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A Continuing
Bibliography
with Indexes

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AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(Supplement 197)

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 January 1986 in

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



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INTRODUCTION

This issue of *Aeronautical Engineering -- A Continuing Bibliography* (NASA SP-7037) lists 488 reports, journal articles, and other documents originally announced in January 1986 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 by the first nine *STAR* specific categories and the remaining *STAR* major categories. This arrangement offers the user the most advantageous breakdown for individual objectives. The citations include the original accession numbers from the respective announcement journals. The *IAA* items will precede the *STAR* items within each category.

Seven indexes -- subject, personal author, corporate source, foreign technology, contract number, report number, and accession number -- are included.

An annual cumulative index will be published.

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AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 197)

FEBRUARY 1986

01

AERONAUTICS (GENERAL)

A86-10148#

AGONIES OF THE LEAR FAN

R. DEMEIS Aerospace America (ISSN 0740-722X), vol. 24, Oct. 1985, p. 52-54, 56, 58, 60.

The design and attempted certification of the Lear Fan 2100 are discussed. The twin-turbine, single pusher prop aircraft, which was built with composites, is described. The costs incurred due to an effort to speed completion of a prototype resulted in new investors and work was centered on certification of the aircraft. Static and pressure testing were conducted; the problems encountered and the required redesigning are explained. The technique and composite used to build the structure are described. The FAA testing of the gearbox and the failures observed are discussed. The effects of testing full-size production structures are examined. I.F.

A86-10351

REMOTELY PILOTED VEHICLES; INTERNATIONAL CONFERENCE, 4TH, BRISTOL, ENGLAND, APRIL 9-11, 1984, PROCEEDINGS AND SUPPLEMENTARY PAPERS

Conference sponsored by the Royal Aeronautical Society and University of Bristol. Bristol, University of Bristol, 1984. Proceedings, 211 p.; Supplementary Papers, 48 p. For individual items see A86-10352 to A86-10376.

Among the topics discussed are: the operability of RPVs in bad weather; multi-mission RPV system experience; and the operational Eyrie multi-role all-weather advanced RPV system. Consideration is also given to: low cost-propulsion systems for unmanned vehicles; the aerodynamics of RPV airframes; and design standards for unmanned vehicles. Additional topics discussed include: launch and recovery systems for airborne RPVs; magnetic RPV guidance systems; and the development of a vertical gyroscope system for RPV applications. I.H.

A86-10353

UNMANNED AIRCRAFT FOR THE ROYAL AIR FORCE?

P. G. JENKINS (Logica UK, Ltd., London, England) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings. Bristol, University of Bristol, 1984, p. 2.1-2.7. refs

Some possible applications of unmanned aircraft for the Royal Air Force are discussed in connection with the state of the art of RPV design. Attention is given to the tactical advantages of operating an unmanned aircraft in a hostile battlefield environment including lower attrition; mission flexibility and lower man-hour maintenance costs. However, it is shown that shortcomings of current sensing and computing technologies continue to make manned aircraft a cheaper and more efficient alternative to military RPVs. The near term and long term uses of unmanned aircraft are described on the basis of their technological characteristics. Emphasis is given to the reconnaissance and electronic warfare roles of nonexpendable RPVs; and surveillance and target drones.

It is shown that an autonomous squadron of ground launched RPVs of equal force effectiveness as a squadron of ALCM-armed aircraft would save over \$1.6 billion over a 10 year period. I.H.

A86-10356

MULTI-MISSION RPV SYSTEM EXPERIENCES

G. R. SEEMANN, G. L. HARRIS, C. K. LAIR, and H. E. KRACHMAN (Developmental Sciences, Inc., City of Industry, CA) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings. Bristol, University of Bristol, 1984, p. 8.1-8.9.

The operational capabilities and design characteristics of a multi-role RPV system, the R4E-40 RPV, are described. The system is designed to carry a variety of telescopic and other sensors for real-time or way-point surveillance in hostile airspace. The control system of the R4E-40 consists of a three-axis autopilot coupled with quick-response servos for maximum stability in rough air. The R4E-40 can be launched by a mobile hydraulic launcher and is recoverable either by a landing ski or a cruciform parachute. Some of the payloads carried by the R4E-40 include: forward looking infrared sensors for target acquisition in low light; a panoramic film camera; and an infrared line scanner with a 120-degree cross track scan. Black and white photographs of the RPV system are provided. I.H.

A86-10357

OPERATIONAL PHILOSOPHY OF INTERNATIONAL FULL-SCALE AERIAL TARGETS

J. R. JACKSON (Sperry Flight Systems, Albuquerque, NM) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings. Bristol, University of Bristol, 1984, p. 9.1-9.9.

A program to convert obsolete aircraft for autonomous operation as target drones is described. The advantages of full scale aerial targets (FSATs) in comparison with subscale targets are considered, including: realistic threat simulation; greater payloads; and lower acquisition costs. Some safety features built into the QF-4 FSAT or the USAF are described including redundant command and control; a self-destruct system; and automatic loss-control computer routines. The sequence of events in a typical FSAT mission is shown in a diagram. I.H.

A86-10359

NOW IS THE TIME FOR REMOTELY PILOTED HELICOPTERS

R. G. AUSTIN and W. J. ALLDRIDGE (ML Aviation Co., Ltd., Bristol, England) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings. Bristol, University of Bristol, 1984, p. 11.1-11.14.

The development of small lightweight remotely piloted helicopters (RPHs) for battlefield surveillance applications is discussed. Some of the tactical advantages of small-scale RPV systems in today's dense military electronics environment are considered with emphasis given to the small radar and infrared signatures of RPHs; and their lower acquisition costs, i.e., expendability. The design characteristics of a prototype RPH system, the SPRITE, are described. The SPRITE is a dual rotor RPH which has a payload capacity of 6 kg and an endurance of about 2.5 hours per tank of fuel. The powerplant consists of two 6-bhp two-cycle engines. Electronic subsystems on the SPRITE include an on board alternator; a servomotor drive amplifier; and

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a command link airborne receiver. A photograph of the SPRITE RPH is provided. I.H.

A86-10373 AREA SEARCH RATE AND IMAGE INTERPRETER PERFORMANCE

R. S. HARVEY (Army Personnel Research Establishment, Farnborough, England) and E. M. CARVER (British Aerospace, PLC, Bristol, England) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Supplementary Papers. Bristol, University of Bristol, 1984, p. 3.1-3.10.

A study by the Army Personnel Research Establishment (APRA) and the British Aerospace Human Factors Group (BAe) to determine the limits to image interpreter target acquisition performance for diverse area search rate conditions imposed by various factors is presented. The APRE method of simulated optical imagery and the BAe method of simulated infrared linescan imagery utilized to study area search rate are explained and compared. Both photographic interpreters and civilians participated in the test and tabular and graphic presentations of the results are provided. A comparison of the two methods based on imagery effects, terrain effects, air vehicle velocity, area search rate, method of presentation, and fields of view is presented. The results revealed that higher search rates are achieved with an IR linescan than with an optical sensor. I.F.

A86-10375 TECHNOLOGY FOR MINI-RPV'S

H. WALD and V. SCHLENKRICH (Messerschmitt-Boelkow-Blohm GmbH, Bremen, West Germany) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Supplementary Papers. Bristol, University of Bristol, 1984, p. 17.1-17.13.

The design of a mini-RPV system for real-time reconnaissance and surveillance and fire control for artillery and post strike reconnaissance is discussed. The operational requirements for the mini-RPV, the composition of the platoon, and the operational sequence are explained. The design requirements and advantages of the stabilization and point unit of the mini-RPV, which is based on roll/pitch axes gimbal stabilization, are described. A block diagram of the jam resistant data link, and an explanation of the main features of the system are presented. The use of stealth technology to camouflage the radar, infrared, acoustic, and visual signals of the mini-RPV is discussed. Diagrams, charts, and photographs explaining the mini-RPV are provided. I.F.

A86-10928# LOGISTICS SUPPORTABILITY CONSIDERATIONS DURING CONCEPTUAL AND PRELIMINARY DESIGN

D. P. SCHRAGE and S. A. MEYER (Georgia Institute of Technology, Atlanta) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 9 p. (AIAA PAPER 85-3052)

Big payoffs in aircraft life cycle costs and mission effectiveness can be achieved if logistic supportability considerations are adequately addressed during conceptual and preliminary design. Logistic supportability considerations must be sensitized and traded off like other quantifiable design parameters. With current aircraft design practices this has been difficult. This paper discusses methods to address logistic supportability trade-offs. The concept formulation effort for the U.S. Army's Light Helicopter Experimental (LHX) program is used to illustrate these methods. Author

A86-10930*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

SOME COMPARISONS OF US AND USSR AIRCRAFT DESIGN DEVELOPMENTS

M. L. SPEARMAN (NASA, Langley Research Center, Hampton, VA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 15 p. refs (AIAA PAPER 85-3060)

A review is given of the design and development of some U.S. and U.S.S.R. aircraft. The emphasis is on the historical development of large aircraft - civil and military transports and bombers. Design trends are somewhat similar for the two countries and indications are that some fundamental characteristics are dictated more by ideological differences rather than technological differences. A brief description is given in a more or less chronological order of the major bomber aircraft, major civil and military transport aircraft, and the development of the air transport systems. Author

A86-10950# LHX PROGRAM OVERVIEW

R. K. ANDRESON (U.S. Army, Materiel Command, St. Louis, MO) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 5 p. (AIAA PAPER 85-4006)

The LHX helicopter concept is being developed by the U.S. Army to serve as a replacement for existing UH-1, AH-1, OH-58 and OH-6 helicopters. The LHX will incorporate state of the art technology, provide higher readiness, lower support costs and improved safety, and will function in a variety of high threat environments. Two variants are planned: scout/attack (SCAT) and light utility, both being conventional rotorcraft. Advanced avionics, sensor fusion and flight control systems will obviate the need for a copilot on the SCAT. Laser and FLIR guidance and target acquisition systems will be augmented by helmet-mounted displays, with the helmet offering chemical, biological and laser protection. The T800-XX-800 turboshaft engine contracts have been awarded, and RFPs for development of the LHX prototypes will be issued in 1986. M.S.K.

A86-10952# POST-2000 - THE MULTIMODE AIRCRAFT SYSTEM

S. A. TREMAINE (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 6 p. (AIAA PAPER 85-4015)

The multimode aircraft system concept and its potential use are examined. Some of the requirements necessary for future weapons systems are described. These weapon systems will be specialized, complex, and expensive; therefore, the design of an inexpensive aeronautical system which can perform more than one specific, specialized mission is needed. Examples of aircraft which have been designed for growth and operational improvements are provided. The difficulty in designing a multimode system and the positive and negative aspects of the development of this system are discussed. Examples of aircraft designed for modularization are presented. I.F.

A86-11602*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

FUTURE DIRECTIONS IN AEROPROPULSION TECHNOLOGY

N. T. SAUNDERS and A. J. GLASSMAN (NASA, Lewis Research Center, Cleveland, OH) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 3-22. Previously announced in STAR as N85-23685.

Future directions in aeropropulsion technology that have been identified in a series of studies recently sponsored by the U.S. Government are discussed. Advanced vehicle concepts that could become possible by the turn of the century are presented along with some of their projected capabilities. Key building-block

propulsion technologies that will contribute to making these vehicle concepts a reality are discussed along with projections of their status by the year 2000. Some pertinent highlights of the NASA aeropropulsion program are included in the discussion. Author

A86-11647#
THE HISTORY AND FORESEEABLE DEVELOPMENTS IN RECIPROCATING ENGINES FOR AIRCRAFT

C. M. EHRESMAN (Purdue University, West Lafayette, IN) and R. L. SPENCER (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 408-412. refs

A review of engine development for aircraft is presented. The major advances incorporated into engine designs from 1903 to the present are described. A chart explaining engine performance based on horse power, specific power, specific output, and specific fuel consumption is provided. The areas where further research is required, particularly in reducing fuel consumption and using alternative fuels, are examined and proposed designs are discussed. I.F.

A86-11872
REPAIR OF AIR-COOLED TURBINE VANES OF HIGH-PERFORMANCE AIRCRAFT ENGINES - PROBLEMS AND EXPERIENCE

P. BRAUNY, M. HAMMERSCHMIDT, and M. MALIK (Deutsche Lufthansa AG, Hamburg, West Germany) Materials Science and Technology (ISSN 0267-0836), vol. 1, Sept. 1985, p. 719-727. refs

Air-cooled turbine vanes made from nickel- and cobalt-base superalloys undergo distortion, cracking, burning, and material degradation in operation. The complex geometry of the parts and the compositional and microstructural heterogeneity of cast alloys impose limitations on the selection of repair methods. Selective chemical stripping of the diffusion coatings; elimination of cracks and restoration of dimensions by joining processes involving both welding and brazing techniques; and formation of coatings by pack cementation are the major processes employed. These processes may give rise to defects that significantly diminish the integrity of the parts. Author

A86-12296
HUMAN-POWERED FLIGHT

M. DRELA (Institute for Defense Analyses, Alexandria, VA) and J. S. LANGFORD Scientific American (ISSN 0036-8733), vol. 253, Nov. 1985, p. 144-151.

For many centuries, people have dreamed of human flight. These dreams were concerned with flight in which the flier would provide the power, as a bird does. Yet only in the past 25 years has a human-powered aircraft been developed. In 1977, a prize related to the achievement of human-powered flight was finally won by flying the Gossamer Condor around a one-mile, figure-eight course exclusively under human power. In June 1979, a similar aircraft was pedaled across the English Channel. Details concerning three generations of human-powered aircraft are discussed along with the special characteristics which distinguish aircraft for human-powered flight from other aircraft. Attention is also given to a utilization of the technology, developed for human-powered aircraft, in other application areas. G.R.

N86-10001# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ACTA AERONAUTICA ET ASTRONAUTICA SINICA (SELECTED ARTICLES)

4 Oct. 1984 64 p refs Transl. into ENGLISH from Hangkong Xuebao (China), v. 4, no. 4, 1983 p 1-19, 11-19; 39-47; 101-104 (AD-A147304; FTD-ID(RS)T-1120-84) Avail: NTIS HC A04/MF A01 CSCL 01B

Research in aeronautics and astronautics in China is discussed. Some areas of research are: (1) approximation method for transonic flow over swept wings; (2) shock turbulent interaction over a compression corner for supersonic flow; (3) optimum design of an

aircraft wing; and (4) a simple estimation method for two phase flow in a nozzle of rocket ramjet engine.

N86-10006# Information Spectrum, Inc., Arlington, Va.
F-16X MSIP (MULTI-NATIONAL STAGED IMPROVEMENT PROGRAM) CASE EXAMPLE: OPERATING AND SUPPORT COST ESTIMATION USING VAMOSC (VISIBILITY AND MANAGEMENT OF OPERATING AND SUPPORT COSTS) Final Technical Report

W. C. REDEEN 17 Aug. 1984 71 p
 (Contract F33600-82-C-0543)
 (AD-A156893; ISI-V-4859-02) Avail: NTIS HC A04/MF A01 CSCL 05A

This case example of a hypothetical F-16X MSIP (Multi-National Staged Improvement Program) Operating and Support (O&S) cost estimate, sponsored by AFLC/MM (VAMOSC), has been prepared to demonstrate and test the capability of the Air Force Visibility and Management of Operating and Support Costs (VAMOSC) system to provide unique and detailed experience data suitable for credible and explicit O&S cost estimation for advanced Air Force aircraft systems and subsystems. The specific objective of this effort is: To produce a case example of VAMOSC applicability to O&S cost estimation which conforms to the following conditions: Is compatible with OSD/CAIG and USAF costing guidance. Is linkable to reported experience data for existing aircraft. Provided a VAMOSC-Supported Methodology which can be utilized to predict the impact of configuration changes on system O&S costs. Depicts a methodology which is applicable to O&S costing for any aircraft system in advanced conceptual development. Provides estimates which are verifiable by tests. Identifies areas of VAMOSC requiring enhancement or modification to improve system integrity and applicability. GRA

N86-10007# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THREE ARTICLES ON NEW CALCULATION METHODS IN AERONAUTICS (SELECTED ARTICLES)

17 Aug. 1984 55 p refs Transl. into ENGLISH from Hangkong Xuebao (China), v. 4, no. 3, Sep. 1983 p 1-18, 56-62, and 102-104
 (AD-A145745; FTD-ID(RS)T-0910-84) Avail: NTIS HC A04/MF A01 CSCL 01B

Selected research topics are investigated in search of new calculation methods for aeronautics. Numerical solutions are sought for calculating hypersonic flow and unsteady supersonic aerodynamic forces. Methods for determining aerodynamic coefficients are discussed. Selected highlights of the third conference of the Aeronautical Society of China are also discussed. Shear layer effects on the stability of an axisymmetrical external compression air intake are investigated.

N86-11147# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).

AERODYNAMICS AND ACOUSTICS OF PROPELLERS

Loughton, England Feb. 1985 458 p refs In ENGLISH and FRENCH Symp. held in Toronto, 1-4 Oct. 1984 (AGARD-CP-366; ISBN-92-835-0374-0) Avail: NTIS HC A20/MF A01

A state of the art review of the aerodynamic design and testing of modern propellers, acoustic and vibration environmental problems and their solutions, and considerations in the integration of the propeller(s) and airframe is presented. Propellers have recently become a focus of attention after having been neglected for many years. The efficient use of propellers as a propulsion medium up to Mach 0.6 was realized at the expense of high noise and vibration. Since the mid-1970s there have been many developments, including the propfan, with an aerodynamic efficiency of 80% at Mach 0.8 now seriously challenges the fanjet. The advent of the supercritical airfoil is another significant development beginning to influence propeller design.

01 AERONAUTICS (GENERAL)

N86-11178# Joint Publications Research Service, Arlington, Va.
DEPUTY MINISTER ON SECTOR'S TECHNICAL PROGRESS
I. Y. MASHKIVSKIY *In its USSR Rept.: Transportation*
(JPRS-UTR-85-011) p 1-6 7 Oct. 1985 Transl. into ENGLISH
from *Grazhdanskaya Aviats. (Moscow)*, no. 4, Apr. 1985 p 2-3
Avail: NTIS HC A06

Measures to accelerate the U.S.S.R.'s scientific and technical progress in the area of civil aviation are discussed. The development of more economical and efficient modifications of airplanes, helicopters, and engines to replace outdated models is described. The increased use of automated diagnostic equipment for aircraft maintenance is highlighted. B.W.

02

AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

A86-10021#
SUPERSONIC WIND TUNNEL SIMULATION OF PROPULSIVE JETS

R. A. WHITE (Illinois, University, Urbana), J. AGRELL (Flygtekniska Forsoksanstalten, Bromma, Sweden), and S.-E. NYBERG *Journal of Spacecraft and Rockets (ISSN 0022-4650)*, vol. 22, Sept.-Oct. 1985, p. 530-535. Research supported by the Flygtekniska Forsoksanstalten. refs
(Contract DAJA37-81-C-1213; DAAG29-79-C-0184)

This paper describes improvements in a modeling methodology for congruent plumes produced from nonideal nozzle flows and a series of verification tests including complex afterbody and wake flows caused by angle of attack and afterbody-mounted control fins at incidence. The results show that the modeling methodology gives good agreement for the base pressure and separation location for stagnation pressure ratios of + or 25 percent from the design condition, for angles of attack as high as + or - 20 deg, and with the effects of control fins deflected + or - 10 deg in conjunction with angle of attack of + or - 6 deg. A small but systematic difference between the prototype and model results is evident, and a possible explanation is offered. Author

A86-10268* George Washington Univ., Washington, D.C.
COMPARISON OF UNIFORM PERTURBATION AND NUMERICAL SOLUTIONS FOR SOME POTENTIAL FLOWS PAST SLENDER BODIES

T.-C. WONG (George Washington University, Washington, DC), C. H. LIU (NASA, Langley Research Center, Hampton, VA), and J. GEER (New York, State University, Binghamton) *Computers and Fluids (ISSN 0045-7930)*, vol. 13, no. 3, 1985, p. 271-283. Previously announced in STAR as N85-14799. refs
(Contract NAS1-14605; NAS1-17070)

Approximate solutions for potential flow past an axisymmetric slender body and past a thin airfoil are calculated using a uniform perturbation method and then compared with either the exact analytical solution or the solution obtained using a purely numerical method. The perturbation method is based upon a representation of the disturbance flow as the superposition of singularities distributed entirely within the body, while the numerical (panel) method is based upon a distribution of singularities on the surface of the body. It is found that the perturbation method provides very good results for small values of the slenderness ratio and for small angles of attack. Moreover, for comparable accuracy, the perturbation method is simpler to implement, requires less computer memory, and generally uses less computation time than the panel method. In particular, the uniform perturbation method yields good resolution near the regions of the leading and trailing edges where other methods fail or require special attention. Author

A86-10269* Grumman Aerospace Corp., Bethpage, N.Y.
SOLUTION OF VISCOUS TRANSONIC FLOW OVER WINGS
R. R. CHOW (Grumman Aerospace Corp., Bethpage, NY)
Computers and Fluids (ISSN 0045-7930), vol. 13, no. 3, 1985, p. 285-317. refs
(Contract NAS1-16858)

Since the calculations of plane steady transonic flows conducted by Murman and Cole (1971), steady progress has been made with respect to the computation of inviscid transonic flows. It has been found that it is inadequate to consider practical wing design at transonic speeds without considering the effects of viscosity and turbulence. The present study has the objective to develop a zonal method for viscous transonic flow over three-dimensional (3-D) wings. The employed approach follows closely the viscous/inviscid interaction techniques discussed by Melnik et al. (1983) for viscous flow about airfoils. Attention is given to inviscid flow equations and boundary conditions, the solution of 3-D boundary layer and wake, an iterative solution to viscid-inviscid interaction analysis, and results obtained for a transonic cruise wing of transport type. G.R.

