vehicles/active controls technology (CCV/ACT) in the past decade few applications of this promising technology have appeared in recent aircraft designs The status of CCV/ACT is summarized and some of the constraints which are retarding its wider application are described Suggestions toward establishing an increased level of confidence in the technology are given Author

N76-31163* McDonnell-Douglas Astronautics Co St Louis Mo
ACTIVE CONTROL TRANSPORT DESIGN CRITERIA
Bertrand M Hall and Robert B Harris (Douglas Aircraft Co Santa Monica Calif) *In* NASA Dryden Flight Res Center Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 677-705 refs

CSCL 01C
Vehicle design considerations for active control applications to subsonic transports are examined Active control is defined along with those functions which are considered in the study of design criteria The FAA regulations governing transport aircraft design are briefly discussed Author

N76-31164* National Aeronautics and Space Administration Ames Research Center Moffett Field Calif
ADVANCED CONTROL TECHNOLOGY AND AIRWORTHINESS FLYING QUALITIES REQUIREMENTS
C Thomas Snyder *In its* Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 707-733 refs
CSCL 01C
Flying quality requirements are specified in terms of the complete pilot-airframe-systems loop the task and the environment Results from a study of flying qualities are reported A review of the treatment of failure cases in various flying quality requirements is presented along with a description of the methods used and relevant lessons learned from recent Autoland certification programs Author

N76-31165* Air Force Flight Dynamics Lab Wright-Patterson AFB Ohio
HANDLING QUALITIES REQUIREMENTS FOR CONTROL CONFIGURED VEHICLES
R J Woodcock and F L George *In* NASA Dryden Flight Res Center Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 735-746 refs

CSCL 01C
The potential effects of fly by wire and control configured vehicle concepts on flying qualities are considered Failure mode probabilities and consequences controllability and dynamics of highly augmented aircraft are among the factors discussed in terms of design criteria Author

N76-31166* Lockheed-California Co San Diego
THE F-12 SERIES AIRCRAFT APPROACH TO DESIGN FOR CONTROL SYSTEM RELIABILITY
F L Schenk and J R McMaster *In* NASA Dryden Flight Res Center Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 749-760

CSCL 01C
The F-12 series aircraft control system design philosophy is reviewed as it pertains to functional reliability The basic control system i e cables mixer feel system trim devices, and hydraulic systems are described and discussed In addition the implementation of the redundant stability augmentation system in the F-12 aircraft is described Finally the functional reliability record that has been achieved is presented Author

N76-31167* Boeing Co Wichita Kans
B-52 STABILITY AUGMENTATION SYSTEM RELIABILITY

T C Bowling and L W Key *In* NASA Dryden Flight Res Center Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 761-778 refs

CSCL 01C
The B-52 SAS (Stability Augmentation System) was developed and retrofitted to nearly 300 aircraft It actively controls B-52 structural bending provides improved yaw and pitch damping through sensors and electronic control channels and puts complete reliance on hydraulic control power for rudder and elevators The system has experienced over 300 000 flight hours and has exhibited service reliability comparable to the results of the reliability test program Development experience points out numerous lessons with potential application in the mechanization and development of advanced technology control systems of high reliability Author

N76-31169* National Aeronautics and Space Administration Hugh L Dryden Flight Research Center Edwards Calif
THE ACT TRANSPORT PANACEA FOR THE 80'S OR DESIGNER'S ILLUSION (PANEL DISCUSSION)
In its Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 805-827

CSCL 01C
A panel discussion was held which attempted to make an objective and pragmatic assessment of the standing of active control technology The discussion focused on the standing of active control technology relative to civil air transport applications the value as opposed to the cost of the projected benefits the need for research development and demonstration the role of government and industry in developing the technology the major obstacles to its implementation and the probable timing of the full utilization of active control technology in commercial transportation An edited transcription of the prepared statements of the panel members and the subsequent open discussion between the panel and the audience is presented Author

N76-31170* National Aeronautics and Space Administration Langley Research Center Langley Station Va
SOME EXPERIENCES USING WIND-TUNNEL MODELS IN ACTIVE CONTROL STUDIES
Robert V Doggett Jr Irving Abel and Charles L Ruhlin *In its* Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 831-892 refs

CSCL 14B

A status report and review of wind tunnel model experimental techniques that have been developed to study and validate the use of active control technology for the minimization of aeroelastic response are presented Modeling techniques test procedures and data analysis methods used in three model studies are described The studies include flutter mode suppression on a delta-wing model flutter mode suppression and ride quality control on a 1/30-size model of the B-52 CCV airplane and an active lift distribution control system on a 1/22 size C-5A model
Author

N76-31171* Air Force Flight Dynamics Lab Wright-Patterson AFB, Ohio
DEVELOPMENT OF METHODS FOR THE ANALYSIS AND EVALUATION OF CCV AIRCRAFT
Robert C Schwanz *In* NASA Dryden Flight Res Center Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 895-921 refs

CSCL 01C
The development of an advanced computerized method for the analysis and evaluation of the aeroelastic stability and control parameters of controls fixed and controls free flight vehicles is presented Specifically the Level 2 01 FLEXSTAB computer program system is described Technical areas in aerodynamics dynamics and control system synthesis are defined in which further research and development are planned to extend the analysis capability of the system for future CCV applications
Author

N76-31172* National Aeronautics and Space Administration Ames Research Center Moffett Field Calif
METHODOLOGY FOR DESIGN OF ACTIVE CONTROLS FOR V/STOL AIRCRAFT
George Meyer and Luigi Cicolani *In its* Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 923-931
CSCL 01C
An effort to develop techniques for the design of integrated fully automatic flight control systems for powered lift STOL and VTOL aircraft is described The structure is discussed of the control system which has been developed to deal with the strong nonlinearities inherent in this class of aircraft to admit automatic coupling with the advanced ATC requiring accurate execution of complex trajectories and to admit a variety of active control tasks The specific case considered is the Augmentor Wing Research Aircraft
Author

N76-31173* Honeywell Inc Minneapolis Minn
ACTIVE CONTROL SYSTEM TRENDS
Eugene E Yore and Dale C Gunderson *In* NASA Dryden Flight Res Center Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 933-944 refs

CSCL 01C
The active control concepts which achieve the benefit of improved mission performance and lower cost and generate system trends towards improved dynamic performance more integration and digital fly by wire mechanization are described Analytical issues and implementation requirements and tools and approaches developed to address the analytical and implementation issues are briefly discussed
Author

N76-31174* Sperry Flight Systems Phoenix Ariz
THE IMPLEMENTATION OF FAIL-OPERATIVE FUNCTIONS IN INTEGRATED DIGITAL AVIONICS SYSTEMS
Stephen S OSoer *In* NASA Dryden Flight Res Center Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 947-971
CSCL 01D
System architectures which incorporate fail operative flight guidance functions within a total integrated avionics complex are described It is shown that the mixture of flight critical and nonflight critical functions within a common computer complex is an efficient solution to the integration of navigation guidance flight control display and flight management Interfacing subsystems retain autonomous capability to avoid vulnerability to total avionics system shutdown as a result of only a few failures
Author

N76-31175* Stanford Research Inst Menlo Park Calif
A FORWARD VIEW ON RELIABLE COMPUTERS FOR FLIGHT CONTROL
Jack Goldberg and John H Wensley *In* NASA Dryden Flight Res Center Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 973-988 refs (For

(Contract NAS1-10920)
CSCL 01C
The requirements for fault-tolerant computers for flight control of commercial aircraft are examined it is concluded that the reliability requirements far exceed those typically quoted for space missions Examination of circuit technology and alternative computer architectures indicates that the desired reliability can be achieved with several different computer structures though there are obvious advantages to those that are more economic more reliable and very importantly more certifiable as to fault tolerance Progress in this field is expected to bring about better computer systems that are more rigorously designed and analyzed even though computational requirements are expected to increase significantly
Author