A86-10270
SHOCK FITTING IN CONICAL SUPERSONIC FULL POTENTIAL FLOWS

M. J. SICLARI (Grumman Aerospace Corp., Bethpage, NY) and M. VISICH *Computers and Fluids (ISSN 0045-7930)*, vol. 13, no. 3, 1985, p. 319-335. refs

The full potential equation is solved implicitly for supersonic conical flows with the bow shock fitted as an external boundary. Existing potential flow computational procedures capture the embedded crossflow shock within the context of transonic relaxation schemes. In this study, the crossflow shock is fitted for the first time in potential flow as an internal boundary. Hence, all shocks are implicitly fit making the computation fully conservative. For thin elliptic cones, the outer segment of the crossflow shock was found to be oblique to the incoming or supersonic crossflow. This behavior was not found for circular cones. The shock fitted solutions are compared to both Euler and potential captured solutions. The full potential shock fitted results are in favorable agreement with conservative captured solutions. Author

A86-10271
ENTROPY CORRECTIONS TO SUPERSONIC CONICAL NONLINEAR POTENTIAL FLOWS

M. J. SICLARI and A. RUBEL (Grumman Aerospace Corp., Bethpage, NY) *Computers and Fluids (ISSN 0045-7930)*, vol. 13, no. 3, 1985, p. 337-359. refs

Entropy corrections are applied to full potential supersonic conical flows that have the bow shock fit as a boundary. The entropy corrections require the implementation of the Rankine-Hugoniot shock relations instead of the isentropic shock conditions. In addition, the pressure must be corrected to account for the bow shock induced entropy variation. For high Mach number and/or large deflection angles, the correction to the potential pressures can be of the same order of magnitude as the Euler pressures. Considering the simplistic nature of the corrections, remarkably accurate results are achieved for circular and elliptic cones. Additional corrections account for embedded crossflow shocks. Author

A86-10363
AN EXPERIMENTAL INVESTIGATION INTO THE EFFECTS OF MODIFYING THE TRAILING EDGE GEOMETRY OF A WORTMANN FX63-137 AEROFOIL

P. M. RENDER (Cranfield Institute of Technology, England) *IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings. Bristol, University of Bristol, 1984, p. 15.1-15.13. Research supported by the Ministry of Defence (Procurement Executive).*

Wind tunnel tests were carried out to study the effects of modified trailing edge geometry on the aerodynamics of a number of FX63-137 airfoil configurations corresponding to Reynolds numbers in the range 300,000-1,000,000. One particular airfoil,

the Goettingen 797, showed reduced laminar separation due to its flat lower surface configuration. A total of four alternative trailing edges having reduced undercamber and increased trailing edge thickness were tested in addition to the Goettingen airfoil. It is shown that modification of the thin trailing edge and undercamber of FX63-137 incurred only slight penalties in aerodynamic performance and actually led to improvements in the lift/drag ratio. Pressure measurements for the FX63-137 and the modified airfoil sections are provided. I.H.

A86-10480#
STUDY ON DESIGN OF A SUPERSONIC NOZZLE. I - IMPROVEMENT OF A CALCULATING METHOD FOR A FLOWFIELD OF MIXED TYPE

K. SETO, M. MATSUOKA (Saga University, Japan), and O. FUKUOKA (KYOCERA, Ltd., Kokubu, Japan) JSME, Bulletin (ISSN 0021-3764), vol. 28, July 1985, p. 1396-1400. refs

The flowfield inside a nozzle is analyzed under both upstream and downstream boundary conditions using a series expansion procedure of the velocity components. The analysis is confined to the two-dimensional case. The results are consistent with those from other authors and from experiment. C.D.

A86-10517#
EFFECT OF HINGE GAP ON AERODYNAMICS OF THIN AIRFOILS HAVING AN OSCILLATING FLAP

S. ANDO (Nagoya University, Japan) and D.-H. LEE (Ulsan Institute of Technology, Republic of Korea) ASME, Transactions, Journal of Applied Mechanics (ISSN 0021-8936), vol. 52, Sept. 1985, p. 712-717. refs

Nonsteady load distributions on a thin airfoil in inviscid incompressible flow having an oscillating flap with a narrow hinge gap are investigated. The angle of attack is assumed to be zero in front of the hinge gap. The problem is first attacked numerically through Poisson's integral equation to compare it with analytical methods derived later. The logarithmic singularity in the kernel function is treated with special care. Secondly the method of matched asymptotic expansions is used to analyze the problem. It brings forth simple closed-form expressions. Comparisons of results of the two methods show excellent agreement with each other, when gap width-to-chord ratio is less than 0.1. In addition, a simplified method is presented where no inner solution needs to be considered. It is useful for the gap/chord ratio less than 0.01. Author

A86-10658
THEORY OF LOCAL INTERACTION IN A RAREFIED GAS - VARIANT OF THE METHOD OF TANGENT CONES [TEORIYA LOKAL'NOGO VZAIMODEISTVIA V RAZREZHENNOM GAZE VARIANT METODA KASATEL'NYKH KONUSOV]

R. N. MIROSHIN Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia (ISSN 0024-0850), July 1985, p. 103-105. In Russian. refs

The aerodynamic coefficients of the frontal drag and lift of an arbitrary convex body of revolution are represented through the corresponding coefficients for sharp cones tangent to the body and having a common axis of rotation with the body. This shows that the theory of the hypersonic-aerodynamic theory of local interaction in a rarefied gas is a variant of the method of tangent cones. B.J.

A86-10729
BOUNDED FLOW PAST A SUPERCAVITATING FINITE-SPAN WING [OB OBTEKANII SUPERKAVITIRUIUSHCHEGO KRYLA KONECHNOGO RASMAKHA OGRANICHENNYM POTOKOM]

M. V. MAKASEEV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), July-Aug. 1985, p. 64-68. In Russian. refs

The problem of bounded flow past a supercavitating finite-span wing is treated numerically using the nonlinear programming approach. The numerical method proposed here makes it possible to calculate the flow from the specified cavitation number and can be easily extended to a wide class of linear supercavitation

problems that involve solving integral equations. The method is sufficiently general and accurate to be used in engineering calculations and can be readily implemented in software. V.L.

A86-10735
NONSYMMETRIC SOLUTIONS IN THE PROBLEM OF FLOW PAST A PLATE WITH A PAIR OF VORTEX-SINK COMBINATIONS [NESIMMETRICHNYE RESHENIIA V ZADACHE OBTEKANIIA PLASTINKI S PAROI VIKHRESTOKOV]

M. G. GOMAN and A. N. KHRABROV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), July-Aug. 1985, p. 181-183. In Russian. refs

Stationary flow past a plate with a pair of free attached vortex-sink combinations is analyzed for the case of normal flow incidence. The resulting flow pattern approximately corresponds to cross-section flow in the case of separated flow past a low-aspect-ratio wing at large angles of attack. It is shown that for some values of the sink intensity, solutions with a nonsymmetric arrangement of vortex-sink combinations exist along with symmetric solutions. V.L.

A86-10933#
INTEGRATED FLOWFIELD ANALYSIS METHODOLOGY FOR FIGHTER INLETS

R. R. COSNER (McDonnell Aircraft Co., St. Louis, MO) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 9 p. refs (AIAA PAPER 85-3071)

A methodology has been developed to predict viscous flow over integrated fighter forebody-inlet combinations. It includes the effects of Mach number, Reynolds number, angle of attack, and engine mass flow. The analysis is based on a relaxation solution to the steady state Navier-Stokes equations, executed on a multiple-zone mesh. The solution costs are affordable; the procedure can be executed on VAX-11/780 computers. In this paper, computed results are compared with wind tunnel data on two contemporary aircraft: the F/A-18A and the AV-8B. Author

A86-10934#
SUBSONIC DIFFUSER DESIGN AND PERFORMANCE FOR ADVANCED FIGHTER AIRCRAFT

C. C. LEE (McDonnell Aircraft Co., St. Louis, MO) and C. BOEDICKER (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 12 p. refs

(Contract F33615-82-C-3018)

(AIAA PAPER 85-3073)

McDonnell Aircraft Company (MCAIR), in conjunction with the Air Force, is conducting a study entitled 'Subsonic Diffusers For Highly Survivable Aircraft' to develop a methodology for designing short, highly offset, subsonic diffusers. The design concepts were selected and refined through analytical and experimental investigations. Test results indicate that compact diffusers can be made to yield acceptable performance by proper duct shaping and boundary layer bleed. Author

A86-10939#
NOISE FROM A CIRCULATION CONTROL WING WITH UPPER SURFACE BLOWING

M. SALIKUDDIN, W. H. BROWN, and K. K. AHUJA (Lockheed-Georgia Co., Marietta) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 12 p. Research supported by Lockheed Independent Research and Development Program. refs (AIAA PAPER 85-3083)

The work presented in this paper represents a first step in understanding and evaluating the noise characteristics of a circulation control wing with upper surface blowing (CCW/USB). It was found that high frequency noise was dominated by the effects of the circulation control jet and that low frequency noise was dominated by the effects of the upper surface blowing. The individual effects of the CCW and the USB can be superimposed

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to yield a good approximation of the resultant effect in a combined CCW/USB configuration. Author

A86-10940#

MAXIMUM CIRCULATION LIFT COEFFICIENT DEVELOPED ON A LOW ASPECT RATIO WING WITH A BLOWN FLAP

V. R. STEWART (Rockwell International Corp., Columbus, OH) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 9 p. refs (AIAA PAPER 85-3085)

The maximum circulation lift coefficient attainable on a low aspect ratio wing is discussed by comparing test results to various theoretical studies. Several theoretical predictions have been made of the maximum circulation lift coefficient. The predicted values have ranged from 1.2 times the wing aspect ratio to 1.94 times the aspect ratio. This paper briefly examines these studies and compares the results to test data. Available data from a recent test of a low aspect ratio propulsive wing/fuselage which included surface pressure instrumentation in addition to force balance measurements are analyzed to support the conclusions. Comparisons of the force and pressure data are explored to aid in the understanding of the factors limiting the circulation lift. The test results indicate that maximum circulation lift coefficients of approximately 1.9 times the aspect ratio have been obtained on the propulsive wing configuration. Author

A86-10965#

LASER DOPPLER VELOCIMETER MEASUREMENTS IN A 3-D IMPINGING TWIN-JET FOUNTAIN FLOW

K. R. SARIPALLI (McDonnell Douglas Research Laboratories, St. Louis, MO) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 14 p. Research sponsored by the McDonnell Douglas Independent Research and Development Program. refs (AIAA PAPER 85-4036)

Mean velocity and turbulence measurements were conducted on the three-dimensional fountain flow-field generated by the impingement of two axisymmetric jets on a ground plane with application to vertical-take-off and landing (VTOL) aircraft. The basic instantaneous velocity data were obtained using a two-component laser Doppler velocimeter in a plane connecting the nozzle centerlines at different heights above the ground emphasizing the jet impingement region and the fountain upwash region formed by the collision of the wall jets. The distributions of mean velocity components and turbulence quantities, including the turbulence intensity and the Reynolds shear stress, were derived from the basic velocity data. Detailed studies of the characteristics of the fountain revealed self-similarity in the mean velocity and turbulence profiles across the fountain. The spread and mean velocity decay characteristics of the fountain were established. Turbulence intensities of the order of 50 percent were observed in the fountain. Author

A86-11026#

ANALYSIS OF LEADING-EDGE VORTICES ON COMPLEX CONFIGURATIONS

J. K. NATHMAN (Analytical Methods, Inc., Redmond, WA) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 11 p. refs (AIAA PAPER 85-4054)

This paper describes the theory and application of VORSEP, a wake synthesizer for panel methods that use an iterative procedure to determine the position of strongly interacting vortex sheets. The estimation of the wake geometry is based on slender body theory with separation. An unsteady, two-dimensional airfoil program was automated with the addition of routines to interpolate cross-sectional geometry from arbitrary three-dimensional bodies, generate multi-core wakes and synthesize a three-dimensional wake structure. The method is applied to the leading-edge separation on delta and double-delta wings, the strake vortex of an STOL fighter, and the A-pillar separation on an automobile. Comparison with experimental data show results with the estimated wakes are physically more realistic than attached flow calculations

and would be a suitable starting point for a three-dimensional iterative solution. In some cases, no improvement in the solution is required. Author

A86-11027*# North Carolina State Univ., Raleigh.

AN EXPERIMENTAL INVESTIGATION OF APEX FENCE FLAPS ON DELTA WINGS

R. J. VESS (North Carolina State University, Raleigh), R. A. WAHLS, and C. A. MOSKOVITZ AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 11 p. refs (Contract NCC1-46) (AIAA PAPER 85-4055)

The effects on leading edge vortex formation produced by apex fences mounted on two delta wings were examined in a subsonic wind tunnel. Pressure data were collected on the upper surface of the test wings and oil flow and bubble flow visualizations were performed. The deflections studied were 74, 90 and 65 deg in one-sided and two-sided configurations. Full span and semi-span delta wing planforms were used. Relatively small, symmetrically deployed apex fences provided enhanced upper surface suction which, in some angle-of-attack situations, could lead to a pitch-up force. Asymmetrically-deployed fences showed promise for yaw control at high angles of attack, although the force effectiveness has yet to be quantified. M.S.K.

A86-11028#

A UNIQUE APPLIED COMPUTATIONAL METHOD FOR VORTEX LIFT AERODYNAMICS AND VORTEX BURST FOR ARBITRARY AIRCRAFT

C. J. DIXON and G. T. DRISKILL (Lockheed-Georgia Co., Marietta) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 19 p. refs (AIAA PAPER 85-4057)

This paper describes a unique method to predict the aerodynamic forces on a variety of aircraft configurations employing leading edge vortex lift. A rigorous two-dimensional solution of a combined free leading edge vortex and sink on a flat plate airfoil has been combined with a three-dimensional vortex lattice method to predict the loads and moments on the configuration and the boundary conditions for the free vortex. With these boundary conditions, the analysis includes the effects of transition of the vortex core from laminar to turbulent and subsequent burst. Two breakdown criteria are required to analyze configurations with a wide range of leading edge sweep. Reynolds number is shown to have large effects at the low values typical of smoke tunnels and water channels. Experimental data are compared with theory, showing excellent agreement prior to vortex breakdown and good agreement after breakdown. Author

A86-11029#

AN EFFICIENT METHOD FOR COMPUTING UNSTEADY TRANSONIC AERODYNAMICS OF SWEEPED WINGS WITH CONTROL SURFACES

D. D. LIU (Arizona State University, Tempe), K. Y. FUNG (Arizona University, Tucson), and Y. F. KAO AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 17 p. Navy-supported research. refs (AIAA PAPER 85-4058)

A transonic equivalent strip (TES) method has been further developed for unsteady flow computations of arbitrary wing planforms. The TES method consists of two consecutive correction steps to a given nonlinear code such as LTRAN2; namely, the chordwise mean-flow correction and the spanwise phase correction. The computation procedure requires direct pressure input from either computed or measured data. Otherwise, it does not require airfoil shape or grid-generation for given planforms. To validate the computed results, four swept, tapered wings of various aspect ratios, including those with control surfaces, are selected as computational examples. Overall trends in unsteady pressures are established with those obtained by XTRAN3S codes, Isogai's full potential code and measured data by NLR and RAE. In comparison with these methods, the TES has achieved considerable saving in

computer time and reasonable accuracy which suggests immediate industrial applications. Author

A86-11030#
SUBSONIC/SUPERSONIC LINEAR UNSTEADY ANALYSIS

W. CLEVER (Rockwell International Corp., Los Angeles, CA) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 12 p.
(AIAA PAPER 85-4059)

Using an expansion in powers of reduced frequency, a linearized unsteady panel formulation is developed which is valid for both subsonic and supersonic Mach numbers. With this formulation a numerical pilot code was developed, using chord plane singularities, to analyze relatively general three-dimensional geometries for a wide range of oscillation frequencies. A constant value of unsteady Delta Cp across each panel eliminates the problem of singularities associated with control points near Mach cones emanating from panel corners, and from singularities associated with panels having sonic edges. Results from the computations indicate good agreement with a doublet lattice analysis at subsonic Mach numbers, for a nonplanar oblique wing configuration, and with an exact solution at supersonic speeds for a 60 degree delta wing. All integrations are done exactly in closed form and the technique may be expanded to more general panels of the Pan-Air type.

Author

A86-11031#
FULL POTENTIAL AND EULER SOLUTIONS FOR THE UNSTEADY TRANSONIC FLOW PAST A FIGHTER WING

L. N. SANKAR (Georgia Institute of Technology, Atlanta), J. B. MALONE, and D. SCHUSTER (Lockheed-Georgia Co., Marietta) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 13 p. Research supported by the Lockheed-Georgia Independent Research and Development Program. refs
(AIAA PAPER 85-4061)

The problem of steady and unsteady transonic flow over modern fighter wing configurations has been addressed using two solution procedures. In the first procedure, the three-dimensional unsteady full potential equation is solved in a body-fitted coordinate system using a Strongly Implicit Procedure (SIP). In the second approach, the unsteady Euler equations are solved using a stable, hybrid numerical scheme. A number of steady and unsteady calculations are presented for a F-5 fighter wing configuration and compared with experiments.

Author

A86-11032#
UNSTEADY FULL POTENTIAL CALCULATIONS FOR COMPLEX WING-BODY CONFIGURATIONS

J. B. MALONE (Lockheed-Georgia Co., Marietta) and L. N. SANKAR (Georgia Institute of Technology, Atlanta) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 15 p. refs
(AIAA PAPER 85-4062)

A solution procedure is described for solving the unsteady transonic full potential equation for wing-body configurations undergoing arbitrary motions. This procedure is an extension of a previously published solution technique for unsteady transonic flow past wing-alone configurations. Numerical results are presented for a variety of configurations in both steady and unsteady subsonic and transonic flow conditions. Where possible, the theoretical predictions are compared with experimental data.

Author

A86-11033#
AERODYNAMIC BUGS - CAN CFD SPRAY THEM AWAY?

R. S. SHEVELL (Stanford University, CA) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 12 p. refs
(AIAA PAPER 85-4067)

The potential for CFD techniques for eliminating aerodynamic problems in the design stage of subsonic transport aircraft is assessed. Conventional, non-CFD mathematical tools cannot accurately predict performance at stall speeds and high angles of

attack, i.e., situations encountered at take-off, landing and shocked separated flow conditions. CFD allows the numerical study of previously inaccessible flight regimes, and rapid focusing on the individual effects surrounding external aircraft components. However, understanding of the fundamental flow physics will always be a cornerstone to applied aerodynamics, but is not necessarily a part of CFD, which is therefore a validation tool for designer calculations. Techniques for the fruitful interaction of the two methods are illustrated by tracing the evolution of the DC-8 airfoils to the DC-10 airfoils.

M.S.K.

A86-11037#
AERODYNAMIC TRADEOFF STUDY OF CONVENTIONAL, CANARD, AND TRI-SURFACE AIRCRAFT SYSTEMS

B. P. SELBERG and K. ROKHSAN (Missouri-Rolla, University, Rolla) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 11 p. refs
(AIAA PAPER 85-4071)

Conventional, canard, and three-surface aircraft configurations are investigated analytically to determine each configuration's induced and viscous drag under trimmed conditions. A three-surface vortex lattice method is used to trim the aircraft as well as to predict the induced drag of each configuration. A vortex panel method, in conjunction with a momentum integral boundary layer method, is used to predict inviscid and viscous characteristics. Parameters varied included wing to stabilator surface area ratio, static margin, canard to tail loading ratio, and total lift coefficient trim. For all parameters considered the conventional configuration had the highest total lift coefficient trim/induced drag coefficient. At the lower stabilator aspect ratios the conventional's total lift coefficient trim/total drag coefficient was the highest whereas for the highest stabilator aspect ratio considered the canard configuration had the highest total lift coefficient trim/total drag coefficient. The tri-surface was superior to the canard at the lower aspect ratio, with the canard becoming superior at the higher values.

Author

A86-11038*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

IMPACT OF AIRFOIL PROFILE ON THE SUPERSONIC AERODYNAMICS OF DELTA WINGS

R. M. WOOD and D. S. MILLER (NASA, Langley Research Center, Hampton, VA) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 13 p. refs
(AIAA PAPER 85-4073)

A nonlinear flow model was employed to predict the flowfield, pressure and force data for delta wings at supersonic speeds. The goal of the study was to investigate the influence the airfoil profiles has on the wing aerodynamics. The analysis covers wing aspect ratios from 0.5-3.0 with leading edge sweep of 0.5-4.0 on diamond, circular arc and NACA modified 4-digit airfoils. Nonlinear aerodynamics are approximated with nonlinear zero-lift wave drag curves, yielding results significantly different from those obtained from linear calculations. The analytical technique, useful in preliminary design studies, indicates in all cases that 90 percent of wave drag is generated at the wing apex and trailing edge.

M.S.K.

A86-11039*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

COMPUTATIONAL WING DESIGN IN SUPPORT OF AN NLF VARIABLE SWEEP TRANSITION FLIGHT EXPERIMENT

E. G. WAGGONER, R. L. CAMPBELL, and P. S. PHILLIPS (NASA, Langley Research Center, Hampton, VA) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 11 p. refs
(AIAA PAPER 85-4074)

A natural laminar flow outer panel wing glove has been designed for a variable sweep fighter aircraft using state-of-the-art computational techniques. Testing of the design will yield wing pressure and boundary-layer data under actual flight conditions and environment. These data will be used to enhance the understanding of the interaction between crossflow and

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Tollmien-Schlichting disturbances on boundary-layer transition. The outer wing panel was contoured such that a wide range of favorable pressure gradients could be obtained on the wing upper surface. Extensive computations were performed to support the design effort which relied on two- and three-dimensional transonic design and analysis techniques. A detailed description of the design procedure that evolved during this study is presented. Results on intermediate designs at various stages in the design process demonstrate how the various physical and aerodynamic constraints were integrated into the design. Final results of the glove design analyzed as part of the complete aircraft configuration with a full-potential wing/body analysis code indicate that the aerodynamic design objectives were met. Author

A86-11040#

A DIRECT-INVERSE TRANSONIC WING DESIGN-ANALYSIS METHOD WITH VISCOUS INTERACTIONS

L. A. CARLSON (Texas A & M University, College Station) and R. A. WEED (Lockheed-Georgia Co., Marietta) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 12 p. Research supported by the Texas A & M Research Foundation and Lockheed-Georgia Co. refs (Contract N0167-81-C-0078-P00004) (AIAA PAPER 85-4075)

A direct-inverse transonic wing design method which includes the effects of viscous interaction due to a turbulent boundary layer is presented. The method is based upon the fully conservative ZEBRA II transonic potential flow algorithm, uses a Cartesian-like grid system, and includes automatic relifting to control the amount of trailing edge thickness at each design station. Viscous interaction is included by a two-dimensional boundary layer scheme modified to account for the first order effects of three dimensionality. Comparisons with experimental data are presented which verify that this method improves transonic aerodynamic studies associated with preliminary design and analysis. Author

A86-11041*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

AERODYNAMIC DESIGN CONSIDERATIONS FOR EFFICIENT HIGH-LIFT SUPERSONIC WINGS

D. S. MILLER and R. M. WOOD (NASA, Langley Research Center, Hampton, VA) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 9 p. refs (AIAA PAPER 85-4076)

A previously developed technique for selecting a design space for efficient supersonic wings is reviewed; this design-space concept is expanded to include thickness and camber effects and is evaluated for cambered wings at high-lift conditions. The original design-space formulation was based on experimental upper-surface and lower-surface normal-force characteristics for flat, uncambered delta wings; it is shown that these general characteristics hold for various thickness distributions and for various amounts of leading-edge camber. The original design-space formulation was also based on the assumption that the combination of Mach number and leading-edge sweep which would produce an equal division of flat-wing lift between the upper and lower surface would also be the proper combination to give the best cambered-wing performance. Using drag-due-to-lift factor as a measure of performance, for high-lift conditions cambered-wing performance is shown to significantly increase as conditions approach the design space; this correlation is demonstrated for both subcritical and supercritical flows. Author

A86-11042#

EXPERIMENTAL VERIFICATION OF THREE-DIMENSIONAL TRANSONIC INVERSE METHOD

S. TATSUMI (Mitsubishi Heavy Industries, Ltd., Nagoya, Japan) and S. TAKANASHI (National Aerospace Laboratory, Tokyo, Japan) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 11 p. refs (AIAA PAPER 85-4077)

A three-dimensional transonic wing design method was developed for wing alone and wing-body combination. The method

is based on an iterative 'residual-correction' concept combined with existing three-dimensional transonic full potential flow analysis code. Transonic swept wings with specified pressure distribution were designed for typical civil transports and wind tunnel tests were conducted to verify the usefulness of the method. The comparison in pressure distribution of experimental data with design targets show satisfactory agreements, suggesting that the method provides a practical and effective tool in aerodynamic design of aircraft wings. Author

A86-11043#

NUMERICAL EXPERIMENT WITH INVISCID VORTEX-STRETCHED FLOW AROUND A CRANKED DELTA WING - SUBSONIC SPEED

A. RIZZI (Flygtekniska Forsoksanstalten, Bromma, Sweden) and C. J. PURCELL (ETA Systems, Inc., St. Paul, MN) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 12 p.

(AIAA PAPER 85-4080)

A numerical method that solves the Euler equations for compressible flow is used to study vortex stretching. The particular case simulated is subsonic flow with freestream $M = 0.3$ and $\alpha = 10$ deg around the twisted and cambered cranked-and-cropped TKF delta wing of MBB. This geometry induces multiple leading-edge vortices in a straining velocity field that brings about flow instabilities but the result is a state of statistical equilibrium. The discretization contains over 600,000 cells and offers sufficient degrees of freedom in the solution to exhibit the onset of chaotic vortex flow that could well lead to turbulence. The simulated results are compared with wind-tunnel measurements. Author

A86-11044#

FLOW-FIELD COMPUTATIONS AROUND NOZZLE/AFTERBODY CONFIGURATIONS AT TRANSONIC MACH NUMBERS

U. C. GOLDBERG, J. J. GORSKI, and S. R. CHAKRAVARTHY (Rockwell International Science Center, Thousand Oaks, CA) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 8 p. refs (AIAA PAPER 85-4081)

The flow field around nozzle-afterbody configurations is computed using a finite volume code, incorporating a total variation diminishing implicit upwind biased scheme for high accuracy. Results are shown for two combinations of jet and freestream conditions, using the k-epsilon turbulence model, with a new near-wall treatment. Agreement with experimental data is very good. Author

A86-11048#

OPTIMIZATION OF THREE-DIMENSIONAL COMPUTATIONAL GRIDS

R. CARCAILLET, S. R. KENNON, and G. S. DULIKRAVICH (Texas, University, Austin) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 9 p. refs (AIAA PAPER 85-4087)

A method for generating and optimizing arbitrary three-dimensional boundary-conforming computational grids has been developed. The smoothness and local orthogonality of the grid are maximized using a fast iterative procedure, and provision is made for clustering the optimized grid in selected regions. An optimal grid can be obtained iteratively, irrespective of the method used to generate the initial grid. Unacceptable grids and even singular grids (i.e., grids containing regions of overlap) can be made useful for computation using this method. Application of the method to several test cases shows that grids containing regions of overlap are typically untangled in two to five iterations, and that the conjugate gradient optimization procedure converges to an optimal grid within fifty iterations. Taking advantage of the original properties of this method, a new concept for generating optimal three-dimensional computational grids is proposed. It consists in optimizing a first guess of the desired grid, using an imperfect grid generated by a simple, inexpensive method as input. Author

A86-11049#
COMPUTATIONAL GRID GENERATION FOR REALISTIC AIRCRAFT CONFIGURATIONS

D. M. SOMMERFIELD, G. S. DULIKRAVICH, and S. R. KENNON (Texas, University, Austin) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 8 p. refs
 (AIAA PAPER 85-4089)

A computational technique is presented for transforming three-dimensional space into a series of two-dimensional planes for conformal mapping of flowfields around aircraft designs. The aircraft geometry is radially sheared to convert the fuselage into a circular cylinder. The lifting surfaces are thereby also radially sheared and stretched. The intersections between the computational surfaces and the distorted lifting surfaces are obtained by fitting spanwise cubic splines to chordwise locations using Newton's iteration scheme. The surfaces are unwrapped after the intersections are determined, yielding planar strips. Further computations identify the grid points for the planes, which can then be rewrapped around the physical space of interest. Sample results are provided for grids generated for the F-16 and NASA F-8 oblique wing aircraft. M.S.K.

A86-11050#
AN INVESTIGATION OF GRIDGING ON THE ACCURACY OF FLO57MM AND FLO57MG EULER WING SOLUTIONS

C. J. WOAN and E. BONNER (Rockwell International Corp., Computational Fluid Dynamics Group, Los Angeles, CA) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 13 p. Research supported by the Rockwell International Independent Research and Development Program. refs
 (AIAA PAPER 85-4090)

The impact of gridging on the solution accuracy of Jameson's wing-alone Euler codes FLO57MM and FLO57MG was evaluated for the ONERA M6 wing at a Mach number of 0.84 for an angle of attack 3.06 degrees. Axial, vertical and lateral grid sizes of 66 x 16 x 16, 96 x 16 x 16, and 96 x 24 x 24 with various degrees of clustering in the three coordinate directions were considered. Details of grid generation and spacing are given. Experimental comparisons indicate the double shocks on the wing upper surface are accurately captured for the most dense grid with suitable grid clustering, and show substantial improvement over the previously published results. Author

A86-11051#
COMPARISON OF RESULTS FROM A PANEL METHOD AND AN EULER CODE FOR A CRANKED DELTA WING

L. FORNASIER (Messerschmitt-Boelkow-Blohm GmbH, Ottobrun, West Germany) and A. RIZZI (Flygtekniska Forsoksanstalten, Bromma, Sweden) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 12 p. refs
 (AIAA PAPER 85-4091)

A panel code and an Euler code are evaluated as prediction tools for simulating the flow around a cranked-delta wing configuration at Mach numbers equal to 0.30, 0.90, and 1.20. Comparisons are made for global longitudinal characteristics, spanwise variations of local aerodynamic coefficients, and surface pressures. Predictions from the two codes are in good agreement with experimental data at low angles of attack for all Mach numbers studied. At higher angles of attack, the panel code is unable to simulate the phenomena related to the development of a separated leading edge vortical flow and to the formation of large regions of supercritical flow at transonic speeds. The Euler code proved to be able to predict the essential features of such nonlinear effects, especially at 10 deg angle of attack. At intermediate values where the flow is in transition from linear to shed vortex flow, the Euler code seems to overpredict the nonlinear effect. C.D.

A86-11052#
EVALUATION OF FOUR PANEL AERODYNAMIC PREDICTION METHODS (MCAERO, PAN AIR, QUADPAN, AND VSAERO)

W. Z. STRANG, C. H. BERDAHL, E. L. NUTLEY, and A. J. MURN (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 17 p. refs
 (AIAA PAPER 85-4092)

Four linearized potential panel codes are compared using three test cases having datum solutions. The test cases are a simple wing, a straked-wing, and a nacelle. Each code predicts similar flow, but VSAERO and QUADPAN usually 'leak' more and predict lower section loading than PAN AIR and MCAERO. Execution times and user friendliness are compared. Although all four codes solve the linearized potential flow about a vehicle, each code has unique features which may influence a prospective user's choice of a code for flow analysis or vehicle design. Author

A86-11054#
A TECHNIQUE FOR THE INVERSE AERODYNAMIC DESIGN OF NACELLES AND WING CONFIGURATIONS

J. B. MALONE, J. VADYAK (Lockheed-Georgia Co., Marietta, GA), and L. N. SANKAR (Georgia Institute of Technology, Atlanta, GA) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 10 p. refs
 (AIAA PAPER 85-4096)

A semi-inverse design algorithm is presented which is based on the well-known Garabedian-McFadden procedure. The modified inverse algorithm permits the design of aerodynamic components with prescribed surface pressures. Details of the present design procedure are given and several examples illustrating the use of the design technique with existing aerodynamic analysis methods are discussed. Computed results for sample design problems are presented for 2-D airfoils, 2-D nacelle inlets, and 3-D nacelle configurations. Author

A86-11055#
THE CONCEPT OF LATERAL BLOWING

D. A. TAVELLA and L. ROBERTS (Stanford University, CA) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 9 p. refs
 (AIAA PAPER 85-5000)

The concept of lateral blowing consists in utilizing thin jets of air, which are ejected in the spanwise direction from slots at the tips of straight or swept wings to generate aerodynamic forces without the assistance of deflecting solid surfaces. For weak intensities of blowing the so-generated forces could be used for roll and lateral control of aircraft. In this work a theory for this concept as applied to straight wings is presented, revealing the analytical relationship between blowing and aerodynamic forces. The approach is based on perturbing the span of an elliptically loaded wing. Scaling laws involving blowing intensity, aspect ratio, and angle of attack are derived and compared with experiments. It is concluded that this concept has potential as a novel roll and lateral control device. Author

A86-11056#
INFLUENCE OF TIP BLOWING ON RECTANGULAR WINGS

D. A. TAVELLA, N. J. WOOD, and P. HARRITS (Stanford University, CA) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 9 p. refs
 (AIAA PAPER 85-5001)

The aerodynamics of a rectangular wing with a jet exhausting in the spanwise direction from the tips has been explored experimentally. By effectively changing the span of the wing as well as outwardly displacing the tip vortices, such jets can induce aerodynamic forces that could be used for roll and lateral control of aircraft. The concept has been investigated for a variety of jet intensities, aspect ratios and angles of attack. The results appear to confirm theoretically predicted scaling laws for lift and moment gains due to blowing. Author

02 AERODYNAMICS

A86-11058# FLOW SIMULATIONS FOR DETAILED NACELLE-EXHAUST FLOW USING EULER EQUATIONS

H. C. CHEN, K. KUSUNOSE, and N. J. YU (Boeing Commercial Airplane Co., Seattle, WA) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 8 p. refs
(AIAA PAPER 85-5003)

A simulation method for the detailed analysis of nacelle exhaust flowfields based on Jameson et al. (1981) Euler technology has been presented. An axisymmetric code and a general three-dimensional (3-D) code have both been developed. The axisymmetric version is particularly useful for fundamental studies such as grid density requirements, whereas the 3-D version is particularly suited for real applications involving nonaxisymmetric geometry and angle-of-attack effects. The addition of one-plane-of-symmetry to the 3-D code enhances its usefulness by doubling the number of available grid points. Reasonable agreement has been obtained in test-theory comparison for both axisymmetric and 3-D cases. The analysis of a transport nacelle at high power setting reveals complex expansion-compression flow patterns in the exhaust flow region. Author

A86-11059*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif. TRANSONIC SEPARATED SOLUTIONS FOR AN AUGMENTOR-WING

J. FLORES and W. R. VAN DALSEM (NASA, Ames Research Center, Moffett Field, CA) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 11 p. refs
(AIAA PAPER 85-5004)

The viscous transonic flow about a multielement airfoil (augmentor-wing) is simulated by coupling full-potential and direct/inverse differential boundary-layer algorithms. Solutions have been obtained for a variety of conditions and are in fair agreement with available experimental data. Typical results from this transonic augmentor-wing code (TAUG-V) require approximately three minutes of CRAY-XMP CPU time. Since this viscous transonic code accounts for most of the important flow physics, yet is still economical, it is a practical tool for the design aerodynamicist. Author

A86-11060# LEADING EDGE FLAP PLANFORM EFFECTS FOR WINGS OF MODERATE LEADING EDGE SWEEP

A. C. GRANTZ (Northrop Corp., Aircraft Div., Hawthorne, CA) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 18 p. refs
(AIAA PAPER 85-5005)

A low-speed wind tunnel investigation was conducted which addressed the effects of leading edge flap area, flap deflection, and flap hinge-line sweep for wings of moderate (40 to 55 degrees) leading edge sweep. Oil flow visualization photographs and VLM-SA comparisons were made for selected configurations. Leading edge flaps of conventional taper were shown to provide higher L/D than flaps of constant chord and inverse taper planforms for wings with a leading edge sweep angle of 50 degrees. In all cases, the 14 and 17 percent area leading edge flaps yielded the best L/D performance at moderate to high lift coefficients independent of wing leading edge sweep angle. Despite the mixed, attached and vortical flowfields produced by the leading edge flaps investigated, the VLM-SA calculations agreed very well with the experimental drag polars. Author

A86-11062# SYMMETRIC SEPARATED FLOW PAST SLENDER BODIES AT ANGLES OF ATTACK IN SUBSONIC AND SUPERSONIC FLOWS

A. K. SREEKANTH (Indian Institute of Technology, Madras, India) and S. PANNEERSELVAM (Defence Research Development Laboratory, Hyderabad, India) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 9 p. refs
(AIAA PAPER 85-5007)

A prediction method has been developed for determining the normal force and pitching moment on bodies of revolution both in subsonic and supersonic flows at angles of attack up to the onset of asymmetric vortex shedding. The analysis assumes that the force on the body is the sum of inviscid and viscous contributions. Woodward's three dimensional panel method is used for inviscid flow calculations. In the viscous analysis the contributions from the shed vortices and the feeding sheet are accounted for separately. Comparisons are made of the predicted values with available experimental data on a representative ogive cylinder body. Author

A86-11063# COMPARISON BETWEEN EXPERIMENTAL AND COMPUTATIONAL RESULTS FOR AIRFOILS EQUIPPED WITH A SPOILER AND A FLAP

M. COSTES (ONERA, Chatillon-sous-Bagneux, France) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 7 p. Research supported by the Service Technique des Programmes Aeronautiques and DRET.
(AIAA PAPER 85-5008)

A computer code including viscous effects by strong coupling is used to compute the steady flow around an airfoil equipped with a spoiler. Comparison with experimental data shows that the code is able to predict, at least qualitatively, the influence of aerodynamic and geometric parameters such as free stream Mach number, spoiler deflection, spoiler chord, spoiler position, trailing edge flap deflection, Reynolds number. Author

A86-11065*# Scientific Research Associates, Inc., Glastonbury, Conn.

NUMERICAL STUDY OF THREE-DIMENSIONAL TURBULENT FLOW INTERACTIONS BETWEEN BLOCKAGE MODELS AND WIND TUNNELS INCLUDING LONGITUDINALLY SLOTTED TEST SECTIONS

S.-J. LIN and R. LEVY (Scientific Research Associates, Inc., Glastonbury, CT) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 14 p. refs
(Contract NAS3-24224)
(AIAA PAPER 85-5017)

A spatial forward-marching approach is applied to compute three-dimensional turbulent flows for several blockage models in free flight, in a solid wall wind tunnel, and in a wind tunnel with longitudinal slots in the test section. The effects of area blockage in the tunnel, model growth and tunnel wall boundary layers, and of the slots are included. The large blockage models are found to have significant wall interference effects which can be reduced by the slots. The effects of the latter are confined to the region near the tunnel wall. Model/wall interference effects are not limited to the effects of area blockage; in particular, boundary layer profile shapes for a wind tunnel model in a tunnel are different from shapes for a model in free flight even when slots are used. This indicates that the flow responds differently in these two cases with the same pressure gradient. C.D.

A86-11066#
COMPUTATIONAL ESTIMATIONS OF STRUT SUPPORT INTERFERENCE AT TRANSONIC MACH NUMBERS
 N. E. SUHS (Calspan Corp., Arnold Air Force Station, TN) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 7 p. refs
 (AIAA PAPER 85-5018)

A computational method is presented that numerically quantifies the interference of model support struts in transonic wind tunnel tests. The method solves the three-dimensional Euler equations for a wing/body/strut model configuration in a typical wind tunnel installation. Computations and measurements are in good agreement over the range of transonic Mach numbers. Author

A86-11067#
APPLICATION OF EXPERIMENTAL AND THEORETICAL METHODS TO VALIDATE RESULTS OBTAINED ON AN ISOLATED INLET COWL WIND TUNNEL TEST RIG
 E. C. CARTER and W. HIRST (Aircraft Research Association, Ltd., Bedford, England) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 10 p. refs
 (AIAA PAPER 85-5019)

Recent analysis of results obtained on a cowl inlet test rig in a transonic test section indicated some doubt over the standard corrections to free stream Mach number which were used to allow for the effects of rig blockage and interference. Investigative tests of tunnel flow have been made and these results, together with correlations with current theory have indicated that early interference corrections to M have been underestimated. This paper describes the steps in the investigation, the justification for the new correction terms and the reasons for the original errors. The work shows how the development of improved CFD methods can be incorporated with experimental data to improve the quality of tests. Author

A86-11068#
ESTIMATING WATER VAPOR CONDENSATION EFFECTS FOR TRANSONIC AND SUPERSONIC FLOW FIELDS
 C. E. ROBINSON, R. C. BAUER (Calspan Corp., Arnold Air Force Station, TN), and R. H. NICHOLS (USAF, Arnold Engineering Development Center, Arnold Air Force Station, TN) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 8 p. refs
 (AIAA PAPER 85-5020)

A computer code has been developed which estimates the effect of water vapor condensation on flow fields using the Euler equations. The program computes the effect by including the energy release attributable to condensation in the energy equation. In this manner, the local effect of condensation is included in the calculation of the flow-field properties. A species equation for the conservation of water vapor is also included as well as an empirical method of predicting the onset of condensation. To evaluate the effectiveness of the code, calculations of the transonic flow field about a two-dimensional airfoil and the flow in two planar two-dimensional supersonic nozzles have been made at discrete values of specific humidity. The effects of local condensation estimated by the code are in good agreement with the experimental data found in the literature for nozzle flows. Author

A86-11070*# Colorado Univ., Boulder.
NUMERICAL SIMULATION OF TRANSONIC FLOW OVER POROUS AIRFOILS
 C.-Y. CHOW (Colorado, University, Boulder, CO), T. L. HOLST, W. R. VAN DALSEM (NASA, Ames Research Center, Moffett Field, CA), and C.-L. CHEN AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 9 p. Previously announced in STAR as N85-27828. refs
 (Contract NCC2-355)
 (AIAA PAPER 85-5022)

A numerical study was made to examine the effect of a porous surface on the aerodynamic performance of a transonic airfoil. The pressure jump across the normal shock wave on the upper surface of the airfoil was reduced by making the surface below

the shock porous. The weakened shock is preceded by an oblique shock at the upstream end of the porous surface where air is blown out of the cavity. The lambda shock structure shown in the numerical result qualitatively agrees with that observed in the wind tunnel. According to the present analysis, the porous airfoil has a smaller drag and a higher lift than the solid airfoil. Author

A86-11071#
COMPARISON OF TRANSONIC AIRFOIL CHARACTERISTICS BY NAVIER-STOKES COMPUTATION AND BY WIND TUNNEL TEST AT HIGH REYNOLDS NUMBER

J. MIYAKAWA (Mitsubishi Heavy Industries, Ltd., Aerodynamic Research Section, Nagoya, Japan), N. HIROSE, and N. KAWAI (National Aerospace Laboratory, Tokyo, Japan) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 10 p. refs
 (AIAA PAPER 85-5025)

Two-dimensional Navier-Stokes code (NSFOIL) is validated in terms of analysis of practical transonic advanced technology airfoil compared to wind tunnel test. The comparison is carried out at high Reynolds number of 23 million which is corresponding to actual flight condition of a transonic transport aircraft. The agreements are satisfactory in both aerodynamic forces and pressure coefficients so that the code is concluded to be a very effective tool to predict non-linear characteristics of transonic airfoils, which has never been possible by any inviscid code. In the course of the careful comparison process, some future improvements of the code are probed in order to get even better simulation by this hopeful computer code. Author

A86-11072#
THE USE OF NUMERICAL OPTIMIZATION FOR AIRFOIL DESIGN

J. RENEUX and J.-J. THIBERT (ONERA, Chatillon-sous-Bagneux, France) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 11 p. refs
 (AIAA PAPER 85-5026)

The paper describes an airfoil design method based on numerical optimization techniques. This method allows the design of airfoils with certain aerodynamic objectives and with respect to geometric or aerodynamic constraints. After a presentation of the method, the paper describes different applications. Airfoil design processes for ultralight aircraft, for propeller and helicopter blades and for shrouded tail rotor are explained and the performances of these airfoils are given. The new airfoils designed using this method perform better than other known airfoils which demonstrates the efficiency of the numerical optimization technique. In conclusion, some remarks concerning the disadvantages of the method are presented as well as its possible use for other aerodynamic applications. Author

A86-11073#
THE SEPARATED AND NON-SEPARATED AIRFOIL WAKE BEHAVIOR IN THE PRESENCE OF FREE STREAM TURBULENCE

M. ARDEBILI, B. K. HAZARIKA, and R. RAJ (City College, New York) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 12 p. refs
 (AIAA PAPER 85-5027)

The wake of a cambered airfoil was measured at three angles of attack and at two free stream turbulence levels. At high angle of attack and low free stream turbulence level a separation bubble was observed on the airfoil surface. Separation bubble was removed with the increase of free stream turbulence and the results were compared. The experimental results obtained were also empirically correlated for predicting the mean wake properties. Author

02 AERODYNAMICS

A86-11096*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

AERODYNAMIC INTERACTION BETWEEN VORTICAL WAKES AND THE VISCOUS FLOW ABOUT A CIRCULAR CYLINDER

P. M. STREMEL (NASA, Ames Research Center, Moffett Field, CA) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 19 p. refs (AIAA PAPER 85-4063)

In the design analysis of conventional aircraft configurations, the prediction of the strong interaction between vortical wakes and the viscous flow field about bodies is of considerable importance. Interactions between vortical wakes and aircraft components are even more common on rotorcraft and configurations with lifting surfaces forward of the wing. An accurate analysis of the vortex-wake interaction with aircraft components is needed for the optimization of the payload and the reduction of vibratory loads. However, the three-dimensional flow field beneath the rotor disk and the interaction of the rotor wake with solid bodies in the flow field are highly complex. The present paper has the objective to provide a basis for the considered interactions by studying a simpler problem. This problem involves the two-dimensional interaction of external wakes with the viscous flow about a circular cylinder. G.R.