N76-31176* National Aeronautics and Space Administration Hugh L Dryden Flight Research Center Edwards Calif
THE EFFECTS OF LIGHTNING ON DIGITAL FLIGHT CONTROL SYSTEMS
J Anderson Plumer (GE Co) Wilbert A Malloy (General Motors Corp) and James B Craft *In its* Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 989-1008 refs
CSCL 01C
Present practices in lightning protection of aircraft deal primarily with the direct effects of lightning such as structural damage and ignition of fuel vapors There is increasing evidence of troublesome electromagnetic effects however in aircraft employing solid-state microelectronics in critical navigation instrumentation and control functions The potential impact of these indirect effects on critical systems such as digital fly by wire (DFBW) flight controls was studied The results indicate a need for positive steps to be taken during the design of future fly by wire systems to minimize the possibility of hazardous effects from lightning
Author

N76-31177* Boeing Commercial Airplane Co Seattle Wash
REDUNDANCY OF HYDRAULIC FLIGHT CONTROL ACTUATORS
C C Chenoweth and D R Ryder *In* NASA Dryden Flight Res Center Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 1009-1018 refs

CSCL 01C
The constraint of requiring airplanes to have inherent aerodynamic stability can be removed by using active control systems The resulting airplane requires control system reliability approaching that of the basic airframe Redundant control actuators can be used to achieve the required reliability but create mechanization and operational problems Of numerous candidate systems two different approaches to solving the problems associated with redundant actuators which appear the most likely to be used in advanced airplane control systems are described
Author

N76-31178* Lockheed-Georgia Co Marietta
ACTIVE CONTROL TECHNOLOGY AND THE USE OF MULTIPLE CONTROL SURFACES
John E Hart *In* NASA Dryden Flight Res Center Advanced Control Technol and its Potential for Future Transport Aircraft Aug 1976 p 1019-1025
CSCL 01C
Needed criteria for active control technology applications in commercial transports are lacking Criteria for redundancy

requirements believed to be consistent with certification philosophy are postulated to afford a discussion of the relative value of multiple control surfaces The control power and frequency bandpass requirements of various active control technology applications are shown to be such that multiple control surfaces offer advantages in minimizing the hydraulic or auxiliary power for the control surface actuators Author

N76-31179# Advisory Group for Aerospace Research and Development Paris (France)
AGARD HIGHLIGHTS, SEPTEMBER, 1976
Sep 1976 21 p
(AGARD-Highlights-76/2) Avail NTIS HC $3 50

Highlights of the 1976 AGARD meeting held in Paris France are presented Topics discussed were the following the control configured vehicle concept anti-flutter systems and anti-turbulence systems direct force control surfaces load reduction during maneuvers aircraft safety systems reliability and stall/spin problems of military aircraft B B

N76-31180# European Space Agency Paris (France)
LA RECHERCHE AEROSPATIALE BI-MONTHLY BULLETIN NO 1975-1
Dec 1975 115 p refs Transl into English of La Rech Aerospatiale Bull Bimestriel (Paris) no 1975-1 Jan -Feb 1975 p 1-60 Original French report available from ONERA Paris FF 30
(ESA-TT-232) Avail NTIS HC $5 50

Publications appear on the following subjects three dimensional boundary layers in a supersonic curved nozzle unsteady forces caused by tail surfaces interactions iterative method for structural dynamic characteristics branch modes method for the dynamic characteristics of a helicopter unsteady lift forces on a vibrating cylinder and compact laser velocimeter

N76-31182 European Space Agency Paris (France)
A METHOD FOR CALCULATING THE UNSTEADY FORCES CAUSED BY THE INTERACTION BETWEEN TAIL SURFACES
Yoshio Akamatsu *In its* La Rech Aerospatiale Bi-monthly Bull *No* 1975-1 (ESA-TT-232) *Dec* 1975 *p* 21-36 *refs Transl* into ENGLISH from La Rech Aerospatiale Bull Bimestriel (Paris) no 1975-1 Jan -Feb 1975 p 11-20

A program is reported for the calculation of unsteady aerodynamic forces on a set of surfaces comprising a horizontal tail plane and a vertical fin by applying the potential method The calculation method differs from conventional ones in that the normal velocity was obtained by numerical derivation of the potential calculated for the lifting surfaces and their immediate environs It permits an appreciable simplification in programming and a saving of computer time Comparison of results with those obtained by other methods shows good agreement
Author (ESA)

N76-31184 European Space Agency Paris (France)
DETERMINATION OF THE DYNAMIC CHARACTERISTICS OF A HELICOPTER BY THE BRANCH-MODES METHOD

Henri Loiseau and Jacques-Roger Nicholas *In its* La Rech Aerospatiale Bi-monthly Bull No 1975-1 (ESA-TT-232) Dec 1975 p 61-81 refs Transl into ENGLISH from La Rech Aerospatiale Bull Bimestriel (Paris) no 1975-1 Jan -Feb 1975 p 35-44

Dynamic characteristics of a helicopter structure with a moving rotor are determined by using the branch modes method The base, rotor head, and blades were from low damping homogenous materials with rigid or flexible connections having no dissipating hinge points Test conditions were such that the unsteady aerodynamic forces on the blades were either zero or negligible The mechanical properties of the model were linear and reproducible The experiments allow an estimation of the precision required to obtain correct calculation results and show the validity limits of the method if applied to an actual helicopter Author (ESA)

N76-31187# European Space Agency Paris (France)
LA RECHERCHE AEROSPATIALE BI-MONTHLY BULLETIN NO 1973-6
Jul 1976 84 p refs Transl into ENGLISH of La Rech Aerospatiale Bull Bimestriel (Paris) no 1973-6 Nov -Dec 1973 p 311-354 Original French report available from ONERA Paris FF 20
(ESA-TT-308) Avail NTIS HC $5 00

Publications appear on the following subjects linear filtering simulation of rocket trajectory and satellite attitude restitution internal noise in injector driven wind tunnels numerical analysis of vortex sheets near the leading edge of a wing three-dimensional flows in an axial turbomachine row and use of branch modes for the calculation of helicopter structural dynamic characteristics

N76-31190 European Space Agency Paris (France)
***NUMERICAL INVESTIGATION OF VORTEX SHEETS ISSUED* ALONG A SEPARATION LINE NEAR THE LEADING EDGE OF A WING**
Colmar Rehbach *In its* La Rech Aerospatiale Bi-monthly Bull No 1973-6 (ESA-TT-308) Jul 1976 p 31-42 refs Transl into ENGLISH from La Rech Aerospatiale Bull Bimestriel (Paris) no 1973-6 Nov -Dec 1973 p 325-330 Presented at the Euromech Colloq 41 on Concentrated Vortices Norwich Engl 18-21 Sep 1973

The vortex sheets formed along the separation line near the leading edge of a slender delta wing were investigated The theoretical treatment of this problem was possible for this simple form of wing and was carried out within the limits of such approximations as slender body theory and/or conical flow Yet the phenomenon of building up vortex sheets on the leading edge of airfoils is encountered by more general geometric configurations for which an analytic treatment is out of the question For these configurations an iterative method of calculation is suggested based on the replacement of the vortex sheet representing the wing and its trailing sheet by a system of concentrated line vortices The presented results are limited to plane delta wings The results are compared with those obtained by purely analytic methods and with the experiments performed with the ONERA water tunnel Author (ESA)