A86-11157*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

LIFTING SURFACE THEORY FOR A HELICOPTER ROTOR IN FORWARD FLIGHT

H. TAI (NASA, Langley Research Center, Hampton, VA) and H. L. RUNYAN (College of William and Mary, Hampton, VA) IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings. Alexandria, VA, AHS, 1984, 11 p. Previously announced in STAR as N85-10916. refs

A lifting surface theory was developed for a helicopter rotor in forward flight for compressible and incompressible flow. The method utilizes the concept of the linearized acceleration potential and makes use of the vortex lattice procedure. Calculations demonstrating the application of the method are given in terms of the lift distribution on a single rotor, a two-bladed rotor, and a rotor with swept-forward and swept-back tips. In addition, the lift on a rotor which is vibrating in a pitching mode at 4/rev is given. Compressibility effects and interference effects for a two-bladed rotor are discussed. Author

A86-11226# AIRFOIL DYNAMIC STALL PERFORMANCE WITH LARGE-AMPLITUDE MOTIONS

M. S. FRANCIS and J. E. KEESEE (USAF, Office of Scientific Research, Washington, DC) AIAA Journal (ISSN 0001-1452), vol. 23, Nov. 1985, p. 1653-1659. refs (Contract AF PROJECT 2307; AF TASK F1)

Dynamic lift levels approaching three times the corresponding quasisteady maximum values have been observed to occur and sustain to very high incidence angles (60 deg) when airfoils undergo rapid, large-amplitude pitchup motions at constant rate. Measurements of unsteady surface pressure distributions on two different airfoil shapes have captured the footprint of an energetic separation vortex which originates at the leading edge and exerts a substantial influence on the loading history as it convects downstream. To evaluate the potential of exploiting lifting surface motions as a possible means of load enhancement and control, a dimensionless impulse function that is not dependent on the type of motion is introduced and applied to experimental data. Results suggest that optimum lift performance can be achieved at relatively low pitch rates when the motion is terminated at the rate-determined angle at which the dynamic lift coefficient reaches its maximum value. Author

A86-11227#

THE PITCHING DELTA WING

M. GAD-EL-HAK and C.-M. HO (Flow Research Co., Kent, WA) AIAA Journal (ISSN 0001-1452), vol. 23, Nov. 1985, p. 1660-1665. refs (Contract F49620-80-C-0020)

Delta wings in steady flow can provide high lift at large angles of attack and are therefore used on many high-performance aircrafts. However, the unsteady aerodynamic properties of a delta wing are practically unknown, although vital for operating and designing airplanes for poststall and other maneuvering. In this study, the flowfields around to pitching delta wings with apex angles of 90 and 60 deg were visualized in a towing tank at chord Reynolds numbers up to 350,000. The reduced frequency was varied in the range 0.05-3. The leading-edge separation vortex went through a growth-decay cycle with hysteresis during a pitching period. A distinct change of the separated flow was observed at a reduced frequency around π . Author

A86-11230#

THREE-DIMENSIONAL CALCULATION OF TRANSONIC VISCOUS FLOWS BY AN IMPLICIT METHOD

H. HOLLANDERS, A. LERAT, and R. PEYRET (ONERA, Chatillon-sous-Bagneux, France) (Computational Fluid Dynamics Conference, 6th, Danvers, MA, July 13-15, 1983, Collection of Technical Papers, p. 621-629) AIAA Journal (ISSN 0001-1452), vol. 23, Nov. 1985, p. 1670-1678. Research supported by the Ministere de la Defense. Previously cited in issue 18, p. 2637, Accession no. A83-39412. refs

A86-11233*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

SECOND-ORDER-ACCURATE SPATIAL DIFFERENCING FOR THE TRANSONIC SMALL-DISTURBANCE EQUATION

P. M. GOORJIAN (NASA, Ames Research Center, Moffett Field, CA) and H. D. VAN BUSKIRK AIAA Journal (ISSN 0001-1452), vol. 23, Nov. 1985, p. 1693-1699. Previously cited in issue 06, p. 715, Accession no. A84-19230. refs

A86-11255*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

FINITE DIFFERENCE SOLUTIONS OF THE EULER EQUATIONS IN THE VICINITY OF SHARP EDGES

P.-M. HARTWICH (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 23, Nov. 1985, p. 1820-1822. refs

Attempts have been made to explain why finite difference solutions of the Euler equations can describe flows with large vortical structures around sharp-edged bodies. The present paper is concerned with the influence of a singular sharp edge on the truncation error for a set of discretized Euler equations. An analysis is conducted of the distribution of the truncation error of one finite difference approximation of the Euler equations near a sharp edge of a thin plate. The analysis leads to a determination of the size of the region of the neighborhood of such a singularity. Attention is given to the consistency of a discretization of the Euler equations, and numerical experiments. G.R.

A86-11605#

A COUPLED INVERSE-INVERSE METHOD FOR OVER-EXPANDED SUPERSONIC NOZZLES

G. MEAUZE and A. FOURMAUX (ONERA, Chatillon-sous-Bagneux, France) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 45-49. refs (ONERA, TP NO. 1985-109)

An inverse-inverse coupling method is proposed for taking into account internal flow separations occurring in supersonic nozzles in overexpanded regimes. First, various coupling techniques are briefly reviewed, and a justification is given for the proposed approach. The application to supersonic nozzles is then discussed in more detail, with computations for different overexpanded configurations included. V.L.

A86-11606#

JET PLUME TEMPERATURE EFFECTS ON AFTERBODY PRESSURE DISTRIBUTION AND DRAG

N. B. MATHUR and K. S. YAJNIK (National Aeronautical Laboratory, Bangalore, India) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 50-55. refs

Experiments have been carried out on an axisymmetric configuration with a circular arc boattailed afterbody to study the jet plume temperature effects on afterbody pressure distribution and drag. It is found that the jet plume temperature systematically affects afterbody pressure distribution and that the afterbody drag decreases with increasing jet plume temperature. At Mach 0.62 and a jet pressure ratio of 2.9, the afterbody pressure drag coefficient at a jet temperature of 945 K is 30-40 percent less than its value at a jet temperature of 307 K (cold jet). V.L.

A86-11611#

THE SHOCK PATTERNS IN THE TWO-DIMENSIONAL INLET WITH A BLEED

J. B. XING and C. M. CHANG (Beijing Power Plant Research Laboratory, People's Republic of China) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 111-117.

The various shock patterns in the two-dimensional inlet with a bleed slot located in front of a geometric throat were recorded by means of TV tapes. The downstream static pressure was measured to determine the relationship between the total pressure recovery (Po) and the mass flow ratio (Fi). The results indicated that, as the downstream pressure varied, the variations in the terminal shock wave system and of the Po and Fi relationship for this type of inlet. The analysis of the Po and Fi relationship has shown that the relationship is single and continuous. The various patterns of the terminal shock wave system in conditions of different Mach numbers ahead of the geometric throat are discussed. I.S.

A86-11612#

THREE-DIMENSIONAL FLOW EFFECTS IN A TWO-DIMENSIONAL AIR INTAKE WITH MIXED SUPERSONIC COMPRESSION

S. A. FISHER (Department of Defence, Aeronautical Research Laboratories, Melbourne, Australia) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 118-124. refs

The internal flow in a two-dimensional mixed compression intake having focussed internal compression was examined experimentally at its design Mach number of 3.05, using pressure instrumentation and flow visualization. A pair of streamwise vortices was identified, which apparently resulted from interaction of the sidewall boundary layers with the internal shock system and which, depending on detailed geometry, could dominate the flow in the subsonic diffuser. It is argued that similar flows could exist in a variety of intakes designed for supersonic flight, with implications for both turbine and ram compression engine applications. Author

A86-11615*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

NUMERICAL SIMULATION OF SELF-EXCITED OSCILLATIONS IN A RAMJET INLET-DIFFUSER FLOW

T. HSIEH (U.S. Navy, Naval Surface Weapons Center, Silver Spring, MD) and T. COAKLEY (NASA, Ames Research Center, Moffett Field, CA) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 149-156. Navy-sponsored research. refs

This paper describes numerical simulations of self-excited oscillations in a two-dimensional transonic inlet-diffuser flow by solving the Navier-Stokes equations with a two-equation turbulence model. The calculated amplitudes of oscillations for the terminal shock and the velocity fields compare well with experimental measurements; however, the predicted frequency of oscillations is

about 50 percent higher. The formation of a pair of downstream-traveling, counter-rotating vortices at each cycle of velocity fluctuations, as reported experimentally, is vividly revealed by the numerical results. Author

A86-11616#

CALCULATION OF EXTERNAL AND INTERNAL TRANSONIC FLOW FIELD OF A THREE-DIMENSIONAL S-SHAPED INLET

H. SHEN, L. SHIJUN, M. JI, and Z. XING (Northwestern Polytechnical University, Xian, Peoples Republic of China) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 157-162. refs

A procedure for the numerical solution of the transonic flow about a three-dimensional s-shaped inlet was developed by the hybrid use of two methods: the mixed finite difference method (FDM) and the sweep finite element method (SFEMK). The FDM of the velocity potential equations, applicable to cylindrical or Cartesian mesh, irrotational schemes and boundary-continuation methods, is used to calculate the external and internal flow fields of a three-dimensional inlet. Then the SFEM is used to improve the accuracy of the computed values of field variables at an embedded domain near the lip of the inlet. The hybrid method was used to compute the flow about an s-shaped inlet with free stream Mach number 0.8 at different angles of attack. The results were in excellent agreement with the experimental data and with those computed by the perturbation method of Lin (1984). I.S.

A86-11635#

MODERN TECHNOLOGY APPLICATION TO COMPRESSOR AND TURBINE AERODYNAMICS

J. HOURMOUZIAS and H.-J. LICHTFUSS (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, West Germany) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 307-320. refs

The historical evolution of compressor and turbine design has led to a situation in which the methods used for the analysis of compressor characteristics are different from the approaches employed for turbines. However, as actually the fundamental phenomena involved in both cases are the same, compressor and turbine design systems tend to converge to one single turbomachinery design system. In the near future, transonic and supersonic flow will become dominant in the next generation of turbomachinery for airbreathing engines. Turbomachinery design systems are discussed, taking into account annulus and velocity-triangle design, blade to blade analysis, and three-dimensional analysis and design. It is pointed out that turbomachinery design is becoming an integral part of the engine computer-aided design system. Aspects of experimental research and development are also discussed, giving particular attention to measurement techniques. G.R.

A86-11636#

AN EXPERIMENTAL STUDY OF THE COMPRESSOR ROTOR FLOW FIELD AT OFF-DESIGN CONDITION USING LASER DOPPLER VELOCIMETER

P. POPOVSKI and B. LAKSHMINARAYANA (Pennsylvania State University, University Park) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 321-330. refs

The measurement of the flow field at the peak pressure rise condition in an axial flow compressor rotor is reported in this paper. The inviscid flow measurement was carried out using a laser Doppler velocimeter and the blade boundary layers were measured using a two sensor hot wire probe. The blade to blade distribution of velocities at several axial and radial locations are plotted, interpreted, and compared with the conditions existing at a lower (design) flow coefficient. The leading edge effects on inviscid flow is found to be appreciable. The flow field is dominated by inviscid flow at most radial locations, and the blade boundary layers thickness is found to be appreciable in the tip region. The

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flow near the tip is dominated by the leakage flow and its influence is more severe at the peak pressure rise condition. Author

A86-11639#

DEVELOPMENT OF A SHORT RADIAL DIFFUSER IN THE HIGH SUBSONIC AND SUPERSONIC RANGE WITH SPECIAL APPLICATION TO AIR BREATHING ENGINES

W. WAWSZCZAK (Calgary, University, Canada) and J. DE KRASINSKI IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings . New York, AIAA, 1985, p. 344-350. NSERC-sponsored research. refs

This paper describes the experimental research done on a very short, axially symmetrical diffuser. This diffuser, developed originally for low speed, has been redesigned for high subsonic and supersonic ranges with the objective of meeting high efficiency and low aerodynamic noise criteria. Besides the classical boundary layer concepts required to avoid separation, general trends following from Lighthill's concepts of aerodynamically generated sound were also adopted. The results are more than encouraging. Shortness, high efficiency and almost complete noise abatement have been achieved. Author

A86-11675#

TURBULENT BOUNDARY LAYER SEPARATION ON ENGINE COMPONENTS

W. H. SCHOFIELD (Aeronautical Research Laboratories, Melbourne, Australia) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings . New York, AIAA, 1985, p. 631-639. refs

A unified description of the entire separating turbulent flow field is presented by coupling a proposed description for the mean velocity profile of turbulent boundary layers (b.l.s.), in flow approaching separation, during separation, and downstream after separation, and an empirical formulation for the mean reversed flow profile. It was found that the velocity profiles in adverse pressure gradient b.l.s. defined by Schofield and Perry (1972, 1973) can be extended to separating and separated layers, provided that the effective origin of the layer is relocated. It is proposed that turbulent b.l.s. separate with a universal mean velocity profile, which can be defined by a standard shape factor (displacement to momentum thickness ratio) of 3.3. The application of this theory to practical b.l.s. with three-dimensional components is discussed. I.S.

A86-11692#

RECENT PROGRESS ON COMPRESSOR STABILITY IN FRANCE

J. CHAUVIN (Marseille II, Universite, France) and PH. RAMETTE (DRET, Paris, France) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings . New York, AIAA, 1985, p. 758-764. refs

A discussion of numerical models for predicting the stability limits of an aircraft's axial and centrifugal compression systems in terms of rotating stall, surge and flutter is presented, including modeling of the response of an axial compressor to a distorted inlet flow. Calculated values on surge line are compared with the experimental data. I.S.

A86-11912#

THE GOVERNING INFLUENCE OF THE NOSE RADIUS ON THE UNSTEADY EFFECTS OF LARGE SCALE FLOW STRUCTURE IN THE TURBULENT WING AND PLATE JUNCTION FLOW

E. P. ROOD (David W. Taylor Naval Ship Research and Development Center, Bethesda, MD) IN: Forum on unsteady flow; Proceedings of the Winter Annual Meeting, New Orleans, LA, December 9-14, 1984 . New York, ASME, 1984, p. 7-9.

Experimental results are reported from trials to quantify the effects of two values of the ratio of the nose radius to the boundary layer thickness (RTBL). The studies were conducted with a wing section attached to a rigid plate, with data taken one chord length downstream from the wing, which was at a 5.0 deg angle of

attack. The flow velocity was 30 m/sec. Values of the RTBL of 0.12 and 0.71 were examined. The wing nose radius had a significant effect on the across-stream unsteady flow spatial pattern produced by convective structures at the downstream interaction between the boundary layer and wake. The nose radius also influences the location and skew of the surface dividing unsteady flows from the two sides of the wing. M.S.K.

A86-12020#

CRITICAL EXAMINATION OF TURBULENCE MODELS FOR A SEPARATED THREE DIMENSIONAL TURBULENT BOUNDARY LAYER

R. SCHMITT (ONERA, Chatillon-sous-Bagneux, France) and R. ABID La Recherche Aerospaciale (English Edition) (ISSN 0379-380X), no. 6, 1984, p. 1-17. refs

Four turbulence models are evaluated in comparisons with experimental data on the evolution of a three-dimensional boundary layer to separation. Attention is given to an algebraic mixing length theory, a kinetic energy-dissipation rate (k-e) model, an algebraic stress model (ASM), and a model comprising four transport equations. Solutions are obtained by a finite difference technique in an inverse mode. The mixing length model consistently overestimates the growth of shear stresses once destabilization is initiated. The ASM is the only model which correctly portrays the changes in shear stresses observed, and also the associated lag phenomena and velocity profiles. Further work is still necessary to model the wall flow. M.S.K.

A86-12021#

A VORTEX POINT METHOD FOR CALCULATING INVISCID INCOMPRESSIBLE FLOWS AROUND ROTARY WINGS

B. CANTALOUBE (ONERA, Chatillon-sous-Bagneux, France) and S. HUBERSON (CNRS, Paris, France) La Recherche Aerospaciale (English Edition) (ISSN 0379-380X), no. 6, 1984, p. 19-31. refs

An integral method is presented for calculating incompressible inviscid unsteady flow around thin bodies in arbitrary motion, i.e., rotor blades in motion with respect to one another. Because an integral method is used, discretization is limited to the solid boundaries and the vortices. Boundary conditions are treated in terms of equation for the slipstream on the walls, the vorticity vector, a volume integral for the vorticity and a first-order Fredholm integral. The Helmholtz equation governs the evolution of vorticity, which forms a sheet of doublets. The pressure jumps on the blades are covered by the unsteady Bernoulli equation. Applications of the method to helicopter rotors, medium- and high-aspect ratio propellers and low-aspect ratio nautical propellers are demonstrated. M.S.K.

A86-12022#

EFFECT OF THE REYNOLDS NUMBER ON THE AERODYNAMIC CHARACTERISTICS OF AN OGIVE-CYLINDER AT HIGH ANGLE OF ATTACK

P. CHAMPIGNY (ONERA, Chatillon-sous-Bagneux, France) La Recherche Aerospaciale (English Edition) (ISSN 0379-380X), no. 6, 1984, p. 33-41. refs

Low-speed wind tunnel data for an ogive model at high angles of attack (AOA) are analyzed in terms of the flow separation regimes. The flows covered the Re range of 280,000-2 million, AOAs up to 80 deg and a Mach 0.35 flow velocity. The sting-mounted model was instrumented with 354 pressure taps. The data were used to calculate the normal and side forces. The drag coefficient was found to be dependent on the Re and the AOA. Both laminar and turbulent flows produced large side forces, which had cyclic distributions. Finally, the separations that occurred produced four types of flows for separate Re regimes. M.S.K.

A86-12024#

DYNAMIC STALL MODELING OF THE NACA 0012 PROFILE

D. PETOT (ONERA, Chatillon-sous-Bagneux, France) La Recherche Aerospaciale (English Edition) (ISSN 0379-380X), no. 6, 1984, p. 55-58. refs

Correlations obtained by ONERA researchers in studies of large amplitude oscillations in airfoils are discussed. The correlation

values were generated with a dynamic model for helicopter rotor blades experiencing nonlinear oscillations in the lift/angle of attack or moment/angle of attack hysteresis loops. Comparisons were made between the model predictions and data from NASA experiments with NACA 0012 airfoils at varying angles of attack, amplitudes and frequencies. The model proved adequate for predicting the hysteresis loops and in identifying stall behavior.

M.S.K.

A86-12062
THREE-DIMENSIONAL SOLUTIONS TO THE EULER EQUATIONS WITH ONE MILLION GRID POINTS

A. RIZZI (Flygtekniska Forsoksanstalten, Bromma, Sweden) Communications in Applied Numerical Methods (ISSN 0748-8025), vol. 1, Sept. 1985, p. 193-198. Research supported by the Control Data Corp. refs

Three dense-mesh solutions are presented. The first solution, for the M6 wing (Mach 0.84, α 3.06 deg), shows only slight improvements in accuracy in comparison with earlier standard-mesh solutions. The other two solutions, for subsonic and supersonic flow around the 70-deg swept Dillner wing, reveal flow fields of much more complex expansion and compression phenomena than do the standard-mesh solutions. In both cases, weak and local shock waves interact with the vortex over the wing. The sequence of lift and drag coefficients is presented for three levels of grid density, 33 x 11 x 15 (coarse), 65 x 21 x 29 (standard), and 193 x 57 x 97 (dense). V.L.