N76-31192 European Space Agency Paris (France)
ON THE USE OF BRANCH MODES FOR THE CALCULATION OF HELICOPTER STRUCTURAL DYNAMIC CHARACTERISTICS
Cam Thuy Tran, William Twomey and Rolland Dat *In its* La Rech Aerospatiale Bi-monthly Bull No 1973-6 (ESA-TT-308) Jul 1976 p 51-80 refs Transl into ENGLISH from La Rech Aerospatiale Bull Bimestriel (Paris) no 1973-6 Nov -Dec 1973 p 337-354 Sponsored by Soc Natl Ind Aerospatiale

The dynamic characteristics of the complete structure including fuselage and rotor are determined from the normal branch modes which characterize separately the fuselage and the blades With an appropriate choice of coordinates a set of *second order linear differential equations with constant coefficients* was obtained The solutions define natural vibration modes which vary with the blade rotational speed The results obtained on a helicopter model are in agreement with the experiments
Author (ESA)

N76-31193# Aeronautical Research Council London (England)
THE CHARACTERISTICS OF A FAMILY OF ROOFTOP AEROFOILS DESIGNED AT THEIR DRAG-RISE CONDITION IN VISCOUS, COMPRESSIBLE FLOW PART 1 DESIGN CONDITION
B G J Thompson and S W Cosby 1975 47 p refs Supersedes RAE-TR-72141-Pt-1 ARC 34-437
(CP-1320) Avail NTIS HC $4 00, HMSO £1 80 PHI

Twenty-eight members of the original family of aerofoils presented previously were redesigned using an inverse method which takes account of the major influence of the boundary layer and wake on the pressure distribution The more accurate compressibility law devised by Wilby and Lock is used Hodges results suggesting that the published family has an overoptimistic performance are confirmed The new sections have design lift coefficients which are usually lower than the original values by amounts up to 10% Their drag coefficients are higher by 0 0001 to 0 0004 but they have a wider range of attached flow in conditions of practical interest according to Stratford s method because of more realistic trailing edge pressures The drag values separation boundaries and drag-rise boundaries are presented together with tabulation of ordinates and design pressure distributions for the complete series of redesigned aerofoils The 50% rooftop sections as typical examples and the basis upon which the new designs were obtained are presented Author

N76-31194*# Scientific Translation Service Santa Barbara Calif
PRESSURE DISTRIBUTION OVER SYMMETRIC WING PROFILES FOR TRANSONIC FLOW
J C Rotta and K Oswatitsch Washington NASA Aug 1976 23 p refs Transl into ENGLISH from the book "Symposium Transsonicum Berlin Springer Verlag 1964 p 137-151
(Contract NASw-2791)
(NASA-TT-F-17201) Avail NTIS HC $3 50 CSCL 01A

Pressure distribution measurements for flows close to the speed of sound in a free jet wind tunnel come very close to those in free flow In the calculation method for the pressure distribution of two dimensional flow over wing profiles it is important that the distribution ahead and behind the shock are determined independently The position of the shock is determined by satisfying pressure change over the shock and the Betz resistance condition Author

N76-31195*# Lockheed Aircraft Corp Burbank Calif
FEASIBILITY STUDY OF INLET SHOCK STABILITY SYSTEM OF YF-12
G C Blausey D M Coleman and D S Harp 17 Nov 1972 145 p refs
(NASA-CR-134594 Sp-1964) Avail NTIS HC $6 00 CSCL 01A

The feasibility of self actuating bleed valves as a shock stabilization system in the inlet of the YF-12 is considered for vortex valves slide valves and poppet valves Analytical estimation of valve performance indicates that only the slide and poppet valves located in the inlet cowl can meet the desired steady state stabilizing flows and of the two the poppet valve is substantially faster in response to dynamic disturbances The poppet valve is therefore selected as the best shock stability system for the YF-12 inlet Author

N76-31198*# National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio
EFFECT OF SIMULATED FORWARD AIRSPEED ON SMALL-SCALE-MODEL EXTERNALLY BLOWN FLAP NOISE
Jack H Goodykoontz Robert G Dorsch and William A Olsen Washington Sep 1976 58 p refs
(NASA-TN-D-8305 E 8697) Avail NTIS HC $4 50 CSCL 01A

Noise tests were conducted on a small-scale model of an externally blown flap lift augmentation system The nozzle/wing model was subjected to external flow that simulated takeoff and landing flight velocities by placing it in a 33-centimeter-diameter free jet The results showed that external flow attenuated the noise associated with the various configurations tested The amount of attenuation depended on flap setting More attenuation occurred with a trailing-flap setting of 20 deg than with one of 60 deg Noise varied with relative velocity as a function of the trailing-flap setting and the angle from the nozzle inlet Author

N76-31202# Von Karman Inst for Fluid Dynamics Rhode-Saint-Genese (Belgium)
EDUCATION AND RESEARCH, 1956 - 1976
1975 118 p refs
Avail NTIS HC $5 50

The scope relationship with other organizations educational programs and research activities of the Von Karman Institute for Fluid Dynamics are presented Work is detailed of the main departments such as the Aeronautics/Aerospace Department (low and high speed aeronautics reentry flow studies rarefied gas dynamics) the Turbomachinery Department (axial and radial compressors pumps turbines computational methods for turbomachinery) the General and Environmental Fluid Dynamics Department (heat and mass transfer mechanics of turbulence wind effects on buildings and structures etc) and the Computational Fluid Dynamics Department (inviscid flows viscous flows and heat transfer) The instrumentation developments are also included The main technical facilities which are presently available at the Institute as well as the necessary technical support are briefly described ESA

N76-31204# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Goettingen (West Germany) Abteilung Theoretische Gasdynamik
REPRESENTATION AND CALCULATION OF FLOW PAST WINGS IN STEADY SUPERSONIC FLIGHT, BASED ON LIFT-UPWASH RELATIONS
Erich Leiter (Tech Hochschule Vienna) 26 Aug 1975 127 p refs In GERMAN ENGLISH summary Report will also be announced as translation
(DLR-FB-75-61) Avail NTIS HC $6 00 DFVLR Cologne DM 57 50

A linearized wing theory was derived from a general relation between lift- and down/upwash-distribution This equation was obtained as a solution of an initial value problem of Hadamards integration theory The known results were deduced Analytical approximations are given for the upwash-distribution In case of wings with two subsonic leading edges successive approximations and estimations of errors are made available A new subsonic-supersonic analogy is pointed out Author (ESA)

N76-31205# Royal Aircraft Establishment Farnborough (England) Aerodynamics Dept
THE PREDICTION OF HELICOPTER ROTOR HOVER PERFORMANCE USING A PRESCRIBED WAKE ANALYSIS
C Young London Aeron Res Council 1976 52 p refs Supersedes RAE-TR-74078 ARC-35652
(ARC-CP-1341 RAE-TR-74078, ARC-35652) Avail NTIS HC $4 50 HMSO £2 00 PHI

A method of calculating the performance of a helicopter rotor in the hover is presented The method combines the downwash velocity distribution induced by a contracting spiral vortex wake with strip element-momentum theory The shape of the wake takes a prescribed geometry developed from an extensive series of model tests made in the U S The predicted thrust and power is in good agreement with measurements made on model and full scale rotors provided that the airfoil data is sufficiently well defined The calculated load distribution along the blade is also compared with measurements made on Wessex helicopters The load distribution is shown to be very sensitive to a light wind but theory compares well with experiment when this effect is eliminated The hover performance predicted using only the wake induced velocity distribution is also discussed The rotor performance is shown to be too sensitive to the geometry of the wake for the method to be used as a design tool with confidence, and the mathematical representation of the wake needs improving Author (ESA)

N76-31209# New York City Transporation Administation N Y Office of the Administrator
THE OPERATION OF HOVERCRAFT IN THE NEW YORK CITY METROPOLITAN AREA VOLUME 1 A TECHNICAL EVALUATION Final Report, 2-4 Oct 1973
Feb 1975 79 p refs
(Contract DOT-PS-40282)

(PB-251234/1 DOT-TST-75-86-Vol-1) Avail NTIS HC $5 00 CSCL 13B

The technical feasibility of using air cushion vehicles (ACV) in the inland waterways of the New York City metropolitan area was evaluated This evaluation was based on 1973 tests with a Wellington Class BH 7 hovercraft along routes representing the main corridors of activity of the New York City regional waterways The hovercraft was a military configuration without weapons heavily instrumented for trial and testing for military purposes and not intended for use as a commercial vehicle During the 3-day trials data were collected on speed docking procedures fueling requirements airport access operating noise levels and operational flexibility Observations were made of performance comfort and convenience GRA

N76-31214*# Sperry Flight Systems Phoenix Ariz

A TECHNIQUE FOR GENERATING ARBITRARILY SHAPED CURVED APPROACH PATHS Final Report

Walter J McConnell Jr Washington NASA Aug 1976 60 p refs

(Contract NAS1-12365)

(NASA-CR-2734 Rept-71-0839-00-00) Avail NTIS HC $4 50 CSCL 17G

A technique for creating and using arbitrarily curved flight paths is described in conjunction with either automatic or manual guidance Operating techniques for VTOL aircraft in the terminal area environment are investigated Straight lines and elliptical segments to connect a series of data points into a continous approach path were developed Software was created to allow the generation of arbitrarily shaped altitude and speed profiles in conjunction with the lateral curved paths Author

N76-31217*# National Aeronautics and Space Administration Langley Research Center Langley Station Va

PRELIMINARY STUDY OF A VERY LARGE CATAMARAN FREIGHTER AS A DERIVATIVE OF A CURRENT WIDE-BODY AIRCRAFT

Harry H Heyson 18 Aug 1976 24 p refs

(NASA-TM-X-73940) Avail NTIS HC $3 50 CSCL 01C

The development of a very large cargo aircraft by combining in catamaran fashion two existing wide body transports was studied Advantages of this system include lighter weight and increased payload increased fuel economy and reduction in direct operating costs Author

N76-31218# Technion - Israel Inst of Tech Haifa Dept of Aeronautical Engineering

COMMENTS ON THE NOTION OF LOFT CEILING

J Shinar J Levin and A Marari May 1976 15 p refs

(TAE-283) Avail NTIS HC $3 50

The loft ceiling is defined as the highest altitude permitting vertical equilibrium in level flight This notion is briefly discussed Author

N76-31219*# National Aeronautics and Space Administration Langley Research Center Langley Station Va

SUPERSONIC TRANSPORT Patent Application

Paul L Coe Jr inventor (to NASA) Filed 27 Aug 1976 16 p

(NASA-Case-LAR-11932-1 US-Patent-Appl-SN-718244) Avail NTIS HC $3 50 CSCL 01C

Ideas were proposed to improve the design of supersonic transport aircraft These include thrust vectoring in conjunction with wing apex segments used as canard surfaces during take-off landing and low-speed flight The angle of incidence of the wing apex segments when the segments are functioning as canard surfaces is variable with respect to the aircraft angle of attack The wing apex segments furthermore form a portion of the main wing panel swept leading edge when not functioning as canard surfaces The combination of thrust vectoring and deployable wing apex segments results in increased aircraft range and improved low-speed longitudinal stability while providing acceptable take-off length capabilities NASA

N76-31220# Messerschmitt-Boelkow-Blohm G m b H Munich (West Germany) Unternehmensbereich Flugzeuge

AIRCRAFT COMPARISON DATA EXTRACT FROM AERONAUTICAL HANDBOOK, VOLUME TYPE COMPARISON [FLUGZEUG-VERGLEICHSUNTERLAGEN AUSZUG AUS LUFTFAHRTTECHNISCHEM HANDBUCH, BAND TYPENVERGLEICH]

D Fiecke Bonn DOKZENTBw 1975 104 p refs In GERMAN ENGLISH summary Sponsored by Bundesmin der Verteidigung (BMVg-FBWT-75-20) Avail NTIS HC $5 50 DOKZENTBw DM 30

An extract from the Aeronautical Handbook is presented presenting data for the F-100 aircraft and some statistical and analytical correlations These correlations show geometrical aerodynamic weight propulsion and performance data as a function of technical parameters useful for comparison purposes Author (ESA)

N76-31221# National Aerospace Lab Amsterdam (Netherlands) Flight Dynamics Div

THE DEVELOPMENT OF TRANSONIC AIRFOILS FOR *HELICOPTERS*

J W Slooff F X Wortmann (Stuttgart Univ) and J M Duhon (Bell Helicopter Co) May 1975 15 p refs Presented at the 31st Ann Natl Forum of the Am Helicopter Soc Washington May 1975

(NLR-MP-75032-U) Avail NTIS HC $3 50

Two approaches to the design of helicopter main rotor blade airfoils are presented which attempt to satisfy specific design criteria in the transonic regime The successful design of such airfoils results in significant performance improvements Examples of power required savings are discussed One of the two design approaches is a simplified three-step method to achieving shockless flow for the low lift high Mach number and the high lift moderate Mach number conditions The second method developed at the Netherlands National Aerospace Laboratory (NLR) aims at the same objectives by use of a transonic hodograph method Airfoils designed by the two methods are described and their qualities are discussed Performance of a helicopter using such airfoils is analytically determined and compared with more conventional designs Author (ESA)

N76-31222# Laboratorium fuer Betriebsfestigkeit Darmstadt (West Germany)

AN EXPERIMENTAL STUDY ABOUT THE EFFECT OF THRESHOLDS ON G ACCELERATION COUNTINGS OBTAINED FROM A MILITARY AIRPLANE

O Buxbaum and V Ladda Sep 1975 27 p refs Sponsored by Min of Defence

(LBF-TB-123/75) Avail NTIS HC $4 00

Constant g vertical accelerations of a military airplane which have been recorded continuously on magnetic tape during flight operation in two types of missions were analyzed statistically by means of a digital computer in which the different counting procedures of acceleration counting systems (fatigue meters) as used by various countries for fatigue life monitoring of aircraft were simulated The results are presented in form of cumulative frequency distributions and have been critically valued Author (ESA)

N76-31223# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt Brunswick (West Germany) Abteilung Entwurfsaerodynamik

GENERAL SURVEY OF COMPUTER-METHODS USED FOR AERODYNAMIC DESIGN IN THE FEDERAL REPUBLIC OF GERMANY

H Koerner 15 Sep 1975 64 p refs Presented at the Fluid Dyn Panel Meeting London 9 Oct 1975

(DLR-IB-151-75/13) Avail NTIS HC $4 50

The survey contains methods for transonic flow on airfoils wings and wing-fuselage combinations for aerodynamic interference in sub- and supersonic flow and for viscous interactions The methods are mainly network integral equation and hodograph methods In addition to the description some

examples are given which show the applicability of the methods Some test cases for computer methods are proposed
Author (ESA)

N76-31224# Royal Aircraft Establishment Farnborough (England) Structures Dept
A STUDY OF THERMAL FATIGUE ACCELERATION IN BOX BEAMS UNDER MECHANICAL AND THERMAL STRESS
F E Kiddle R J Kite and R F Mousley London Aeron Res Council 1976 69 p refs Supersedes RAE-TR-75039 ARC-36487
(ARC-CP-1342 RAE-TR-75039 ARC-36487) Avail NTIS HC $4 50 HMSO £2 30 PHI