A86-12263#
UNSTEADY AERODYNAMIC CHARACTERISTICS OF A BLADE IN PITCHING OSCILLATIONS WITH FLOW SEPARATION. I - THE CASE WITH LAMINAR SEPARATION BUBBLE. II - THE CASE WITH LEADING EDGE STALL. III - THE CASE NEAR THE STALLING ANGLE OF ATTACK

I. FUJIMOTO, K. YAMAGUCHI (Tokyo, University, Japan), H. TANAKA (Tokai University, Hiratsuka, Japan), and S. ISHII (Nihon University, Chiba, Japan) JSME, Bulletin (ISSN 0021-3764), vol. 28, Aug. 1985, p. 1610-1633. refs

A86-12265#
STRUCTURE AND DECAY OF SECONDARY FLOW IN THE DOWNSTREAM OF A CASCADE

T. KAWAI, T. ADACHI (Tsukuba, University, Sakura, Japan), and K. AKASHITA (Nissan Motor Co., Ltd., Yokosuka, Japan) JSME, Bulletin (ISSN 0021-3764), vol. 28, Aug. 1985, p. 1642-1650. refs

An experimental investigation has been done on trailing and passage vortices downstream of a decelerating cascade. Hot wire traverses gave distributions of secondary flow velocities and streamwise vorticities at four axial locations. A spanwise distribution of passage circulations per unit span agrees well with a prediction by an inviscid classical secondary flow theory. The trailing vortex is well approximated by a vortex sheet immediately downstream of the blade, beginning to roll up at the position of maximum circulation per unit span. It develops into an almost axisymmetric vortex two chord lengths downstream. The trailing vortex decays faster in the vicinity of the blade trailing edge but more slowly far downstream, than the passage vortex does. The experimental trailing vortex is generated very far away from an endwall as compared with a theoretical position, exerting significant influences on the maximum underturning and the pitch-averaged streamwise vorticity in the main flow region. Author

A86-12266#
A STUDY OF AERODYNAMIC PERFORMANCE OF DIFFUSERS FOR CENTRIFUGAL COMPRESSORS

Y. YOSHINAGA, H. KOBAYASHI (Hitachi, Ltd., Mechanical Engineering Research Laboratory, Tsuchiura, Japan), and T. KANEKI (Hitachi, Ltd., Tsuchiura, Japan) JSME, Bulletin (ISSN 0021-3764), vol. 28, Aug. 1985, p. 1651-1658. refs

The performance of vaneless diffusers and the flow distribution discharged from the impellers of various specific speed centrifugal compressors were studied. The experimental results of 18 different

stages showed that the impeller exit flow distortion in the axial direction increased with an increase in specific speed, and the pressure recovery of vaneless diffusers for high specific speed compressors was extremely low compared with the value expected by an ideal two-dimensional analysis. New type diffusers with half guide vanes on the shroud sidewall are proposed to improve the pressure recovery of the diffuser under the distorted inlet flow condition. The results show that the pressure recovery of the diffuser under distorted inlet flow is considerably improved by half guide vanes, and the best height of the guide vanes is a little less than half the diffuser width. Author

A86-12267#
THE PERFORMANCE CHARACTERISTIC OF AN AIR-SEPARATOR OF AN AXIAL FLOW FAN

Y. MIYAKE (Osaka University, Suita, Japan), I. NOJI (Nissan Motor Co., Ltd., Atsugi, Japan), Y. NISHIKAWA (Toshiba Co., Ltd., Yokohama, Japan), and S. MURATA (Toyota Technical Institute, Nagoya, Japan) JSME, Bulletin (ISSN 0021-3764), vol. 28, Aug. 1985, p. 1659-1666. refs

An air-separator as a new means for stabilizing the characteristics in the low flow rate region of an axial flow fan has been studied experimentally. The influence on the performance of this equipment of such parameters as the structure of the flow passage and the dimensions has been examined, as well as the influence of the hub-tip ratio of the rotor and the aspect ratio of the rotor blades. It is found that the equipment is useful even in conditions where blade separators are useless. Author

A86-12271#
CHARACTERISTICS OF THE FLOW AROUND RECTANGULAR CYLINDERS - THE CASE OF THE ANGLE OF ATTACK 0 DEG
T. IGARASHI (Defense Academy, Yokosuka, Japan) JSME, Bulletin (ISSN 0021-3764), vol. 28, Aug. 1985, p. 1690-1696. refs

Experimental investigations on the characteristics of the flow around rectangular cylinders were carried out in the range of subcritical Reynolds numbers. The width-to-height ratio (C/d) of the sections was varied from 0.1 to 4.0. The fluctuating pressure coefficient has a maximum in the same tendency as that of the drag coefficient when $C/d = 0.67$. The differences in flow patterns between two critical values of the ratios $C/d = 0.67$ and 2.8 become clear. The flow around the cylinder with arc-like leading-edge corners has been found to agree closely with that around the cylinder with a larger value of the ratio of C/d . Author

A86-12283#
EXPERIMENTAL STUDY OF VORTEX BREAKDOWN ON A DELTA WING IN INCOMPRESSIBLE FLOW [ETUDE EXPERIMENTALE DE L'ECLATEMENT DU TOURBILLON D'UNE AILE DELTA EN ECOULEMENT INCOMPRESSIBLE]

D. PAGAN (ONERA, Chatillon-sous-Bagneux, France) (Congres Francais de Mecanique, 7th, Bordeaux, France, Sept. 2-6, 1985) ONERA, TP, no. 1985-107, 1985, 5 p. In French. (ONERA, TP NO. 1985-107)

The average and fluctuation characteristics of a vortex-breakdown field on a delta wing were obtained in a laser-velocimeter study at an angle of attack of 19.3 deg and a flow velocity of 14.5 m/s. Results are presented concerning the meridional and tangential components of the velocity field, and the spatial distribution of fluctuation terms. A histogram of the instantaneous velocity components u and v is also presented. B.J.

A86-12551
REPRESENTATION OF A TURBINE PROFILE IN THE FORM OF A BEZIER CURVE [PREDSTAVLENIE TURBINNOGO PROFILIA V FORME KRIVOI BEZ'E]

B. KH. PERELSHTEIN and S. S. SOLOVEV Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1985, p. 91-94. In Russian. refs

A method for representing plane turbine profiles by a Bezier curve has been developed as part of an effort to create graphics

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software support for a computer-aided design system. The shape of the curve is determined by the position of the vertices of the corresponding polyhedron. A change in the coordinates of the vertices leads to a gradual change in the shape of the curve, which makes it possible to optimize the profile and eventually the blading surfaces of turbomachines when using three-dimensional gasdynamic models. The representation of an aerodynamic curve in the form of a Bezier curve provides a good intuitive relation between the curve and the reference points, which is important when changes are made directly in the graphic image in an interactive manner. V.L.

N86-10002# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

SECOND ORDER APPROXIMATION METHOD FOR TRANSONIC FLOWS OVER SWEEPED WINGS

S. KEYANG (Shanghai Aviation Industry Corp.) *In its Acta Aeron. and Astronautica Sinica* (FTD-ID(RS)T-1120-84) p 1-17 4 Oct. 1984 refs Transl. into ENGLISH from Hangkong Xuebao (China), v. 4, no. 4, 1983 p 1-10

Avail: NTIS HC A04/MF A01 CSCL 01A

The TSDH equation is used to calculate the transonic flows over three dimensional swept wings. It considers the leading edge boundary conditions and leading edge velocity potential equation suitable for the blunt leading edge of wings. The expanded form of the Jameson scheme is used in the unequal step length grid for the discretization of the TSDH equation into a set of finite difference equations. A rarefied grid was arranged in the calculation space, then a dense grid was arranged near the wing and alternate iteration of the rarefied and dense meshes was carried out so as to accelerate convergence and raise calculation precision. Calculations of the supercritical without shock wave and with shock wave conditions of the ONERA M6 wing show that there is good agreement between the TSDH solution and the FVP solution and wind tunnel tests. Author

N86-10003# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

A NUMERICAL SOLUTION OF THE SHOCK-TURBULENT INTERACTION OVER A COMPRESSION CORNER FOR SUPERSONIC FLOW

C. QIPENG (Nanjing Aeronautical Inst.) *In its Acta Aeron. et Astronautica Sinica* (FTD-ID(RS)T-1120-84) p 18-33 4 Oct. 1985 refs Transl. into ENGLISH from Hangkong Xuebao (China), v. 4, no. 4, 1983 p 11-19

Avail: NTIS HC A04/MF A01 CSCL 01A

The shock turbulent boundary layer interaction over a compression corner for supersonic flow is calculated. The calculations use the Cebeci-Kellet box method; the turbulence model uses the algebraic eddy viscosity model; the pressure strength distribution uses the unified hypersonic and supersonic formulas of flowing over a wedge. Iteration correction is carried out of the shock turbulent boundary layer disturbance. The calculations predict the wall pressure distribution as well as the initial rise point location of the pressure. Author

N86-10008# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

NUMERICAL SOLUTION OF HYPERSONIC FLOW NEAR LEADING EDGE OF A FLAT PLATE

D. FU *In its Three Articles on New Calculation Methods in Aeron. (Selected Articles)* (FTD-ID(RS)T-0910-84) p 1-14 17 Aug. 1984 refs Transl. into ENGLISH from Hangkong Xuebao (China), v. 4, no. 3, Sep. 1983 p 1-8 Original language document announced in IAA as A84-23903

Avail: NTIS HC A04/MF A01 CSCL 01B

A one-step difference scheme for solving two-dimensional steady state Navier-Stokes equations is proposed to handle supersonic and hypersonic viscous interaction problems near the leading edge of a flat plate. The scheme is considered and analyzed with a model equation. It has second-order accuracy in space for steady state problems and its stability condition is improved. The scheme is much simpler, compared to the commonly used two-step

predictor-corrector difference scheme for N-S equations and also is convenient for programming. Two viscous interaction problems are solved with the proposed scheme; the solutions are valid throughout the boundary layer, shock-wave structure, and inviscid core. The results show good agreement with experimental data. The numerical solutions show that the nonslip conditions can be used for weak viscous interaction. C.D. (IAA)

N86-10009# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

A NEW METHOD FOR CALCULATING UNSTEADY SUPERSONIC AERODYNAMIC FORCES AND ITS APPLICATION

X. WANG *In its Three Articles on New Calculation Methods in Aeron. (Selected Articles)* (FTD-ID(RS)T-0910-84) p 15-31 17 Aug. 1984 refs Transl. into ENGLISH from Hangkong Xuebao (China), v. 4, no. 3, Sep. 1983 p 9-18

Avail: NTIS HC A04/MF A01 CSCL 01B

This paper proposes a new method for calculating supersonic unsteady aerodynamic forces. It combines the piston theory for unsteady supersonic flow with the conical flow theory for steady flow so that the interaction between points on a wing neglected in the piston theory is approximated by the conical flow theory. This method was used in this paper for flutter calculations of 29 cases for wings with 10 different types of plane forms. The results were compared with flutter test results obtained in wind tunnels and they were in satisfactory agreement. It was especially the case that the accuracy of flutter analysis improved by this method was noticeably higher than that obtained by the piston theory. This shows that this method is reliable and feasible for supersonic flutter analysis. It possesses the advantages of being a more succinct method and having higher calculation accuracy, less computing time and easier programming. Author

N86-10010# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

EFFECT OF A SHEAR LAYER ON THE STABILITY OF AN AXISYMMETRICAL EXTERNAL COMPRESSION AIR INTAKE

K. ZHANG, S. YU, and C. PENG *In its Three Articles on New Calculation Methods in Aeron. (Selected Articles)* (FTD-ID(RS)T-0910-84) p 32-42 17 Aug. 1984 refs Transl. into ENGLISH from Hangkong Xuebao (China), v. 4, no. 3, Sep. 1983 p 56-62

Avail: NTIS HC A04/MF A01 CSCL 01B

The influence of shear layers of various strengths on the stability of an axisymmetric compression supersonic air intake is studied. Strength is defined as the ratio of total pressure difference between the two sides of a shear layer to the total pressure of the incoming flow. Six central bodies with different cone angles were used to produce shear layers with strengths ranging from 5 to 11 percent of the total pressure of upstream flow inside a free stream wind tunnel with a fixed Mach number of 1.72. Shear layers with less than 10 percent strength were strong enough to cause separation of the boundary layer from the inside surface of the cowl. Shear layers of strength less than 11 percent failed to induce buzz in the axisymmetric intake. The influence of a shear layer depended on its distance from the lip of the cowl, and was most noticeable at a distance of 10 to 18 percent of the cowl radius. C.D. (IAA)

N86-10011# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

COMMENT ON DETERMINATION OF AERODYNAMIC COEFFICIENTS FOR A REENTRY BODY BY MEANS OF THE KALMAN FILTER METHOD

J. CAI *In its Three Articles on New Calculation Methods in Aeron. (Selected Articles)* (FTD-ID(RS)T-0910-84) p 43-46 17 Aug. 1984 Transl. into ENGLISH from Hangkong Xuebao (China), v. 4, no. 3, Sep. 1983 p 102-104

Avail: NTIS HC A04/MF A01 CSCL 01B

Research emphatically indicates that a mathematical model for aerodynamic parameter identification of a reentry body bases only on the data of angular rates and accelerations onboard but not on trajectory observation data. It can only determine the ratio

between aerodynamic coefficients of the reentry body but can't determine the aerodynamic coefficients directly. B.W.

N86-10012 Georgia Inst. of Tech., Atlanta.
A STUDY OF THE AERODYNAMIC PERFORMANCE OF WEIS-FOGH WINGS Ph.D. Thesis

H. H. CHEN 1985 145 p

Avail: Univ. Microfilms Order No. DA8510956

A general theory of aerodynamics developed on the basis of viscous flow equations, is utilized in an investigation of the Weis-Fogh problem. The general theory is ideally suited for nonlinear unsteady aerodynamic problems. It is also shown that the general theory permits the important flow elements dominating the aerodynamics of nonlinear unsteady flows to be identified and their contributions evaluated individually. The Weis-Fogh problem is a well known biofluidynamics problem involving articulate lifting bodies. The present study has yielded useful results for the lift and drag acting on a wing undergoing the fling and the clap phases of the Weis-Fogh motion. Closed form expressions have been obtained for the unsteady aerodynamic forces and the power expenditure of the Weis-Fogh wing. These results have led to the identification of major contributions to aerodynamic performance of the Weis-Fogh wings and to an assessment of the relative importance of these contributions. Dissert. Abstr.

N86-10013 Princeton Univ., N. J.
ON THE DESIGN OF AIRFOILS IN TRANSONIC FLOW USING THE EULER EQUATIONS Ph.D. Thesis

J. F. FAY 1985 83 p

Avail: Univ. Microfilms Order No. DA8509636

This work falls naturally into two parts. One part describes a computer program that designs airfoils using the Lighthill method of conformal mappings. This program involves the use of the Euler equations to solve for the flow past a given initial shape, and also around intermediate shapes. The other part is a derivation of an extension of the Lighthill method to compressible flows with the assumptions of potential flow and small disturbances of the free stream. The description of the program speaks to its various aspects, namely the Euler solution formulation and the actual process of design. Several other topics are also mentioned; these include several factors affecting the rate of convergence of the design process, the importance of equaling the lift coefficients of the initial and final shapes; and the effect of using the same design velocity distribution at different freestream Mach numbers. There is a short appendix giving a plausible argument indicating that the interaction for small disturbance and arbitrary subsonic Mach number will converge to a desired shape. Dissert. Abstr.

N86-10014*# Vanderbilt Univ., Nashville, Tenn. Dept. of Mechanical and Materials Engineering.

THE ROLE OF FREESTREAM TURBULENCE SCALE IN SUBSONIC FLOW SEPARATION Interim Progress Report, 1
 Jan. - 30 Jun. 1985

J. L. POTTER, W. R. SEEBAUGH, C. E. FISHER, R. J. BARNETT, and R. B. GOKHALE 30 Jun. 1985 56 p
 (Contract NAG1-483)

(NASA-CR-176237; NAS 1.26:176237; IPR-2) Avail: NTIS HC A04/MF A01 CSCL 01A

The clarification of the role of freestream turbulence scale in determining the location of boundary layer separation is discussed. Modifications to the test facility were completed. Wind tunnel flow characteristics, including turbulence parameters, were determined with two turbulence generating grids, as well as no grid. These results are summarized. Initial results on the role of scale on turbulent boundary layer separation on the upper surface of an airfoil model are also discussed. Author

N86-10015*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

EVALUATION OF AN AERODYNAMIC-LOAD PREDICTION METHOD ON A STOL FIGHTER CONFIGURATION

J. KATZ Aug. 1985 33 p refs Previously announced as N85-33121

(NASA-TM-86782; REPT-85358; NAS 1.15:86782) Avail: NTIS HC A03/MF A01 CSCL 01A

A three-dimensional panel method was used to compute the aerodynamic loads on a large-scale, powered wind tunnel model. The size of the computation grid was selected such that turnaround times, on present computers remained satisfactory. With this constraint, the STOL aircraft configuration was modeled and the capabilities and limitations of the prediction method were investigated. After this study, a similar numerical model was established for a forward-swept-wing aircraft configuration which is planned for large-scale, low-speed testing. The resulting aerodynamic-load predictions are discussed and will be utilized, together with the future experimental results, to obtain a broader validation of this method as well as to reduce the necessary size of the matrix of the test parameters. Author

N86-10016*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

OPERATING CHARACTERISTICS OF THE MULTIPLE CRITICAL VENTURI SYSTEM AND SECONDARY CALIBRATION NOZZLES USED FOR WEIGHT-FLOW MEASUREMENTS IN THE LANGLEY 16-FOOT TRANSONIC TUNNEL

B. L. BERRIER, L. D. LEAVITT, and L. S. BANGERT Sep. 1985 74 p refs

(NASA-TM-86405; L-15960; NAS 1.15:86405) Avail: NTIS HC A04/MF A01 CSCL 01A

An investigation has been conducted in the Langley 16 Foot Transonic Tunnel to determine the weight flow measurement characteristics of a multiple critical Venturi system and the nozzle discharge coefficient characteristics of a series of convergent calibration nozzles. The effects on model discharge coefficient of nozzle throat area, model choke plate open area, nozzle pressure ratio, jet total temperature, and number and combination of operating Venturis were investigated. Tests were conducted at static conditions (tunnel wind off) at nozzle pressure ratios from 1.3 to 7.0. Author

N86-10017*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

THREE-DIMENSIONAL INVISCID ANALYSIS OF RADIAL TURBINE FLOW AND A LIMITED COMPARISON WITH EXPERIMENTAL DATA

Y. K. CHOO and K. C. CIVINSKAS (Army Aviation Research and Technology Activity) 1985 28 p refs To be presented at the ASME Winter Ann. Meeting, 3-Dimensional Flow Phenomena in Fluid Machinery Symp., Miami, Fla., 17-22 Nov. 1985

(NASA-TM-87091; E-2679; NAS 1.15:87091; USAAVSCOM-TR-85-C-12) Avail: NTIS HC A03/MF A01 CSCL 01A

The three-dimensional inviscid DENTON code is used to analyze flow through a radial-inflow turbine rotor. Experimental data from the rotor are compared with analytical results obtained by using the code. The experimental data available for comparison are the radial distributions of circumferentially averaged values of absolute flow angle and total pressure downstream of the rotor exit. The computed rotor-exit flow angles are generally underpredicted relative to the experimental values, which reflect the boundary-layer separation at the trailing edge and the development of wakes downstream of the rotor. The experimental rotor is designed for a higher-than-optimum work factor of 1.126 resulting in a nonoptimum positive incidence and causing a region of rapid flow adjustment and large velocity gradients. For this experimental rotor, the computed radial distribution of rotor-exit to turbine-inlet total pressure ratios are underpredicted due to the errors in the finite-difference approximations in the regions of rapid flow adjustment, and due to using the relatively coarser grids in the middle of the blade region where the flow passage is highly

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three-dimensional. Additional results obtained from the three-dimensional inviscid computation are also presented, but without comparison due to the lack of experimental data. These include quasi-secondary velocity vectors on cross-channel surfaces, velocity components on the meridional and blade-to-blade surfaces, and blade surface loading diagrams. Computed results show the evolution of a passage vortex and large streamline deviations from the computational streamwise grid lines. Experience gained from applying the code to a radial turbine geometry is also discussed.

Author

N86-10018*# National Aeronautics and Space Administration. Johnson (Lyndon B.) Space Center,
NUMERICAL PROCEDURE FOR THREE-DIMENSIONAL HYPERSONIC VISCOUS FLOW OVER AEROBRAKE CONFIGURATION

C. P. LI Aug. 1985 17 p refs
(NASA-TM-58269; S-549; NAS 1.15:58269) Avail: NTIS HC A02/MF A01 CSCL 01A

A numerical method, which is simpler and more efficient than others currently in use, is proposed for the computation of the full viscous flow over an aerobrake body in hypersonic stream at high altitude. It treats the shock layer surrounding the blunt forebody and the near wake behind the base simultaneously by formulating the Navier-Stokes equations in conformal and azimuthal-angle coordinates. The computational domain is confined by the body wall, outflow surface and the shock, which is adjusted along the coordinate normal to the wall in the course of iterations. Because of the optimal grid and a well developed alternating direction implicit factorization technique for the governing equations, reasonably accurate results can be obtained with a 28 x 36 x 7 grid and 400 time-marching iterations. Excellent agreement of shock location is found between the present result and the schlieren photograph. Details of the base flow and shear layer impingement on the cylindrical aft body are presented for an adiabatic wall case.

Author

N86-10019*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

FORCED RESPONSE ANALYSIS OF AN AERODYNAMICALLY DETUNED SUPERSONIC TURBOMACHINE ROTOR

D. HOYNIK and S. FLEETER (Purdue Univ., West Lafayette, Ind.) 1985 24 p refs Presented at 10th Bien. Design Eng. Div. Conf. and Exhibit on Mech. Vibration and Noise, Cincinnati, 10-13 Sep. 1985; sponsored by ASME

(NASA-TM-87093; E-2685; NAS 1.15:87093) Avail: NTIS HC A02/MF A01 CSCL 01A

High performance aircraft-engine fan and compressor blades are vulnerable to aerodynamically forced vibrations generated by inlet flow distortions due to wakes from upstream blade and vane rows, atmospheric gusts, and maldistributions in inlet ducts. In this report, an analysis is developed to predict the flow-induced forced response of an aerodynamically detuned rotor operating in a supersonic flow with a subsonic axial component. The aerodynamic detuning is achieved by alternating the circumferential spacing of adjacent rotor blades. The total unsteady aerodynamic loading acting on the blading, as a result of the convection of the transverse gust past the airfoil cascade and the resulting motion of the cascade, is developed in terms of influence coefficients. This analysis is used to investigate the effect of aerodynamic detuning on the forced response of a 12-blade rotor, with Verdon's Cascade B flow geometry as a uniformly spaced baseline configuration. The results of this study indicate that, for forward traveling wave gust excitations, aerodynamic detuning is very beneficial, resulting in significantly decreased maximum-amplitude blade responses for many interblade phase angles.