In the full-scale fatigue testing of the Concorde there is a need to accumulate damage at a higher rate than in service in order to meet certification requirements One contribution to the more rapid testing of the Concorde comes from accelerating the rate of thermal fatigue damage by increasing the range of temperatures applied to the aircraft and hence increasing the associated thermal stress in each thermal cycle Tests in which thermal stresses were generated in a representative structural specimen and were adjusted to give a designed acceleration factor of 2 are described It is shown that this method of accelerating thermal damage was resonably accurate Further work is discussed which will investigate the acceleration of thermal fatigue damage under conditions more representative of Concorde in service and in the full-scale fatigue test particularly in representing times at temperature
Author (ESA)

N76-31225# Saint Louis Univ Cahokia Ill
UH-1H FLAT RATE MANUAL, VOLUME 2 Final Report, 1 Apr 1971 - 31 Dec 1973
Al Holfeldt and Bernie Perant Jul 1975 191 p
(Contract DAAJ01-72-A-0027)
(AD-A020730 USAAVSCOM-TR-76-4) Avail NTIS CSCL 01C

The purpose of this Flat Rate Manual is to provide stastical man-hour parameters for the performance of tasks involved at the Organizational Direct and General maintenance levels for the UH-1H aircraft It is intended for evaluating and predicting maintenance requirements and/or comparing the performance of an activity against a recognized standard
Author (GRA)

N76-31226# Saint Louis Univ Cahokia Ill
UH-1H FLAT RATE MANUAL, VOLUME 1 Final Report, 1 Apr 1971 - 31 Dec 1973
Al Holfeldt and Bernie Perant Jul 1975 280 p
(Contract DAAJ01-72-A-0027)
(AD-A020729 USAAVSCOM-TR-76-3) Avail NTIS CSCL 01C

For abstract see preceding accession

N76-31227# Naval Ship Research and Development Center Bethesda Md
A TECHNICAL SUMMARY OF AIR CUSHION CRAFT DEVELOPMENT
Peter J Mantle Oct 1975 369 p refs
(AD-A022583 DTNSRDC-4727) Avail NTIS CSCL 13/10

A brief review is given of the technical status of the state-of-the-art in air cushion craft as it exists today The designation air cushion craft is all encompassing in that it covers all craft operating close to the surface and relying on a cushion of air to generate significant portions of their lift It includes both the amphibious craft known as air cushion vehicles (ACV) or hovercraft and the nonamphibious craft known as surface effect ships (SES) Where applicable the technology of other special uses of the air cushion is called upon to illustrate a point
GRA

N76-31228# Air Force Flight Dynamics Lab Wright-Patterson AFB Ohio
A COMPUTER PROGRAM TO AUTOMATE A METHOD FOR PREDICTING ACOUSTICALLY INDUCED VIBRATION IN TRANSPORT AIRCRAFT
Terry Harris Jan 1976 53 p refs
(AD-A022571 AFFDL-TM-75-111-FYS) Avail NTIS CSCL 01/3

The report presents a computer program which automates a vibration prediction method Inputs to the program are estimates of fluctuating pressure levels in third-octave bands These may be either sound pressure levels from the engines or the levels of aerodynamic flow turbulence In addition for new aircraft with structures which differ appreciably from contemporary transport designs values of parameters which characterize the mass and rigidity of the new structure may be input to the program Results are printed in tables of third-octave band accelerations and optionally they may be plotted in graphical form It is intended that this technical memorandum be used in conjunction with AFFDL-TR-74-74 Appendix I as a quick and efficient prediction method for acoustically induced vibration in transport aircraft
GRA

N76-31229*# National Aeronautics and Space Administration Langley Research Center Langley Station Va
TURBULENCE INTENSITY INDICATOR Patent Application
Robert A Champine and Charles W Meissner Jr inventors (to NASA) Filed 23 Sep 1976 8 p
(NASA-Case-LAR-11833-1 US-Patent-Appl-SN-725828) Avail NTIS HC $3 50 CSCL 01D

A device for displaying to the pilot or the flight crew of an aircraft the level of turbulence due to rough air over a selected period of time is described An accelerometer is placed on the aircraft to produce signals of the motion of the aircraft due to rough air The output from the accelerometer is applied to an absolute value circuit and then to a root square circuit The output of the root mean square circuit is measured and displayed in the aircraft in view of the flight crew to give an indication of the turbulence The root mean square circuit includes means for selecting the length of the time period over which the root mean square is obtained
NASA

N76-31230*# Kanner (Leo) Associates, Redwood City Calif
THE CFM56 TURBOFAN ENGINE PROGRESS IN THE REDUCTION OF ENGINE NOISE
J P Bernard and P Raffy Washington NASA Aug 1976 37 p refs Transl into ENGLISH of conf paper from Soc Natl d Etude et de Construction de Moteurs d Aviation Paris Presented at 12th Intern Aeronautics Congr Paris 29-30 May 1975 p 1-31
(Contract NASw-2790)
(NASA-TT-F-17176) Avail NTIS HC $4 00 CSCL 21E

The CFM56 is a double-body dual flow turbofan engine (operating in separated flow and multiphase flow) with 10 tons of thrust Test facilities for examination of the aerodynamic internal and engine noise characteristics of the turbofan are described An installation for the determination of the efficacy of acoustic attenuation treatments on the engine is included Maximum engine noise is plotted as a function of thrust and noise spectra on landing approach takeoff and intermediate flight are presented
Author

N76-31232# Air Force Inst of Tech Wright-Patterson AFB Ohio School of Engineering
A CASE STUDY OF PROGRAM EVALUATION AND REVIEW TECHNIQUES AS APPLIED TO THE COMPRESSOR RESEARCH FACILITY PROGRAM M S Thesis
Charles V Thompson Dec 1975 215 p refs
(AD-A020362 GSM/SM/75D-24) Avail NTIS CSCL 21/5

The objective of this document is to provide a description of CRF PERT and its advantages and disadvantages in order that a program office wishing to use a PERT system will have adequate decision-making information on CRF PERT available to it Also included in the thesis is a cost analysis of the system a section describing the perceptions of Air Force PERT users towards CRF (Compressor Research Facility) PERT and a suggested user methodology for the system
GRA

N76-31233# Forschungsinstitut fuer Anthropotechnik Meckenheim (West Germany)
PROBLEMS AND METHODS IN EVALUATING FORCE STEERING AND OTHER FLIGHT CONTROL MODES A STUDY AND AN EXPERIMENTAL DESIGN
F D Pitrella Dec 1974 82 p refs
(FB-20) Avail NTIS HC $5 00 Forschungsinst fuer Anthropotech Meckenheim West Ger DM 10

To provide guidance for an experimental program a new aircraft control method variously called control wheel and force steering control and similar to automanual control is described This control method permits pilots to remain in the active control loop during automatic landings and to make inputs without disengaging the autopilot by combining pilot and automatic inputs The study s end product is a preliminary experimental design for a well controlled experiment using a fixed-base flight simulator to evaluate force steering control and learn ways to optimize it The study concerns a range of research measurement simulation, and aircraft control problems relevant to experimental design questions Some topics covered are the nature of force steering control previous force steering research the aircraft landing problem the required degree and fidelity of simulation realism performance measurement problems adaptive measurement control of variable etc Author (ESA)

N76-31234# Royal Aircraft Establishment Bedford (England) Aero/Flight Dept
A PILOTED FLIGHT SIMULATION OF THE WESTLAND LYNX
T Wilcock London Aeron Res Council 1976 93 p refs Supersedes RAE-TR-74099, ARC-36079
(ARC-CP-1343 RAE-TR-74099 ARC-36079) Avail NTIS HC $5 00 HMSO £2 90 PHI

A simulation of the Westland WG 13 Lynx helicopter was carried out using the pilot flight simulator of the Aerodynamics Flight Division Royal Aircraft Establishment Bedford in order to predict the flight handling features of this helicopter to identify possible problem areas and to investigate where appropriate solutions to these problems The simulation conducted in conjunction with Westland Helicopters Ltd took place about five months before the first flight of the Lynx Handling features of the helicopter were investigated including the benefits obtained by stabilization using duplex lanes and the problems associated with runaways of the autostabilization equipment A brief qualitative comparison of the simulator results with results of flight tests on the actual Lynx was made and areas of effective simulation identified The need for improved simulator motion and visual cues for certain phases of simulated helicopter flight is noted Author (ESA)

N76-31236# Toronto Univ (Ontario) Inst for Aerospace Studies
DEVELOPMENT AND TESTING OF A FIXED-BASE HOVERCRAFT SUMULATOR
Andrew J Fraser Dec 1975 48 p refs Sponsored by the Canadian Defence Research Board
(UTIAS-TN-197 CN-ISSN-0082-5263) Avail NTIS HC $4 00

Electrical measurements of control position at the pilot s work station are fed to an analog computer where the equations of motion of the vehicle under study are programmed The outputs from the analog computer -- vehicle position orientation and speed -- are fed to a digital computer via an analog to digital converter The digital computer then generates in proper orientation and perspective a wire-frame image of a road lined with telephone poles and displays it on a cathode ray tube As the vehicle moves forward the poles move towards the operator and off the CRT or front window They are then picked up and displayed in their correct position on peripheral displays or side windows In order to assess the effectiveness of the peripheral units, an automobile simulation was programmed and a tracking task carried out When tested to the 95% confidence level the 8-1/2% improvement in tracking performance with the peripheral units functioning was found to be significant In addition subjective comments from those involved in the test program indicated peripheral units facilitated the adjustment to the small display and made it easier to project into the task Author

N76-31298*# United Technologies Research Center East Hartford Conn
MULTI-FIBER COMPOSITES Final Report
R C Novak Apr 1976 107 p refs
(Contract NAS3-18941)
(NASA-CR-135062 R76-912098-11) Avail NTIS HC $5 50 CSCL 11D

Resin matrix composites having improved resistance to foreign object damage in gas turbine engine fan blade applications were developed Materials evaluated include epoxy matrix graphite/glass and boron/glass hybrids thermoplastic matrix boron/glass hybrids and superhybrids consisting of graphite/epoxy boron/aluminum and titanium alloy sheets Static pendulum impact and ballistic impact test results are reported for all materials Superhybrid blade like specimens are shown to be capable of withstanding relatively severe ballistic impacts from gelatin spheres without fracture The effects of ply configuration and projectile angle of incidence on impact behavior are described Predictions of surface strains during ballistic impact are presented and shown to be in reasonable agreement with experimental measurements Author

N76-31330*# National Aeronautics and Space Administration Lewis Research Center Cleveland Ohio
TWO-LAYER THERMAL BARRIER COATING FOR TURBINE AIRFOILS - FURNACE AND BURNER RIG TEST RESULTS
Stephan Stecura Washington Sep 1976 20 p refs
(NASA-TM-X-3425 E-8767) Avail NTIS HC $3 50 CSCL 11C

A simple two-layer plasma-sprayed thermal barrier coating system was developed which has the potential for protecting high temperature air-cooled gas turbine components Of those coatings initially examined the most promising system consisted of a Ni-16Cr-6Al-0 6Y (in wt%) thermal barrier coating (about 0 005 to 0 010 cm thick) and a ZrO2-12Y2O3 (in wt%) thermal barrier coating (about 0 025 to 0 064 cm thick) This thermal barrier substantially lowered the metal temperature of an air-cooled airfoil The coating withstood 3 200 cycles (80 sec at 1 280 C surface temperature) and 275 cycles (1 hr at 1 490 C surface temperature) without cracking or spalling No separation of the thermal barrier from the bond coating or the bond coating from the substrate was observed Author

N76-31333# Idaho National Engineering Lab Idaho Falls
REVIEW OF THE PHYSICAL METALLURGY OF ALLOY 718
D D Keiser and H L Brown Feb 1976 27 p refs
(Contract E(10-1)-1375)
(ANCR-1292) Avail NTIS HC $4 00

The physical metallurgy of Alloy 718 is updated to 1976 on the basis of a survey of post-1967 literature and current experimental data Composition microstructures and mechanical properties are correlated with heat treatment parameters The current state of understanding of phase stability strengthening mechanisms deformation modes recovery and recrystallization in this material is described NSA

N76-31341# National Gas Turbine Establishment, Pyestock (England)
THE EFFECTS OF SALT AND CARBON PARTICLES ON THE EROSION AND CORROSION BEHAVIOUR OF GAS TURBINE MATERIALS
J E Restall Nov 1975 38 p refs
(NGTE-R-339 BR50445) Avail NTIS HC $4 00

Turbine rotor blades withdrawn from aero and marine gas turbine engines were subjected to metallurgical examination In some cases the leading edges of the blades exhibited symptoms of an erosion/wear problem rather than failure by the anticipated sulphidation-corrosion processes Electron metallographic examination revealed the presence of graphite quartz and salt particles in varying amounts on blades withdrawn from any engine Erosion tests were performed using a whirling-arm rig at room temperature and an air-blast apparatus operating in the range from 813 to 873 K A ballistic impact apparatus was also used to implant

small particles of graphite and salt in the surface of laboratory test pieces at high temperature Ingested quartz particles less than 5 micrometers in size may induce erosion damage in the turbine section of small engines Graphite produced in the combustion chamber and dried sea-salt produce both erosion and subsequent chemical degradation at hot blade surfaces Carbon particles detected at the base of craters or corrosion warts on blades appear to be responsible for producing this mode of corrosion damage Author (ESA)

N76-31552# Air Force Inst of Tech Wright-Patterson AFB Ohio School of Engineering

EVALUATION OF F-16 SUBSYSTEM OPTIONS THROUGH THE USE OF MISSION COMPLETION SUCCESS PROBABILITY AND DESIGNING TO SYSTEM PERFORMANCE/COST MODELS M S Thesis

Allan M Doman and Alan G Dunkerley Sep 1975 258 p refs

(AD-A021263 GSM/SM/75D-13) Avail NTIS CSCL 14/4

The Mission Completion Success Probability (MCSP) and Designing to System Performance/Cost (DSPC) models developed by the Office of the Assistant for Study Support provide the program manager with a quantitative method of analysis to aid in reliability management The MCSP model calculates the probability of mission completion without an abort-causing failure of a subsystem In addition, it produces a ranking of subsystems identifying those most likely to cause aborts and performs a sensitivity analysis on non-redundant subsystems The DSPC model analyzes combinations of subsystem options to define those options which lead to a higher MCSP at lower cost Various optimal configurations are presented allowing trade-offs of MCSP for different acquisition costs logistic support costs or total costs When combined with the MCSP results the DSPC model extends the methodology for applications to life cycle cost analysis GRA

N76-31565# Technion - Israel Inst of Tech Haifa Dept of Aeronautical Engineering

EFFECT OF THE LOADING SEQUENCE AND OF OTHER FACTORS ON THE DAMAGE SUM IN FATIGUE

Alfred Buch May 1976 44 p refs

(TAE-281) Avail NTIS HC $4 00

The effect of the loading sequence on the damage sum and on the remaining fatigue life was investigated on notched aircraft material specimens in rotating-bending and tension-compression pulsating-tension and combined loading spectra A normal sequence effect was observed in the cases of rotating-bending tension-compression, and pulsating tension combined with tension-compression in a block test In all these cases the damage sum was smaller for a decreasing loading than for the corresponding increasing loading spectrum which may be explained qualitatively by the nonlinear stress-dependent damage cumulation The reversed effect (damage sum higher for decreasing than for increasing loading sequence) was observed in two-step pulsating-tension tests and may be related to the influence of compressive residual stresses The loading sequence effect was reversed for lugs and the damage sum always exceeded 1 for this component Author