Author

N86-10020# Department of the Air Force, Washington, D.C.
SUBMERGED RAM AIR INLETS FOR ECM (ELECTRONIC COUNTERMEASURES) PODS Patent Application
FOXWELL, inventor (to Air Force) 27 Jun. 1985 15 p
(AD-D011801; US-PATENT-APPL-SN-749333) Avail: NTIS HC A02/MF A01 CSCL 21E

The present invention utilizes a substantially pear-shaped submerged air inlet duct in the surface of an electronic countermeasures (ECM) pod to provide cooling air for heat exchanger units which are utilized to cool electronic components in a ECM pod. The smaller opening is in the forward most position.

GRA

N86-10021# Sandia National Labs., Albuquerque, N. Mex.
INVISCID FLOW FIELD ANALYSIS OF MANEUVERING HYPERSONIC VEHICLES USING THE SCM FORMULATION AND PARABOLIC GRID GENERATION

R. W. NOACK 1985 13 p Presented at the 18th Fluid Dyn., Plasma Dyn. and Lasers, Cincinnati, 16 Jul. 1985.

(Contract DE-AC04-76DP-00789)
(DE85-013950; SAND-84-2670C; CONF-850717-1) Avail: NTIS HC A02/MF A01

The split-coefficient matrix (SCM) form of the Euler equations for a cylindrical base coordinate system is extended to allow the use of a generalized three-dimensional grid generation scheme. A grid generation scheme based on a parabolic partial differential equation is developed. Grids are obtained without iteration by marching from the body to the shock with body and shock points specified. The SCM type body boundary condition has been found to underpredict surface pressure for geometries with small radii of curvature. An improved method of characteristic (MOC) type body boundary condition has been developed which uses SMC type differencing in the crossflow direction. The improved MOC boundary condition has been found to have the robustness of the SCM type scheme while having superior accuracy. Solutions using the SCM form of the Euler equations with the parabolic grid generator and the improved MOC body boundary condition have been obtained for a hypersonic six fin missile. Generally good agreement is found in comparisons of the inviscid predictions with experimental data.

DOE

N86-10022# Office National d'Etudes et de Recherches Aeronautiques, Paris (France). Direction Scientifique de la Resistance des Structures.

THEORETICAL STUDY OF THE UNSTEADY LINEAR PROBLEM FOR A RECTANGULAR WING WITH A PITCHING MOVEMENT

Final Report [ETUDE THEORIQUE DU PROBLEME INSTATIONNAIRE LINEAIRE POUR UNE AILE RECTANGULAIRE ANIMEE D'UN MOUVEMENT DE TANGAGE]

C. CONEIM Jun. 1984 35 p refs In FRENCH
(Contract DRET-83-34-135)

(ONERA-RT-17/1841-RY-010-R) Avail: NTIS HC A03/MF A01

The pressure distribution on a helicopter rectangular wing with a positive angle of attack and a harmonic pitching movement is computed. The flow separation is not taken in account as the incidence is assumed to be low. The treatment of the singularity is detailed. Results for relatively high frequencies and three profiles are presented. The three dimensional effects of the wing tip are shown.

Author (ESA)

N86-10023# Societe Nationale Industrielle Aerospatiale, Toulouse (France). Div. Avions.

AERODYNAMICS OF HYPERLIFT SYSTEMS [AERODYNAMIQUE DES SYSTEMES HYPERSUSTENTATEURS]

P. CAPBERN, J. JAVELLE, N. LARGER, A. J. PAUT, and C. BONNET 23 Jan. 1985 97 p refs In FRENCH

(Contract DRET-83-34-051-00-470-75-01)
(SNIAS-443.501/85) Avail: NTIS HC A05/MF A01

A method to compute two dimensional noncompressible viscous flow on multiprofile configurations is described. The potential flow and the viscous layers are solved interactively. The potential flow is obtained by a singularities method. The boundary layers are

treated by integral equations. Evaluation using the ATR 42 configuration (narrow slots, separated flow) shows the robustness of the method when treating difficult problems and a good prediction of separation and pressure distribution. The computer program is adapted to industrial utilization on CRAY 1 computer.

Author (ESA)

N86-10024# Societe Nationale Industrielle Aerospatiale, Toulouse (France).

ANALYSIS OF HYPERLIFT SYSTEMS. STUDY OF A SINGULARITIES METHOD [ANALYSE DES SYSTEMES HYPERSUSTENATEURS. ETUDE D'UNE METHODE DE SINGULARITES]

N. LARGER 10 Sep. 1984 42 p In FRENCH
(SNIAS-443.529/84; SNIAS-443.501/85) Avail: NTIS HC A03/MF A01

Singularity models are tested to solve problems imposed by narrow airfoil profiles commonly found in industrial configurations. Solutions including computation phases, skeleton and thick profile, and the adoption of vortices for either the skeleton or the full profile are described. The results obtained are better than those from classic methods.

Author (ESA)

N86-10025# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Abt. Hochgeschwindigkeitsstroemungen.

INVESTIGATIONS ON A SUPERCRITICAL AIRFOIL WITH BOUNDARY LAYER SUCTION THROUGH A PERFORATED STRIP IN THE SHOCK REGION

P. KROGMANN Nov. 1984 56 p refs In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-940)

(DFVLR-FB-85-15; ISSN-0171-1342) Avail: NTIS HC A04/MF A01; DFVLR, Cologne DM 16.50

The effect of local boundary layer suction through a perforated strip on the flow development and aerodynamic characteristics of a transonic airfoil is investigated in a 1 m X 1 m transonic wind tunnel. In comparison with reference measurements on the same model with a solid surface, the results show that, aside from the improvements due to suction, the flow development in the non-suction case is most favorably affected by the arrangement of the perforated strip with a cavity underneath. Due to a secondary flow through the perforation and cavity, caused by the strong adverse pressure gradients occurring at higher angles of attack, the shock location as well as the flow field downstream of the shock are affected. Thus, considerable gain in maximum lift and drag reductions can be achieved.

Author (ESA)

N86-10026# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Forschungsbereich Stroemungsmechanik.

EXPERIMENTAL AND THEORETICAL INVESTIGATIONS OF THE FLOW AROUND AIRFOIL SYSTEMS WITH GROUND EFFECT

D. STEINBACH Sep. 1984 63 p refs
(DFVLR-FB-85-17; ISSN-0171-1342) Avail: NTIS HC A04/MF A01; DFVLR, Cologne DM 21.50

For two rectangular wings with flaps (Q/R4 and NACA 4415) pressure distribution for plane flow and low flow velocities is measured. For ground simulation fixed ground boards adjustable in height are used. Reynolds and Mach numbers are 1.6 million and 0.15. For the NACA 4415 wing flow field measurements are carried out also. The surface singularity method with separation model used for the calculations is outlined. Agreement between experiment and theory is good to satisfactory, especially if flow separation is not too large. But even for large separated flow regions the separation model improves results. The presence of ground gives enlarged flow separation, higher pressure and base pressure values, and lower suction peaks. High-lift systems with positive camber line show considerable losses of lift near ground. A static instability of lift with respect to ground distance occurs. This effect becomes stronger as the angle of attack is increased.

Author (ESA)

N86-11183 Kansas Univ., Lawrence.

INLET FLOW DYNAMIC DISTORTION PREDICTION WITHOUT RMS MEASUREMENTS Ph.D. Thesis

Y. S. CHEN 1984 118 p

Avail: Univ. Microfilms Order No. DA8513816

A two-equation turbulence model, k-epsilon model, is used in the prediction of inlet flow dynamic distortion of jet aircraft based on steady state total pressure measurements only. This Turbulence model is solved at the compressor face station by using a finite difference scheme. Total pressure rms level of the inlet flow is predicted by the turbulence model. The Melick statistical method is then employed to estimate the peak dynamic distortion based on the analytically predicted total pressure rms level. A statistical method is developed for the estimation of boundary conditions for the turbulent equations. In order to solve the set of nonlinear, coupled turbulent equations, an implicit formulation is utilized such that a set of discretized finite difference equations can be arranged into tridiagonal matrix equations for efficient numerical iterations. Results of the prediction compare well with experimental measurements of subsonic, transonic and supersonic inlets under various flight conditions. The present method can be used in the preliminary inlet design phases to reduce the design costs.

Dissert. Abstr.

N86-11186*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

EFFECT OF AILERON DEFLECTIONS ON THE AERODYNAMIC CHARACTERISTICS OF A SEMISPAN MODEL OF A SUBSONIC ENERGY-EFFICIENT TRANSPORT

P. F. JACOBS Oct. 1985 344 p refs

(NASA-TP-2478; L-15934; NAS 1.60:2478) Avail: NTIS HC A15/MF A01 CSCL 01A

An investigation was conducted in the Langley 8 Foot Transonic Pressure Tunnel to determine the effect of aileron deflections on the aerodynamic characteristics of a subsonic energy efficient transport (EET) model. The semispan model had an aspect ratio 10 supercritical wing and was configured with a conventionally located set of ailerons (i.e., a high speed aileron located inboard and a low speed aileron located outboard). Data for the model were taken over a Mach number range from 0.30 to 0.90 and an angle of attack range from approximately -2 deg to 10 deg. The Reynolds number was 2.5 million per foot for Mach number = 0.30 and 4 million per foot for the other Mach numbers. Model force and moment data, aileron effectiveness parameters, aileron hinge moment data, otherwise pressure distributions, and spanwise load data are presented.

Author

N86-11187# Cranfield Inst. of Tech., Bedford (England). Coll. of Aeronautics.

GROUND EFFECT ON A ROTOR WAKE Ph.D. Thesis - March 1985

I. KUSMARWANTO Jun. 1985 116 p refs

(COLL-AERONAUTICS-8510) Avail: NTIS HC A06/MF A01

The effect of the ground on a rotor wake in forward flight was investigated experimentally in the working section of an 8 ft x 4 ft straight through wind tunnel. A three bladed fully articulated rotor with a solidity ratio of 0.07 and diameter of 1.06 m, powered by a hydraulic motor, was tested at a height of 0.47 rotor diameter above a solid ground board which has an elliptical leading edge. Tests were run at various low advance ratios (less than 0.1) with two collective pitch settings. A hot wire anemometer probe was used to measure the average value of the three components of velocity. The rotor wake and the ground vortices were visualized by smoke. Both experimental results and theoretical estimates show that the ground induced interference is an upwash and a decrease in forward velocity.

Author

02 AERODYNAMICS

N86-11188*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

SHOCK FITTING APPLIED TO THE PREDICTION OF HIGH-SPEED ROTOR NOISE

J. W. RUTHERFORD Oct. 1985 19 p refs
(NASA-TM-86781; REPT-85384; NAS 1.15:86781;
USAAVSCOM-TR-85-A-8) Avail: NTIS HC A02/MF A01 CSDL
01A

A shock fitting method applied to the transonic small disturbance (TSD) potential equation is described. This method is then applied to a simple, two dimensional (2-D) rotating disturbance which is analogous to a shock radiating from the tip of a rotor blade in high speed hover. A comparison is made between the results of this method and the more standard shock capturing method. This comparison makes it clear that the effect of the results on the acoustic signature of the 2-D model is significant, and similar results can be expected when the method is extended to the three dimensional (3-D) case. Author

N86-11189*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

USER'S MANUAL FOR A 0.3-M TCT WALL INTERFERENCE ASSESSMENT/CORRECTION PROCEDURE: 8- BY 24-INCH AIRFOIL TEST SECTION

C. R. GUMBERT Sep. 1985 49 p refs
(NASA-TM-87582; NAS 1.15:87582) Avail: NTIS HC A03/MF
A01 CSDL 01A

A transonic Wall-Interference Assessment/Correction (WIAC) procedure has been developed and verified for the 8- by 24-inch airfoil test section of the Langley 0.3-m Transonic Cryogenic Tunnel. This report is a user's manual for the correction procedure. It includes a listing of the computer procedure file as well as input for and results from a step-by-step sample case. Author

03

AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

A86-12011 ACCIDENT INVESTIGATION

H. HOPKINS Flight International (ISSN 0015-3710), vol. 128, Sept. 28, 1985, p. 32-36.

The investigation of aircraft accidents by the Accident Investigation Board (AIB) of the United Kingdom is described. Techniques utilized by the AIB staff, such as the detecting of a flight data recorder, taking on land photographs, and performing real-time data presentation on a CRT, are explained. Investigatory organizations in other countries are discussed. The basic questions and procedures which must be conducted for all investigations are described. The problems with advanced electronic flight instrumentation are discussed. The training and credentials of the AIB staff are explained. I.F.

N86-11190# Air Command and Staff Coll., Maxwell AFB, Ala. COMING SOON TO A THEATER NEAR YOU: THE MICROWAVE LANDING SYSTEM

K. S. C. HAMILTON Apr. 1985 23 p
(AD-A156468; ACSC-85-1025) Avail: NTIS HC A02/MF A01
CSDL 01B

This informational handbook has been prepared in response to a requirement levied by the SAC Instrument Flight Course (SIFC), Castle AFB, California. The Microwave Landing System (MLS) is projected for worldwide installation and use by both civilian and military facilities. This handbook has been developed for use in conjunction with an individualized lesson plan, prepared by the SIFC faculty. The history, development, advantages, and future projections for this excellent system are explained. The handbook

is not a text for engineers, but for the pilot who is interested in safety of flight, noise abatement, and increased system confidence. The author's intent in authoring this project was to provide a brief introduction to the reasons behind the transition from Instrument Landing System (ILS) to the Microwave Landing System (MLS), and the international scope of this endeavor. Through the comparison of the operational and maintenance advantages of these two systems the author hopes to capture the interest of pilots by making them aware of the tremendous technological gains embodied in the Microwave Landing System. GRA

N86-11191# Federal Aviation Administration, Atlantic City, N.J. Technical Center.

USER'S MANUAL FOR AC-20-53A PROTECTION OF AIRPLANE FUEL SYSTEMS AGAINST FUEL VAPOR IGNITION DUE TO LIGHTNING

N. RASCH Oct. 1984 72 p
(AD-A157619; DOT/FAA/CT-83/3) Avail: NTIS HC A04/MF
A01 CSDL 01B

This manual provides users of AC 20-53A, protection of aircraft fuel systems against fuel vapor ignition due to lightning, with information on the subject of fuel system lightning protection and methods of compliance of aircraft design with the Federal Aviation Regulations 23.954 and 25.954. The manual is the result of a 3-year effort requested by the FAA Technical Center of the SAE-AE4L committee which is comprised of experts in the field of lightning research and protection of aircraft and systems from the adverse effects associated with atmospheric electricity. GRA

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

A86-10352 A STUDY INTO THE OPERABILITY OF RPVS IN ADVERSE WEATHER

L. V. PARKINGTON (Royal Armament Research and Development Establishment, Fort Halstead, England) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings . Bristol, University of Bristol, 1984, p. 1.1-1.4.

The effect of cloud base height on the operability of an RPV is examined, taking into account the requirement for a direct line of sight (LOS) between the vehicle in the air and the ground data terminal (GDT). Cloud base height measurements carried out in Germany at quarterly intervals were curve fitted by a spline interpolation to calculate the probability of a direct LOS between the vehicle and the GDT, and RPV operability is calculated as a function of range. The mean operability was in the range 0.75-0.95, and the worst case operability at a distance of 70 kms was 0.6. The seasonal variation in operability was within 0.2 for typical operating conditions. It is concluded that the mean operability of about 0.8 should not reduce the effectiveness of RPV systems for most day/night surveillance and target acquisition applications. I.H.

A86-10368 THE VEGA PORTABLE RADAR TRACKING CONTROL SYSTEM

R. F. IRBY (Vega Precision Laboratories, Vienna, VA) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings . Bristol, University of Bristol, 1984, p. 22.1-22.8.

Some past applications of the model 657 portable radar tracking control system are described, and some recent design improvements are noted. The model 657 portable radar tracking system consists of only three major components including the antenna; radar set control; and target position display unit. Some

of the design improvements incorporated into the latest version of the portable radar tracking system, model 6157, include: an increased operational range from 50 to 100 nautical miles; enhanced interference rejection by means of pulse amplitude discrimination and pulse position coding; and more data downlink channels. The new 6157 system is recommended as a tracking radar for RPV applications. Black and white photographs of the model 657 and the model 6157 radars are provided. I.H.

A86-10370
DOPPLER NAVIGATION AND THE RPV

K. HOLFORD (Philips Research Laboratories, Redhill, England) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings. Bristol, University of Bristol, 1984, p. 24.1-24.6. Research supported by the Ministry of Defence (Procurement Executive).

The size, weight and cost of a Doppler navigator suitable for use in a RPV is dependent on the system used and the performance required. A height ceiling of a few thousand feet is substantially less than that of a normal commercial navigator and allows a simplification of the design. The unmodulated carrier type of Doppler navigator design is not, however, the most appropriate for the requirement. This paper looks at navigator construction and describes a suitable one for the RPV application. Author

A86-11116
DATA LINK COMMUNICATIONS IN TACTICAL AIR COMMAND AND CONTROL SYSTEMS

C. L. GOLLIDAY, JR. (Institute for Defense Analysis, Alexandria, VA) IEEE Journal on Selected Areas in Communications (ISSN 0733-8716), vol. SAC-3, Sept. 1985, p. 779-791. DOD-sponsored research. refs

Data links in tactical air command and control systems (ACCSs) connect the computers of command and control units to one another and to weapon systems to enable rapid exchanges of real-time tactical information. This paper presents an overview description of the current and future ACCS data link architecture used by the Services and NATO. This architecture currently consists of various tactical digital information link (TADIL) standards and NATO link standards. In the near future, the Joint Tactical Information Distribution System (JTIDS) will be a major component of the architecture. While the architecture of the far future is speculative, a description of some concepts being considered, such as the role of the International Standards Organization (ISO) reference model, is presented. Author

A86-12046
METHODOLOGY OF THE FLIGHT TESTING OF THE FLIGHT-CONTROL AND NAVIGATION EQUIPMENT OF AIRCRAFT AND HELICOPTERS [METODOLOGIJA LETNYKH ISPYTANI I PILOTAZHNO-NAVIGATSIONNOGO OBORUDOVANIJA SAMOLETOV I VERTOLETOV]

D.-E. P. NOVODVORSKII, G. I. POIARKOV, E. G. KHARIN, O. V. VINOGRADOV, and P. I. VLASOV Moscow, Izdatel'stvo Mashinostroenie, 1984, 136 p. In Russian. refs

The general design of the flight-control and navigation complexes of aircraft and helicopters is discussed, and the principal components of these systems are examined. Attention is then given to the structure and methods of the flight testing of flight-control and navigation systems as well as methods for the processing and analysis of flight test data. The discussion also covers the computer simulation of flight-control and navigation complexes and methods for evaluating their precision. V.L.

A86-12300
TACTICAL JAMMING

A. D. ROBERTSON and F. C. PAINTER (Watkins-Johnson Co., San Jose, CA) Defense Science and Electronics (ISSN 0744-6241), vol. 4, Sept. 1985, p. 20-22, 24, 26, 28.

It is pointed out that various technological factors have combined to increase the ability of modern systems to effectively jam multiple transitory targets without seriously degrading friendly communications. Possibilities for improving jam-resistance are,

therefore, considered. In this context, it is important to review the state of development of short-range VHF/UHF tactical communications systems, and the jamming devices which have been developed to defeat them. Attention is given to three electrical system design approaches commonly used to improve the antijam capabilities of communication systems, the types of jammers, time-share jamming, jamming slower systems, time-gated repeaters, and future developments. G.R.

N86-11192# IIT Research Inst., Annapolis, Md.
TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM SIGNAL ENVIRONMENT MODEL (TCAS SEM) PROGRAMMER'S REFERENCE MANUAL Final Report, Aug. 1984 - Feb. 1985
C. GILCHRIST, E. WOODS, and T. KEECH Jul. 1985 169 p refs Prepared for Dept. of Defense, Annapolis (Contract F19628-80-C-0042) (FAA-PM-85-22; ECAC-CR-85-031) Avail: NTIS HC A08/MF A01

A traffic alert and collision avoidance system signal environment model (TCAS SEM) was developed to predict the time-average TCAS I and minimum TCAS II signal rates in a user-selected air traffic deployment. The TCAS SEM is described which includes: the modeled systems, the data-storage and retrieval subsystems for engineering data, and the software structures of all component subsystems. E.A.K.

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A86-10354
THE OPERATIONAL 'EYRIE' MULTI-ROLE ADVANCED MINI-RPV SYSTEM

M. REED (National Dynamics /Pty/, Ltd., Pinetown, Republic of South Africa) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings. Bristol, University of Bristol, 1984, p. 5.1-5.6.

The design characteristics of the Eyrie multirole returnable RPV are described. Consideration is given to the control and guidance equipment which permit the Eyrie to maintain a round-the-clock all-weather capability for real-time surveillance; electronic countermeasures; and rocket strikes against a variety of targets. The powerplant of the Eyrie consists of one 52 hp two-cylinder two-stroke engine with integral cooling. The ground control and associated tracking equipment for the Eyrie are described including the video link to ground; the command data processing hardware; and payload and weapons management systems. A series of photographs of the vehicle is provided. I.H.

A86-10355
EXPERIMENTAL RPV - AN INDIAN EXPERIENCE

R. KRISHNAN, V. MITTAL, and V. DESIKAN (Aeronautical Development Establishment, Bangalore, India) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings. Bristol, University of Bristol, 1984, p. 7.1-7.11.

The design features of an Indian RPV system for civilian applications are discussed. The vehicle was built for takeoff from short runways, glider strips, or highways carrying a 10-16 lb payload. The vehicle has a high wing twin boom and pusher propeller configuration with a wing span of 3.8 m and a chord of 0.6 m. The airfoil section for the wings corresponded to a NACA 2412 profile. The powerplant for the RPV was a commercially available two cylinder piston engine of 18 hp. Control and data telemetry for the RPV was provided by a UHF FM/FDM/FM system (uplink) and a VHF/FM/FM system (downlink), with all essential flight data transmitted through the downlink. The vehicle stabilization system

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

consisted of a vertical gyro, a heading sensor, a height hold transducer; and an air data transducer. A series of flight tests of the RPV system is described, and photographs of the vehicle in flight are provided. I.H.

A86-10358

THE AUTOGYRO AS A R.P.V

W. M. FRASER (W. Vinten, Ltd., Bury Saint Edmunds, England) IN: Remotely piloted vehicles; International-Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings. Bristol, University of Bristol, 1984, p. 10.1-10.8.