N76-31566# Technion - Israel Inst of Tech Haifa Dept of Aeronautical Engineering

ESTIMATION OF FATIGUE PROPERTIES OF AIRCRAFT LUGS WITH INTERFERENCE FITS

Alfred Buch Jun 1976 36 p refs

(TAE-290) Avail NTIS HC $4 50

Fatigue tests were carried out on 2024-T3 lugs of different shapes Various methods for evaluation of the effect of interference fit were checked Size corrections net area correction factors and N = const lines were obtained for interference fit lugs Tabulated data from the tests are given Author

N76-31582# National Aerospace Lab Amsterdam (Netherlands) Div Structures and Materials

REVIEW OF AERONAUTICAL FATIGUE INVESTIGATIONS IN THE NETHERLANDS DURING THE PERIOD APRIL 1973 - MARCH 1975

J Schijve Apr 1975 55 p refs Presented at the 14th ICAF Conf Lausanne Switz 28-30 May 1975

(NLR-MP-75011-U) Avail NTIS HC $4 50

Contributions from the National Aerospace Laboratory (NLR) the Aerospace Department of the Delft University of Technology and the Fokker Aircraft Industries are reviewed The main topics include loads flight simulation testing procedures crack initiation and propagation fatigue tests on notched specimens and panels residual strength materials evaluation fractography fatigue crack growth cumulative fatigue damage F-28 VFW-614 airbus A 300 B and general investigations Author (ESA)

N76-31586# Royal Aircraft Establishment Farnborough (England)

STRESS INTENSITY FACTORS FOR CRACKS IN STIFFENED SHEETS

D P Rooke D J Cartwright and Elizabeth Davis Jul 1975 27 p refs

(RAE-TR-75072 BR48362) Avail NTIS HC $4 00

The compounding technique of obtaining approximate solutions for stress intensity factors was applied to periodically stiffened sheets containing cracks The basic compounding method requires a simple modification if the stiffener actually crosses the crack Probable errors in compounded results are shown to be small (a few percent) by comparing some compounded results with known results The stress intensity factor is calculated for a crack located asymmetrically between stiffeners Author (ESA)

N76-31591# European Space Agency Paris (France)

DESIGN FOR FATIGUE CONDITIONS

R Somoza-Soler Jun 1976 128 p refs Transl into ENGLISH of Influencia del Proyecto y Fabric en la Resistencia a la Fatiga de Estructuras y Sistemas Mecan Escuela Tec Super de Ing Ind Madrid Report TR-2-62 1962

(ESA-TT-301 TR-2-62) Avail NTIS HC $6 00

The main factors relevant to fatigue failures regarding materials fabrication and design practices are reviewed Each aspect is discussed in sufficient depth to understand the reasons for its applicability under different conditions designer The practices are summarized as a list of easy to read easy to find recommendations They are also presented in tabular form Author (ESA)

N76-31763# Utah Univ Salt Lake City

PROCEEDINGS OF THE INTERAGENCY SYMPOSIUM ON UNIVERSITY RESEARCH IN TRANSPORTATION NOISE (3RD) Final Report

14 Nov 1975 648 p refs Symp held at Salt Lake City 12-14 Nov 1975 Sponsored in part by DOD EPA and NSF

(Contract DOT-OS-50480)

(PB-252075/7 DOT/TST-76-58) Avail NTIS HC $16 25 CSCL 13B

The Symposium dealt with research in basic and applied noise problems related to transportation Papers presented cover surface transportation noise generation noise propagation and transmission community reaction combustion noise aerodynamic noise turbulence rotor noise jet noise and duct acoustics GRA

N76-31978*# Boeing Commercial Airplane Co Seattle Wash

NOISE AND STATIC PERFORMANCE CHARACTERISTICS OF A STOL AIRCRAFT JET FLAP Final Report

D L Harkonen J F McBride and J V OKeefe Dec 1974 61 p refs

(Contract NAS2-7641)

(NASA-CR-137581 D6-42312) Avail NTIS HC $4 50 CSCL 20A

Static noise and performance tests were conducted on a

1/4-scale jet flap model with a multilobe nozzle of array area ratio of 2.7. The model nozzle and flap tested were a two-dimensional section of a distributed blowing system similar to previously investigated augmentor wing systems without the upper shroud and intake door. Noise data were measured with the nozzle alone and also during attached flow conditions with the flap at two turning angles representing takeoff and approach conditions. The noise data are scaled to a 200,000-lb TOGW four-engine airplane and are presented in terms of perceived noise level and one-third octave band sound pressure level. Comparisons are made with the noise levels produced by an augmentor wing airplane fitted with a three-element acoustically lined augmentor flap. The static performance is presented in terms of thrust recovery and effective turning angle. Author

N76-32046# Institute for Defense Analyses, Arlington, Va.
OPPORTUNITIES FOR R AND D ACTION TO REDUCE ACQUISITION AND SUPPORT COSTS OF TACTICAL AIRCRAFT. VOLUME 1. SUMMARY. Final Report, Nov 1974 - Nov 1975
Donald M. Dix and John Metzko. Nov 1975. 66 p. refs.
(Contract DAHC15-73-C-0200)
(AD-A023038; IDA/HQ-75-17904-Vol-1; P-1141-Vol-1) Avail: NTIS CSCL 15/5

The objectives of this study are to relate capabilities of tactical aircraft to their acquisition and support costs and to identify opportunities for R and D action which appear to offer substantial cost reduction potential--with particular emphasis on support costs. The capabilities of tactical aircraft are defined in terms of force capability parameters, unit performance (range, specific vehicle thrust, payload, etc.), number of units, inventory value, availability, utilization, and age. A model is developed which relates these parameters to total force costs as a function of performance-related design-technology characteristics (vehicle structural weight fraction, lift/drag ratio, engine specific fuel consumption, engine specific thrust). Opportunities for R and D action are defined in terms of three decision levels: alternative implementation policies given a design, alternative designs given a system concept, and alternative concepts. The potential downstream impact on force costs and capability of R and D actions at these levels is assessed using associated parameters of the model--alternative implementation policies by means of potential changes in elements of cost, alternative designs by means of potential changes in design-technology characteristics, alternative concepts by means of potential changes in force capability parameters. The study is limited; data are largely confined to USAF fighter and attack aircraft, although a broad range of data is used; the data are unrefined; the rationale used as the basis for the model appears to explain the data but alternative explanations are not explored. GRA

N76-32060# Aeronautical Systems Div., Wright-Patterson AFB, Ohio
AERONAUTICAL ECONOMIC ESCALATION INDICES. Final Report
Bobby Jackson and Craig Lentzsch. Jul 1975. 26 p. refs.
(AD-A022795; ASD-Cost-Res-110B) Avail: NTIS CSCL 05/3

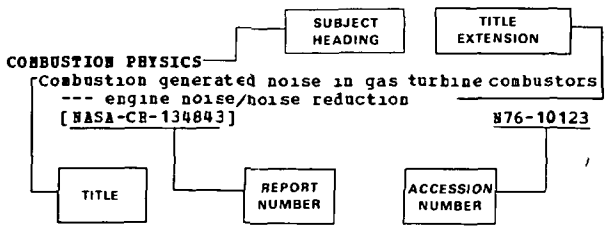
An attempt is made to forecast price level indexes of the aerospace industry taking under consideration the unprecedented inflation of 1973 - 1974 and its impact on the economic environment of the industry and the weapon acquisition process. Historical data for the years 1958-1975 were compiled to develop cost indexes for airframe, engine, and avionics. These data were projected relative to the Wharton Econometric Unit prediction of GNP deflator for years 1975-1983 to generate the forecasted indexes. Overhead was included to reflect this cost element's influence on total industry cost. Economic escalation due to inflation received the most priority and concern given the austere budgetary environment confronting the Department of Defense. Author

N76-32122 European Space Agency, Paris (France)
INTRODUCTION OF UNSTEADY SEPARATION INTO ACCELERATION POTENTIAL THEORY. APPLICATION TO HELICOPTERS
Jean-Joel Costes. *In its* La Rech. Aerospatiale, Bi-monthly Bull., No. 1975-3 (ESA-TT-307) Jul 1976. p 107-145. refs. Transl. into ENGLISH from La Rech. Aerospatiale, Bull. Bimestriel (Paris), no. 1975-3, May-Jun. 1975. p 175-188

The unsteady aerodynamic forces on a lifting surface in the presence of flow separation are predicted using a semi-empirical method. The three-dimensional effects were taken into account by means of the acceleration doublet method. The flow separation was represented by tests on a profile oscillating in a two dimensional flow. Application to a helicopter rotor yielded satisfactory results when unsteady phenomena were taken into account. Author (ESA)

SUBJECT INDEX

Typical Subject Index Listing



The title is used to provide a description of the subject matter When the title is insufficiently descriptive of the document content a title extension is added separated from the title by three hyphens The NASA or AIAA accession number is included in each entry to assist the user in locating the abstract in the abstract section of this supplement If applicable a report number is also included as an aid in identifying the document

A

B

C

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

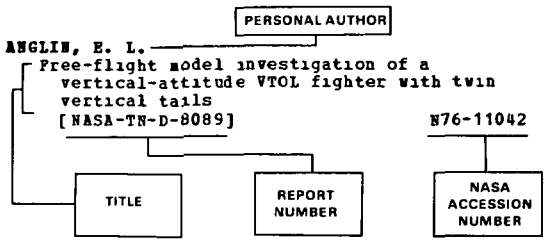
W

Y

Z

PERSONAL AUTHOR INDEX

Typical Personal Author Index Listing



Listings in this index are arranged alphabetically by personal author The title of the document provides the user with a brief description of the subject matter The report number helps to indicate the type of document cited (e g NASA report translation NASA contractor report) The accession number is located beneath and to the right of the title e g N76-11042 Under any one author s name the accession numbers are arranged in sequence with the *IAA* accession numbers appearing first

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

Y

Z

CONTRACT NUMBER INDEX

Typical Contract Number Index Listing

Listings in this index are arranged alphanumerically by contract number Under each contract number the accession numbers denoting documents that have been produced as a result of research done under that contract are arranged in ascending order with the *IAA* accession numbers appearing first The accession number denotes the number by which the citation is identified in either the *IAA* or *STAR* section

1 Report No	2 Government Accession No	3 Recipient's Catalog No
NASA SP-7037 (77)		

4 Title and Subtitle	5 Report Date
AERONAUTICAL ENGINEERING A Special Bibliography (Supplement 77)	December 1976
	6 Performing Organization Code
7 Author(s)	8 Performing Organization Report No
	10 Work Unit No
9 Performing Organization Name and Address National Aeronautics and Space Administration Washington, D. C. 20546	11 Contract or Grant No
	13 Type of Report and Period Covered
12 Sponsoring Agency Name and Address	14 Sponsoring Agency Code

15 Supplementary Notes

16 Abstract

This bibliography lists 304 reports, articles, and other documents introduced into the NASA scientific and technical information system in November 1976.

17 Key Words (Suggested by Author(s))	18 Distribution Statement
Aerodynamics Aeronautical Engineering Aeronautics Bibliographies	Unclassified - Unlimited

19 Security Classif (of this report)	20 Security Classif (of this page)	21 No of Pages	22 Price*
Unclassified	Unclassified	98	$4.00 HC

*For sale by the National Technical Information Service, Springfield, Virginia 22161

PUBLIC COLLECTIONS OF NASA DOCUMENTS

DOMESTIC

NASA distributes its technical documents and bibliographic tools to ten special libraries located in the organizations listed below Each library is prepared to furnish the public such services as reference assistance, interlibrary loans, photocopy service, and assistance in obtaining copies of NASA documents for retention

CALIFORNIA
University of California, Berkeley
COLORADO
University of Colorado, Boulder
DISTRICT OF COLUMBIA
Library of Congress
GEORGIA
Georgia Institute of Technology, Atlanta
ILLINOIS
The John Crerar Library, Chicago
MASSACHUSETTS
Massachusetts Institute of Technology, Cambridge
MISSOURI
Linda Hall Library, Kansas City
NEW YORK
Columbia University, New York
PENNSYLVANIA
Carnegie Library of Pittsburgh
WASHINGTON
University of Washington, Seattle

NASA publications (those indicated by an "*" following the accession number) are also received by the following public and free libraries

CALIFORNIA
Los Angeles Public Library
San Diego Public Library
COLORADO
Denver Public Library
CONNECTICUT
Hartford Public Library
MARYLAND
Enoch Pratt Free Library, Baltimore
MASSACHUSETTS
Boston Public Library
MICHIGAN
Detroit Public Library
MINNESOTA
Minneapolis Public Library
MISSOURI
Kansas City Public Library
St Louis Public Library
NEW JERSEY
Trenton Public Library
NEW YORK
Brooklyn Public Library
Buffalo and Erie County Public Library
Rochester Public Library
New York Public Library
OHIO
Akron Public Library
Cincinnati Public Library
Cleveland Public Library
Dayton Public Library
Toledo Public Library
OKLAHOMA
Oklahoma County Libraries, Oklahoma City
TENNESSEE
Memphis Public Library
TEXAS
Dallas Public Library
Fort Worth Public Library
WASHINGTON
Seattle Public Library
WISCONSIN
Milwaukee Public Library

An extensive collection of NASA and NASA-sponsored documents and aerospace publications available to the public for reference purposes is maintained by the American Institute of Aeronautics and Astronautics, Technical Information Service, 750 Third Avenue, New York, New York, 10017

EUROPEAN

An extensive collection of NASA and NASA-sponsored publications is maintained by the British Library Lending Division, Boston Spa, Wetherby, Yorkshire, England By virtue of arrangements other than with NASA, the British Library Lending Division also has available many of the non-NASA publications cited in *STAR* European requesters may purchase facsimile copy or microfiche of NASA and NASA-sponsored documents, those identified by both the symbols "#" and "*", from ESRO/ELDO Space Documentation Service, European Space Research Organization, 114, av Charles de Gaulle, 92-Neuilly-sur-Seine, France

NASA CONTINUING BIBLIOGRAPHY SERIES

NUMBER	TITLE	FREQUENCY
NASA SP-7011	AEROSPACE MEDICINE AND BIOLOGY Aviation medicine, space medicine, and space biology	Monthly
NASA SP-7037	AERONAUTICAL ENGINEERING Engineering, design, and operation of aircraft and aircraft components	Monthly
NASA SP-7039	NASA PATENT ABSTRACTS BIBLIOGRAPHY NASA patents and applications for patent	Semiannually
NASA SP-7041	EARTH RESOURCES Remote sensing of earth resources by aircraft and spacecraft	Quarterly
NASA SP-7043	ENERGY Energy sources, solar energy, energy conversion, transport, and storage	Quarterly
NASA SP-7500	MANAGEMENT Program, contract, and personnel management, and management techniques	Annually

Details on the availability of these publications may be obtained from:

SCIENTIFIC AND TECHNICAL INFORMATION OFFICE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Washington, D.C. 20546