The design of a remotely piloted autogyro is described. The basic airframe structure consists of a keel and rotor pylon manufactured from light alloy tubing and supported by T section light alloy extrusions. The powerplant of the autogyro is a modified four cylinder air cooled two stroke engine of 70 hp, driving a fixed two blade pusher propeller and a pre-takeoff spin up drive. The autogyro control system consisted of two servo actuators powered by 12V/5 amp batteries, and a two-axis hand controller. A push button was mounted on top of the control column for quick conversion to manual control. The system was tested during the course of one flight, and some improvements in the design of the servo actuators are recommended on the basis of the flight test results. A black and white photograph of the instrumentation panel is presented. I.H.

A86-10365

DESIGN STANDARDS FOR UNMANNED AIRVEHICLES (UMAV)

P. H. MORGAN (Theta Analysis and Systems, Ltd., Camberley, England) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings. Bristol, University of Bristol, 1984, p. 18.1-18.7.

The need for a systematic approach to the design manufacture of unmanned airvehicles (UMAV) in the UK is discussed. Consideration is given to the operational requirements of UMAVs with respect to performance, operating environment, mission role. It is shown that current design requirements of the UK military for UMAVs do not require effective standardization of designs through the use of interchangeable parts, interfaces, and common power capacities. It is recommended that government authorities promulgating UMAV design requirements publish a single stand-alone version of the requirements in order to avoid ambiguity. I.H.

A86-10374

CONDOR - A CANADIAN RPA FOR COMMERCIAL APPLICATIONS

G. F. TOMLINS (British Columbia Research, Vancouver, Canada) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Supplementary Papers. Bristol, University of Bristol, 1984, p. 6.1-6.7. Research supported by the Ministry of Universities, Science and Communications of the Province of British Columbia. refs

The use of remotely piloted aircraft (RPA) for environmental remote sensing is discussed. A fixed-wing model aircraft carrying a 35 mm camera was tested to gain operating experience, evaluate the usefulness of model aircraft for remote sensing, and to determine the limitations of model aircraft. Based on this experiment, general system requirements for a RPA were established; an explanation of these requirements is provided. The B.C. Research RPA program built a new RPA system, the low-cost Condor, based on a conventional puller design. The Condor system is powered by a 6.5 hp single cylinder gasoline engine that drives a 56 cm fixed pitch propeller and is easily dismantled for transportation. The control system, navigation system, sensors, and safety features of the Condor are explained. The Condor system was flight-tested and proved useful for environmental remote sensing as well as for military applications. I.F.

A86-10566

IS THE 680 ROTOR BELL'S LHX CANDIDATE?

M. LAMBERT Interavia (ISSN 0020-5168), vol. 40, Sept. 1985, p. 981, 982.

Features of the prototype 680 all-composite rotor are outlined, together with tested flight qualities which make the 680 a major candidate for the U.S. Army LHX program. The 680 halves the usual number of rotor parts, eliminates heavily loaded bearings, and offers an extremely vibration-free ride, the latter a LHX requirement. Rotor life is estimated at 10,000 hr, the lifetime of a present generation helicopter. A test vehicle equipped with the 680 rotor has performed 200 km/hr dives, pulled 2.8 g, and flown half-rolls and pull-throughs. M.S.K.

A86-10568

TURBOPROP AIRLINERS GET BIGGER - WILL THEY HAVE A MARKET?

B. REK Interavia (ISSN 0020-5168), vol. 40, Sept. 1985, p. 995-998.

New turboprop aircraft seating over 40 passengers are being built by European manufacturers to satisfy the demands of feeder, regional and commuter traffic. The new aircraft include the ATR42-200 44-seater, the F26 50-seater, the ATP 64-seater and the Dash 8 Series 300 50-seater. Variants of all the aircraft are also being planned, some in stretch versions and some with pressurized cabins. Much of the manufacturing activity is spurred by the growth of U.S. regional markets since deregulation. The size of the stretch turboprop aircraft is inherently limited by the overlap with small jet aircraft and their speed advantages. M.S.K.

A86-10926#

LARGE AIRPLANE DERIVATIVE DEVELOPMENT METHODOLOGY

D. L. ROBINSON and M. F. MELARY (Boeing Co., Seattle, WA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 14 p. (AIAA PAPER 85-3043)

The methodology and technologies applied to design derivatives of large commercial aircraft are described. Redesigns are achieved after a five-stage process consisting of requirements definition, preliminary design, detail design and analysis, testing and qualification and product development/design refinement. All factors involved in initiating and accomplishing a new design are performed with an eye to safety as a fundamental design criteria. Decisions can then proceed on the basis of the needs of the market up to 4 yr in advance. The designs must also minimize the airlines' acquisition and operating costs while incorporating state of the art technologies and configuration flexibility. CAD has emerged as a central tool to the development and assessment process. The 747-300 design process is outlined as a case study to illustrate the procedures described. M.S.K.

A86-10932#

A RAPID EVALUATION APPROACH FOR CONFIGURATION DEVELOPMENT OF NEW AIRCRAFT

Y. T. PHOA, F. CAMPISANO, P.-C. CHEN, and G. WAKAYAMA (Northrop Corp., Aircraft Div., Hawthorne, CA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 9 p. refs (AIAA PAPER 85-3068)

Procedures followed in a computerized rapid evaluation (REV) approach to in-depth evaluations of new aircraft configurations at the early conceptual design stage are outlined. REV permits the incorporation of state of the art technology, design trade-off studies and structural design practices which lead to an optimal platform before metal cutting begins. Details of aerodynamic and structural optimization of a wing are reviewed, including the optimization codes employed in the REV CAD studies. Future extensions of the REV process to aeroelastic tailoring of entire aircraft are discussed from the point of view of the required algorithms, particularly in applications with forward swept wing aircraft. M.S.K.

A86-10935#**APPROACH AND LANDING THRUST REVERSER TESTING IN GROUND EFFECT**

P. B. JOSHI (Northrop Corp., Aircraft Div., Hawthorne, CA) and M. K. COMPTON (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 17 p. refs
(Contract F33615-81-C-3025)
(AIAA PAPER 85-3075)

Wind tunnel test results with a thrust reversing twin engine/twin tail scale model similar to a modified F-18 in ground proximity are reported. The trials were performed to expand the database on the thrust reversing twin engine configuration in free air. Tests were run at free air, 0.36 wing span above ground, and landing gear height. The effects of angle-of-attack, sideslip, horizontal tail deflection, rudder deflection, wing trailing edge flap angle, and landing gear were examined. Reverser-induced effects were assessed in terms of the jet/freestream dynamic pressure ratio. Data were also collected on the effects of various jet operational and placement parameters. The results are discussed with regard to aerodynamic effects, particularly at close-to-ground proximity.

M.S.K.

A86-10951#**DEVELOPMENT STATUS OF THE RSRA/X-WING**

R. G. GUERTIN (United Technologies Corp., Sikorsky Aircraft Div., Stratford, CT) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 7 p.
(AIAA PAPER 85-4008)

The four stages of development for the RSRA (Rotor System Research Aircraft)/X-Wing are discussed. A description of the RSRA/X-Wing is provided. The Propulsion System Test Bed (PSTB), which conducts the evaluation and qualification of the drive train and the pneumatic and the rotor components of the X-Wing system, is explained. The functions and testing of the components of the drive train, pneumodynamic, and rotor systems are described. The Vehicle Management System Laboratory (VMSL) which is used to validate the flight control computer software is discussed. The data to be provided by the wind tunnel model are described. The information from PSTB, VMSL, and wind tunnel testing will be incorporated into a ground-based data system. The aircraft is currently being prepared for the final stage of development, flight testing.

I.F.

A86-10953#**ENHANCING AIRCRAFT ROUGH AIRFIELD CAPABILITIES**

G. E. WALROND (USAF, Engineering and Services Center, Tyndall AFB, FL) and M. W. SKINNER (BDM Corp., McLean, VA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 10 p. refs
(AIAA PAPER 85-4018)

USAF research indicates a critical lack of capability for combat and airlift aircraft to operate on rough airfields. Civil engineers will be able to complete repairs and reactivate airfields more rapidly if aircraft rough airfield tolerances are increased. Research shows that coordinating the actions of aircraft undercarriage systems with aerodynamic and propulsion controls can enhance rough surface capability without sacrificing airborne performance. This paper describes the airbase wartime operational environment and a systems approach for designing new aircraft to operate in such an environment. The article is directed toward airbase planners and aircraft designers to increase information transfer regarding problems associated with bomb-damaged airfield operations.

Author

A86-10954#**IN-SERVICE LANDING GEAR ACTUATION SYSTEM PROBLEMS - THE SOLUTION**

W. C. COOK (Lockheed-Georgia Co., Marietta) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 6 p.
(AIAA PAPER 85-4019)

This paper describes the redesigned main landing gear actuation mechanism for the C-5B cargo aircraft and the improvements over that of the C-5A. Difficulties with the existing mechanism are corrected by replacing the entire gearbox/torque tube system with a mechanism consisting of only two gearboxes and a push rod/crank linkage. This yields substantial improvements over the original actuation system such as fail-safe synchronization between gearboxes, dual motor, emergency extension, elimination of clutches in the primary drive train, and improved reliability.

Author

A86-10956#**AN ADHESIVELY SEALED, COMPOSITE SKINNED WING FUEL TANK**

B. J. LOGAN (General Dynamics Corp., Fort Worth, TX) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 12 p. refs
(AIAA PAPER 85-4023)

The development and evaluation of an adhesively sealed wing fuel tank to improve fuel containment is discussed. The adhesive sealing requires a different finish for detail parts than the conventional sealing; these various finishes are described. The benefits of using the adhesive sealing are discussed. The forward wing box design and the assembly of the wing box, which includes the attachment of the understructure assembly and upper and lower skins, are explained. The completed wing fuel tank was fuel leak tested, with cyclic pressure loading and exposure to temperature extremes, to validate the performance of the sealing. The proof test, preconditioning, test block, holding fixture, and method of leak detection are described. The test results are provided; the results revealed that the sealant provided good overall fuel containment.

I.F.

A86-10958*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

A COMPUTER-ASSISTED DESIGN PROCESS FOR SUPERSONIC AIRCRAFT CONCEPTUAL DESIGN

V. S. JOHNSON (NASA, Langley Research Center, Hampton, VA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 12 p. refs
(AIAA PAPER 85-4027)

Design methodology was developed and existing major computer codes were selected to carry out the conceptual design of supersonic aircraft. A computer-assisted design process resulted from linking the codes together in a logical manner to implement the design methodology. The process does not perform the conceptual design of a supersonic aircraft but it does provide the designer with increased flexibility, especially in geometry generation and manipulation. Use of the computer-assisted process for the conceptual design of an advanced technology Mach 3.5 interceptor showed the principal benefit of the process to be the ability to use a computerized geometry generator and then directly convert the geometry between formats used in the geometry code and the aerodynamics codes. Results from the interceptor study showed that a Mach 3.5 standoff interceptor with a 1000 nautical-mile mission radius and a payload of eight Phoenix missiles appears to be feasible with the advanced technologies considered. A sensitivity study showed that technologies affecting the empty weight and propulsion system would be critical in the final configuration characteristics with aerodynamics having a lesser effect for small perturbations around the baseline.

Author

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

A86-10960#

RAPID SIZING METHODS FOR AIRPLANES

J. ROSKAM (Kansas, University, Lawrence) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 8 p.
(AIAA PAPER 85-4031)

A rapid method for preliminary weight sizing of aircraft which uses a series of logarithmic correlations between takeoff weight and empty weight is presented. The method allows rapid calculation of aircraft growth factors due to changes in mission specifications or changes in drag polar, engine specifics, payload, and empty weight. For a given mission specification, a rapid method for estimating takeoff gross weight, empty weight, and mission fuel weight is presented. The method applies to the following 12 types of aircraft: (1) homebuilts; (2) single engine props; (3) twin engine props; (4) agriculturals; (5) business jets; (6) regional turboprops; (7) transport jets; (8) military trainers; (9) fighters; (10) military patrol, bomb, and transport aircraft; (11) flying boats, amphibious, and float aircraft; (12) supersonic cruise aircraft. C.D.

A86-10961#

CONFIGURATION STUDIES FOR FUEL-EFFICIENCY MAXIMISATION

J. E. CHACKSFIELD (British Aerospace, PLC, Airframe Engineering Dept., Kingston-upon-Thames, England) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 8 p. refs
(AIAA PAPER 85-4032)

The use of Multivariate Optimization (MVO), which investigates numerous design options and varies specific parameters, to evaluate configurational changes is examined. The MVO program can handle up to 25 variables and 50 constraints for any one problem. The basic computer design and the design synthesis program, which interface to form MVO are described. The modelling technique used in MVO is explained. An example utilizing MVO to establish maximum fuel efficiency, considering various parameters, for a 40-seat commuter aircraft is presented. I.F.

A86-10962*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

GROUND EFFECTS ON V/STOL AND STOL AIRCRAFT - A SURVEY

J. ESHLEMEN (NASA, Ames Research Center, Moffett Field, CA) and R. E. KUHN AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 25 p. refs
(AIAA PAPER 85-4033)

The flow fields encountered by jet- and fan-powered Vertical/Short Takeoff and Landing (V/STOL) aircraft operating in ground effect are reviewed and their general effects on the aerodynamic characteristics are discussed. The ground effects considered include (1) the suckdown experienced by a single jet configuration in hover, (2) the fountain flow and additional suckdown experienced by multiple jet configurations in hover, (3) the ground vortex generated by jet and jet flap configurations in Short Takeoff and Landing (STOL) operation and the associated aerodynamic and hot-gas-ingestion effects, and (4) the change in the downwash at the tail due to ground proximity. After over 30 years of research on V/STOL aircraft, the general flow phenomena are well known and, in most areas, the effects of ground proximity can be estimated or can be determined experimentally. However, there are some anomalies in the current data base which are discussed. Author

A86-10963#

GROUND EFFECT AND THE HELICOPTER - A SUMMARY

R. W. PROUTY (Hughes Helicopters, Inc., Culver City, CA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 7 p. refs
(AIAA PAPER 85-4034)

The performance benefits and problems of a helicopter in hover and forward flight due to ground effect are examined. When the helicopter is in the hover or forward flight position the influence of the ground on flow conditions at the rotor allows for reduced

power requirements; an explanation of this effect is presented. The measuring of ground effect using models and from actual flight tests is discussed. The influence of the ground effect on the ratio of induced velocities at the rotor disc during hover is graphically represented. Flying close to the ground assists in the balance of the tip vortices of the blades by allowing the induction effects of root vortices. During hover, the ground causes random yaw disturbances and turbulence is felt by observers. The negative ground effect during the transition from hover to forward flight due to increased power is explained. The influence of ground vortex on lateral control and rearward flight is described. Diagrams and graphs of the ground effect are provided. I.F.

A86-10964#

UNSTEADY THRUST REVERSER EFFECTS IN GROUND PROXIMITY

P. B. JOSHI (Northrop Corp., Aircraft Div., Hawthorne, CA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 12 p. refs
(AIAA PAPER 85-4035)

Large and totally unexpected rolling motions observed on a thrust-reversing aircraft model in a wind tunnel operating in ground proximity are described. Time histories of the rolling moment were analyzed to determine the spectral content of the forcing functions which drive the oscillations. The analysis revealed that the forcing function contained significant energies at frequencies to which typical fighter aircraft are sensitive. The magnitude of the forcing function contained was found to be a strong function of the cant or splay angle of the lower reverser jets. Water tunnel tests confirmed that the unsteady behavior resulted from an unsteady interaction between the reverser jets and the free stream. A simplified digital simulation of aircraft motion in ground effect showed that the aircraft experienced both large roll angles and a nose-down attitude at touch-down. C.D.

A86-10967*# Texas A&M Univ., College Station.

COMPARISON OF PREDICTED AND MEASURED DRAG FOR A SINGLE-ENGINE AIRPLANE

D. T. WARD (Texas A&M University, College Station), F. C. TAYLOR, and J. T. P. DOO (Mooney Aircraft Corp., Kerrville, TX) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 11 p. Research supported by the Texas A&M University and Mooney Aircraft Corp. refs
(Contract NAG1-309)
(AIAA PAPER 85-4038)

Renewed interest in natural laminar flow (NLF) has rekindled designers' concerns that manufacturing deviations, (loss of surface contours or other surface imperfections) may destroy the effectiveness of NLF for an operational airplane. This paper reports on experimental research that compares predicted and measured boundary layer transition, total drag, and two-dimensional drag coefficients for three different wing surface conditions on an airplane typical of general aviation manufacturing technology. The three flight test phases included: (1) assessment of an unpainted airframe, (2) flight tests of the same airplane after painstakingly filling and sanding the wings to design contours, and (3) similar measurements after this airplane was painted. In each flight phase, transition locations were monitored using either sublimating chemicals or pigmented oil. As expected, total drag changes were difficult to measure. Two-dimensional drag coefficients were estimated using the Eppler-Somers code and measured with a wake rake in a method very similar to Jones' pitot traverse method. The net change in two-dimensional drag was approximately 20 counts between the unpainted airplane and the 'hand-smoothed' airplane for typical cruise flight conditions. Author

A86-10970#
INTEGRATED FLIGHT DATA PROCESSING SYSTEM -
SUPPORT FOR THE DISCIPLINE ENGINEER

R. M. DAVINO and D. A. FLATTERY (USAF, Flight Test Center, Edwards AFB, CA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 12 p. refs
 (AIAA PAPER 85-4042)

The development of an Integrated Flight Data Processing System (IFDAPS) for real time acquisition, display, and processing of aircraft flight test data is discussed. The functions of the IFDAPS hardware components, which consist of super minicomputers and telemetry preprocessing modules in a distributed network, are described. An explanation of the interrelated computer programs in the software system, which are run file generator, acquisition display subsystem, the range control subsystem, and the control storage subsystem, is provided. The benefits of improved flight testing procedures are examined. The use of IFDAPS to evaluate aircraft performance, propulsion, stability and control, and flutter is discussed. The means by which IFDAPS architecture supports the operation through the normal preflight, real time, and postflight phases of aircraft flight testing are described. The programming of the data display formats and processing capabilities to meet specific flight testing requirements is explained. The procedures for data acquisition, display, and analysis are examined. I.F.

A86-10974*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A PARAMETRIC EVALUATION OF SUPERSONIC STOV L

G. H. KIDWELL (NASA, Ames Research Center, Moffett Field, CA) and D. C. RAPP (General Dynamics Corp., Fort Worth, TX) SAE, Aerospace Vehicle Requirements Conference, Washington, DC, May 20-23, 1985. 16 p. refs
 (SAE PAPER 851170)

This paper describes the results of a study to evaluate parametric variations to a single engine short-takeoff vertical-landing fighter/attack aircraft design. The variables considered involved thrust vectoring, thrust degradation, maximum lift, and other changes to determine the impact on short-takeoff performance, but subject to a vertical-landing capability. The results indicate that there are certain parameters that have a significant effect on short-field performance. Also, the optimal control strategies for transitions from a short-takeoff to forward flight and from forward flight to hover are determined. The results have applicability beyond the configuration evaluated. Author

A86-11036#
PREDICTION OF FIGHTER AIRCRAFT DYNAMIC DERIVATIVES
USING DIGITAL DATCOM

W. B. BLAKE (USAF, Wright Aeronautical Laboratories, Wright-Patterson AFB, OH) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 9 p. refs
 (AIAA PAPER 85-4070)

Digital Datcom is evaluated as a design tool for predicting the dynamic derivatives of fighter aircraft. Comparisons are made with wind tunnel data, flight test results, and strip theory predictions for four modern fighter configurations. Accuracy criteria taken from prior studies are used to judge the Digital Datcom predictions. All comparisons except yaw damping are found to be within the accuracy criteria. Author

A86-11151*
DECENNIAL SPECIALISTS' MEETING ON ROTORCRAFT
DYNAMICS, 2ND, MOFFETT FIELD, CA, NOVEMBER 7-9, 1984,
PROCEEDINGS

Meeting sponsored by the American Helicopter Society and NASA. Alexandria, VA, AHS, 1984, 342 p. For individual items see A86-11152 to A86-11174.

Various papers on helicopter rotor technology are presented. The subjects considered include: ground resonance analysis using a substructure modelling approach, aerolastic stability of a bearingless rotor, experimentally determined flutter from two and

three-bladed model bearingless rotors in hover, lifting surface theory for a helicopter rotor in forward flight, aeroelastic considerations for torsionally soft rotors, and restructuring of a rotor analysis program. Also discussed are: dynamic inflow and its effect on experimental correlations, flap-lag-torsion instability in forward flight, dynamic stability of a bearingless circulation control rotor blade in hover, dynamic response characteristics of a circulation control rotor model pneumatic system, the relations between vibratory loads and airframe vibrations, coupled rotor body vibrations with in-plane degrees of freedom, helicopter vibration reduction concepts. C.D.

A86-11152*#
GROUND RESONANCE ANALYSIS USING A SUBSTRUCTURE
MODELING APPROACH

S.-Y. CHEN, A. BERMAN (Kaman Aerospace Corp., Bloomfield, CT), and E. E. AUSTIN (U.S. Army, Applied Technology Laboratory, Fort Eustis, VA) IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings. Alexandria, VA, AHS, 1984, 9 p. refs

A convenient and versatile procedure for modeling and analyzing ground resonance phenomena is described and illustrated. A computer program is used which dynamically couples differential equations with nonlinear and time dependent coefficients. Each set of differential equations may represent a component such as a rotor, fuselage, landing gear, or a failed damper. Arbitrary combinations of such components may be formulated into a model of a system. When the coupled equations are formed, a procedure is executed which uses a Floquet analysis to determine the stability of the system. Illustrations of the use of the procedures along with the numerical examples are presented. Author

A86-11153#
PARAMETRIC STUDY OF THE AEROELASTIC STABILITY OF
A BEARINGLESS ROTOR

W. E. HOOPER (Boeing Vertol Co., Philadelphia, PA) IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings. Alexandria, VA, AHS, 1984, 15 p. refs

A trade study has been conducted to illustrate the sensitivity of the aeroelastic stability of a bearingless main rotor to the rotor hub coupling parameters that are available for the designer. The results are presented over the complete range of rotor speed and collective pitch available and the effects on air resonance of the 6 beam installation angles are compared together with the results of offsetting the cuff snubber attachment. The major part of the study was conducted using the FLAIR analysis which incorporates a uniform representation of the flexbeam. Results are also shown for a modified version of FLAIR in which the uniform beam is replaced by a member having the geometric tailoring resulting from structural optimization. Author

A86-11154#
NONLINEAR DYNAMICS OF A HELICOPTER MODEL IN
GROUND RESONANCE

E. H. DOWELL (Duke University, Durham, NC) and D. M. TANG IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings. Alexandria, VA, AHS, 1984, 10 p. refs
 (Contract NSF MEA-83-15193)

An approximate theoretical method is presented which determines the limit cycle behavior of a helicopter model which has one or two nonlinear dampers. The relationship during unstable ground resonance oscillations between lagging motion of the blades and fuselage motion is discussed. An experiment has been carried out on using a helicopter scale model. The experimental results agree with those of the theoretical analysis. Author

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

A86-11155#

TEST RESULTS FROM A DYNAMIC MODEL DYNAFLEX ROTOR

C. F. NIEBANCK and R. K. GOODMAN (United Technologies Corp., Sikorsky Aircraft Stratford, CT) IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings . Alexandria, VA, AHS, 1984, 10 p.

A one-fifth scale dynamic model of the Sikorsky Dynaflex rotor has been tested in hover and in forward flight conditions in the United Technologies Research Center Wind Tunnel. The Dynaflex rotor features an advanced composite structure which flexes to provide a constant speed universal joint action. Testing concentrated on confirming that the stability and dynamic response of the rotor were satisfactory. Lift conditions of up to .11 Ct/sigma and advance ratios as high as .46 were reached. Vibratory loads were comparable to those of articulated rotors. The Dynaflex rotor concept appears to be a practical concept from the standpoint of dynamic response and stability. Author

A86-11156#

EXPERIMENTALLY DETERMINED FLUTTER FROM TWO- AND THREE-BLADED MODEL BEARINGLESS ROTORS IN HOVER

W. G. BOUSMAN and S. DAWSON (U.S. Army, Aeromechanics Laboratory, Moffett Field, CA) IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings . Alexandria, VA, AHS, 1984, 19 p. refs

A series of experiments was performed on a 1.8-m-diam model rotor in hover for the principal purpose of investigating the lead-lag stability of isolated bearingless rotors. Incidental to those tests, at least three types of pitch-flap flutter were encountered; those flutter types constitute the subject matter of this paper. Type 1 flutter occurred approximately at the second flap-mode frequency on both two- and three-bladed rotors for both small and large pitch angles and appeared to be a classic pitch-flap flutter. Type 2 flutter showed mostly torsional motion and was seen on both two- and three-bladed rotors. The flutter mode appeared to be the rotor first-torsional mode and the flutter occurred just above 3/rev for low pitch angles. This behavior is similar to wake-excited flutter, but the flutter mode was in the wrong sense for a flutter dependent on lining up of the shed wakes. Type 3 flutter was a regressing flap flutter that occurred for only the three-bladed rotor configurations and appears to be a wake-excited flutter. Although flutter occurred on a number of different configurations, no rotor parameters were identified that were clearly stabilizing or destabilizing. Author

A86-11158#

DEVELOPMENT OF AN UNSTEADY AERODYNAMICS MODEL TO IMPROVE CORRELATION OF COMPUTED BLADE STRESSES WITH TEST DATA

S. T. GANGWANI (Hughes Helicopters, Inc., Culver City, CA) IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings . Alexandria, VA, AHS, 1984, 13 p. refs

A reliable rotor aeroelastic analysis operational at Hughes Helicopters, Inc. that correctly predicts the vibration levels for a helicopter is utilized for the present study to test various unsteady aerodynamics models with the objective of improving the correlation between test and theory. This analysis called Rotor Aeroelastic Vibration (RAVIB) computer program is based on a frequency domain forced response analysis which utilizes the transfer matrix techniques to model helicopter/rotor dynamic systems of varying degrees of complexity. The analysis is a nonmodal analysis and it includes effects of periodic coefficients for the forward flight conditions. The first new aerodynamics model incorporated in the analysis was based on the current state-of-art of unsteady aerodynamics. The results based on this aerodynamics model for the AH-1G helicopter rotor were compared with the flight test data during high speed operation and they indicated a reasonably good correlation for the beamwise and chordwise blade bending moments, but for torsional moments the correlation was poor. As a result, a new aerodynamics model based on unstalled synthesized data derived from the large amplitude oscillating airfoil experiments

was developed and tested with RAVIB analysis. The results indicate a significant improvement in the correlation for the torsional moments. Author

A86-11159*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

AEROELASTIC CONSIDERATIONS FOR TORSIONALLY SOFT ROTORS

W. R. MANTAY (NASA, Langley Research Center, Hampton, VA) and W. T. YEAGER, JR. (U.S. Army, Structures Laboratory, Hampton, VA) IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings . Alexandria, VA, AHS, 1984, 18 p. refs

A research study was initiated to systematically determine the impact of selected blade tip geometric parameters on conformable rotor performance and loads characteristics. The model articulated rotors included baseline and torsionally soft blades with interchangeable tips. Seven blade tip designs were evaluated on the baseline rotor and six tip designs were tested on the torsionally soft blades. The designs incorporated a systematic variation in geometric parameters including sweep, taper, and anhedral. The rotors were evaluated in the NASA Langley Transonic Dynamics Tunnel at several advance ratios, lift and propulsive force values, and tip Mach numbers. A track sensitivity study was also conducted at several advance ratios for both rotors. Based on the test results, tip parameter variations generated significant rotor performance and loads differences for both baseline and torsionally soft blades. Azimuthal variation of elastic twist generated by variations in the tip parameters strongly correlated with rotor performance and loads, but the magnitude of advancing blade elastic twist did not. In addition, fixed system vibratory loads and rotor track for potential conformable rotor candidates appears very sensitive to parametric rotor changes. Author

A86-11160#

OPTICAL DESIGN APPLICATION ON THE ADVANCED AEROELASTIC ROTOR BLADE

F.-S. WEI and R. JONES (Kaman Aerospace Corp., Bloomfield, CT) IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings . Alexandria, VA, AHS, 1984, 14 p. refs

A vibration and performance optimization procedure using regression analysis has been successfully applied to an advanced aeroelastic blade design study. It is concluded that regression technique can be used in the design of future advanced aeroelastic rotor blades. Multiple optimization can be performed to evaluate the effects of various objective functions and constraint functions or to evaluate the combinations of several objective functions with different weight factors for various mission requirements. Regression technique can directly determine the sensitivity of each blade design variable and analyze the dynamic and aerodynamic effects during the entire design process. The results predicted from the regression equations for performance analysis, modal analysis, and vibration analysis are exceptionally good when compared with the C81 and Myklestad outputs. C.D.

A86-11161#

DEVELOPMENT AND APPLICATION OF A TIME-HISTORY ANALYSIS FOR ROTORCRAFT DYNAMICS BASED ON A COMPONENT APPROACH

R. SOPHER and D. W. HALLOCK IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings . Alexandria, VA, AHS, 1984, 15 p. refs

This paper describes a time-history analysis for rotorcraft dynamics based on dynamical substructures, and non-structural mathematical and aerodynamic components. The analysis is applied to predict helicopter ground resonance and response to rotor damage. Other applications illustrate the stability and steady vibratory responses of stopped and gimbaled rotors, representative of new technology. Desirable attributes expected from modern codes are realized, although the analysis does not employ a complete set of techniques identified for advanced software. The analysis is able to handle a comprehensive set of steady state

and stability problems with a small library of components. It has responded to new technologies with timely solutions by limiting the effort required to implement new capabilities through its component structure. Opportunities were taken to reduce development costs by addressing more than one type of problem with a single component, such as using a minimum variance controller for trim and vibration reduction. Author

A86-11162#**RESTRUCTURING THE ROTOR ANALYSIS PROGRAM C-60**

P. G. PHELAN and F. J. TARZANIN, JR. (Boeing Vertol Co., Philadelphia, PA) IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings . Alexandria, VA, AHS, 1984, 13 p. refs

The 'restructuring' of the C-60 rotor analysis program in order to meet the increasing software demands of the rotary wing industry is discussed. The motivation for more capable analyses in this industry and the practical limitations of current programs are reviewed, and structured program design is examined as a solution to this problem. A development strategy for structured program design is discussed, and the restructuring process is described in detail. The current status of the restructuring of the C-60 program is addressed. C.D.

A86-11163#**A REVIEW OF DYNAMIC INFLOW AND ITS EFFECT ON EXPERIMENTAL CORRELATIONS**

G. H. GAONKAR (Indian Institute of Science, Bangalore, India) and D. A. PETERS (Washington University, St. Louis, MO) IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings . Alexandria, VA, AHS, 1984, 15 p. refs
(Contract DAAG29-80-C-0092)

A review is given of the relationship between experimental data and the development of modern dynamic-inflow theory. Some of the most interesting data, first presented 10 years ago at the Dynamic Specialists' Meeting, is now reviewed in light of the newer theories. These pure blade-flapping data correlate very well with analyses that include the new dynamic inflow theory, thus verifying the theory. Experimental data are also presented for damping with coupled inplane and body motions. Although inclusion of dynamic inflow is often required to correlate this coupled data, the data cannot be used to verify any particular dynamic inflow theory due to the uncertainties in modeling the inplane degree of freedom. For verification, pure flapping is required. However, the coupled data do show that inflow is often important in such computations. Author

A86-11164*# California Univ., Los Angeles.**INFLUENCE OF VARIOUS UNSTEADY AERODYNAMIC MODELS ON THE AEROMECHANICAL STABILITY OF A HELICOPTER IN GROUND RESONANCE**

P. P. FRIEDMANN and C. VENKATESAN (California, University, Los Angeles) IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings . Alexandria, VA, AHS, 1984, 12 p. refs
(Contract NAG2-209)

The aeromechanical stability of a helicopter in ground resonance was analyzed, by incorporating five different aerodynamic models in the coupled rotor/fuselage analysis. The sensitivity of the results to changes in aerodynamic modelling was carefully examined. The theoretical results were compared with experimental data and useful conclusions are drawn regarding the role of aerodynamic modeling on this aeromechanical stability problem. The aerodynamic model which provided the best all around correlation with the experimental data was identified. Author

A86-11165*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

THE INFLUENCE OF DYNAMIC INFLOW AND TORSIONAL FLEXIBILITY ON ROTOR DAMPING IN FORWARD FLIGHT FROM SYMBOLICALLY GENERATED EQUATIONS

T. S. R. REDDY and W. WARMBRODT (NASA, Ames Research Center, Moffett Field, CA) IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings . Alexandria, VA, AHS, 1984, 19 p. refs

The combined effects of blade torsion and dynamic inflow on the aeroelastic stability of an elastic rotor blade in forward flight are studied. The Helicopter Equations for Stability and Loads (HESL) program is extended to derive the governing equations of motion for the blade, and a Lagrangian formulation is used to obtain the equations in generalized coordinates. The program generates the steady-state and linearized perturbation equations in symbolic form and then codes them into FORTRAN subroutines. The coefficients for each equation and for each mode are identified through a numerical program; the latter can also be used to obtain the harmonic balance equations. The governing multiblade equations are derived explicitly using HESL. These equations can accommodate any number of elastic blade modes. Stability results are presented for several hingeless rotor blade structural models, and the influence of dynamic inflow in forward flight with an elastic hingeless rotor is investigated. C.D.

A86-11166#**FLAP-LAG-TORSION STABILITY IN FORWARD FLIGHT**

I. CHOPRA (Maryland, University, College Park) and B. PANDA IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings . Alexandria, VA, AHS, 1984, 17 p. refs

An aeroelastic stability of three-degree flap-lag-torsion blade in forward flight is examined. Quasisteady aerodynamics with a dynamic inflow model is used. The nonlinear time dependent periodic blade response is calculated using an iterative procedure based on Floquet theory. The periodic perturbation equations are solved for stability using Floquet transition matrix theory as well as constant coefficient approximation in the fixed reference frame. Results are presented for both stiff-inplane and soft-inplane blade configurations. The effects of several parameters on blade stability are examined, including structural coupling, pitch-flap and pitch-lag coupling, torsion stiffness, steady inflow distribution, dynamic inflow, blade response solution and constant coefficient approximation. Author

A86-11167#**DYNAMIC STABILITY OF A BEARINGLESS CIRCULATION CONTROL ROTOR BLADE IN HOVER**

I. CHOPRA (Maryland, University, College Park) IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings . Alexandria, VA, AHS, 1984, 11 p. refs
(Contract N00167-84-M-1548)

The aeroelastic stability of flap bending, lead-lag bending, and torsion of a circulation-control bearingless blade in hover is studied using a finite element formulation. The multibeams of the flexure and the outboard blade idealized as an elastic beam are discretized into beam elements, each element having 15 nodal degrees of freedom. There is a continuity of axial displacement, flap bending, lead-lag bending, and geometric twist between elements. Quasi-steady strip theory is used to evaluate aerodynamic forces. The airfoil characteristics are represented in the form of data tables. The influence of unsteady aerodynamics is introduced by using dynamic inflow modelling. The formulation is quite general for nonuniform blades. A correlation of analytical and experimental results is made for selected bearingless configurations with conventional airfoil characteristics. C.D.

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A86-11168#

DYNAMIC RESPONSE CHARACTERISTICS OF A CIRCULATION CONTROL ROTOR MODEL PNEUMATIC SYSTEM

C. B. WATKINS, S. K. DUTTA (Howard University, Washington, DC), and K. R. READER (David W. Taylor Naval Ship Research and Development Center, Bethesda, MD) IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings . Alexandria, VA, AHS, 1984, 11 p. refs

Numerical and experimental simulation of unsteady airflow through the control valve and slotted air duct of a circulation control rotor is described. The numerical analysis involves the solution of the quasi-one-dimensional compressible fluid-dynamic equations in the blade air duct together with the coupled isentropic flow equations for flow into the blade through the valve and out of the blade through the Coanda slot. Numerical solutions are compared with basic experimental results obtained for a mockup of a circulation control rotor and its pneumatic valving system. The pneumodynamic phenomena that were observed are discussed with particular emphasis on the characteristic system time lags associated with the response of the flow variables to transient and periodic control valve inputs. Author

A86-11169#

AN EXAMINATION OF THE RELATIONS BETWEEN ROTOR VIBRATORY LOADS AND AIRFRAME VIBRATIONS

C. F. NIEBANCK (United Technologies Corp., Sikorsky Aircraft, Stratford, CT) IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings . Alexandria, VA, AHS, 1984, 18 p. refs

Harmonic rotor hub loads and airframe interactions in steady flight are reviewed, with regard to the objective of achieving lower airframe vibration by modifying blade root loads. Flight test and wind tunnel data are reviewed, along with sample fuselage response data. Trends which could provide a generalized approach to the above objective are found to be very limited. Recent analytical and corresponding experimental blade tuning modifications are reviewed and compared. Rotor vibratory load modification and substantial vibration changes were achieved over a wide range of rotor operating conditions. It is still concluded that improvement of blade tuning has the potential for reduction in airframe vibration. Current analytical methods are found not accurate enough to confidently predict effects of blade tuning on vibration. Test-based development of favorable blade configurations is shown to be feasible, and will also generate data to guide further development of analytical methods. Author

A86-11170*# Boeing Vertol Co., Philadelphia, Pa. PLANNING, CREATING AND DOCUMENTING A NASTRAN FINITE ELEMENT MODEL OF A MODERN-HELICOPTER

R. GABEL, D. REED, R. RICKS, and W. KESACK (Boeing Vertol Co., Philadelphia, PA) IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings . Alexandria, VA, AHS, 1984, 17 p. refs (Contract NAS1-16460)

Mathematical models based on the finite element method of structural analysis as embodied in the NASTRAN computer code are widely used by the helicopter industry to calculate static internal loads and vibration of airframe structure. The internal loads are routinely used for sizing structural members. The vibration predictions are not yet relied on during design. NASA's Langley Research Center sponsored a program to conduct an application of the finite element method with emphasis on predicting structural vibration. The Army/Boeing CH-47D helicopter was used as the modeling subject. The objective was used to engender the needed trust in vibration predictions using these models and establish a body of modeling guides which would enable confident future prediction of airframe vibration as part of the regular design process. Author

A86-11171#

COUPLED ROTOR-BODY VIBRATIONS WITH INPLANE DEGREES OF FREEDOM

M.-S. HUANG and D. A. PETERS (Washington University, St. Louis, MO) IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings . Alexandria, VA, AHS, 1984, 15 p. refs (Contract DAAG29-80-C-0092)

In an effort to understand the vibration mechanisms of helicopters, the following basic studies are considered. A coupled rotor-fuselage vibration analysis including inplane degrees of freedom of both rotor and airframe is performed by matching of rotor and fuselage impedances at the hub. A rigid blade model including hub motion is used to set up the rotor flaplag equations. For the airframe, 9 degrees of freedom and hub offsets are used. The equations are solved by harmonic balance. For a 4-bladed rotor, the coupled responses and hub loads are calculated for various parameters in forward flight. The results show that the addition of inplane degrees of freedom does not significantly affect the vertical vibrations for the cases considered, and that inplane vibrations have similar resonance trends as do flapping vibrations. Author

A86-11172*# United Technologies Research Center, East Hartford, Conn.

ANALYSIS OF POTENTIAL HELICOPTER VIBRATION REDUCTION CONCEPTS

A. J. LANDGREBE and M. W. DAVIS (United Technologies Research Center, East Hartford, CT) IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings . Alexandria, VA, AHS, 1984, 19 p. Research supported by the United Technologies Corp., U.S. Army, and NASA. refs

Several recent helicopter vibration reduction research programs are described. Results of studies of blade design parameters in rotor vibratory response and of an advanced blade design for reduced vibration are examined. An optimization approach to develop a general automated procedure for rotor blade design is described, and analytical results for an articulated rotor operating at a steady 160 kt flight condition are reported. The use of a self-adaptive controller to implement higher harmonic control in closed-loop fashion is addressed, and a computer simulation used to evaluate and compare the performance of alternative algorithms included in the generic active controller is discussed. Results are presented for steady level flight conditions, short-duration maneuvers, blade stresses and rotor performance, blade-appended aeroelastic devices, vibratory airloads, wake-induced blade airloads, and airloads from blade motions, the interaction of rotor and fuselage, and the interaction of rotor and empennage. C.D.

A86-11173#

ADAPTATION OF A MODERN MEDIUM HELICOPTER (SIKORSKY S-76) TO HIGHER HARMONIC CONTROL

J. J. OLEARY, S. B. R. KOTTAPALLI (United Technologies Corp., Sikorsky Aircraft, Stratford, CT), and M. DAVIS (United Technologies Research Center, East Hartford, CT) IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings . Alexandria, VA, AHS, 1984, 13 p. refs

Sikorsky Aircraft has performed analytical studies, design analysis risk reduction tests for Higher Harmonic Control on the S-76, an 8-10,000 lb helicopter which cruises at 145 kts. Flight test hardware has been assembled, main servo frequency response tested and upgraded, aircraft control system shake-tested and verified, open loop controllers designed and fabricated, closed loop controllers defined and evaluated, and rotors turning ground and flight tests planned for the near future. Open loop analysis shows that about 2 deg of higher harmonic feathering at the blade 75 percent radius will be required to eliminate 4P vibration in the cockpit. Analytical computer simulations of a closed loop controller have been evaluated relative to the theses of reducing vibration to low levels while maintaining good ride quality and aircraft

structural stress attributes. The analytical results, design concepts, program approach, and risk reduction tests are reviewed. Author

A86-11607#

VISCOUS DRAG REDUCTION WITH MICROPOROUS-FACED HONEYCOMB SANDWICH FOR MODERN TURBOFAN INSTALLATIONS

J. S. MOUNT and T.-M. LIU (Rohr Industries, Inc., Chula Vista, CA) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings . New York, AIAA, 1985, p. 56-83. refs

The advantages of a structural/acoustic honeycomb sandwich using woven-wire microporous face sheet are examined from the acoustical standpoint. It is shown experimentally that such a sandwich structure is characterized by low drag under duct turbulent flow conditions. A new general mathematical approach linking acoustical and drag properties is then presented. Finally, a nacelle concept is described which uses suction through this type of structure to reduce drag by maintaining laminar flow over the nacelle surface. V.L.

A86-11614#

PERFORMANCE OF A TOP-MOUNTED INLET SYSTEM APPLIED ON TWO COMBAT AIRCRAFT CONCEPTS

K. WIDING (Flygtekniska Forsöksanstalten, Bromma, Sweden) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings . New York, AIAA, 1985, p. 135-148.

The wind tunnel testing of a top-mounted inlet design on attacker and fighter aircraft models is discussed. The advantages of a top-mounted inlet design are explained. The attacker and fighter model configurations are described. The attacker model was tested in a low speed wind tunnel at a Mach number of 0.18 and the fighter model was in a transonic-supersonic wind tunnel with Mach numbers ranging from 0.50-1.18. The techniques used for data acquisition are explained. The results for total pressure losses, steady state distortion indices, and the turbulence index are discussed and graphs are presented. The effects of strakes, central wall, and sideslip on performance is graphically explained. I.F.

A86-11883

OPTIMIZATION OF AIRPLANE WING STRUCTURES UNDER GUST LOADS

S. S. RAO (San Diego State University, CA) Computers and Structures (ISSN 0045-7949), vol. 21, no. 4, 1985, p. 741-749. refs

A methodology is presented for the optimum design of aircraft wing structures subjected to gust loads. The equations of motion, in the form of coupled integro-differential equations, are solved numerically and the stresses in the aircraft wing structure are found for a discrete gust encounter. The gust is assumed to be one minus cosine type and uniform along the span of the wing. In order to find the behavior of the wing structure under gust loads and also to obtain a physical insight into the nature of the optimum solution, the design of the typical section (symmetric double wedge airfoil) is studied by using a graphical procedure. Then a more realistic wing optimization problem is formulated as a constrained nonlinear programming problem based on finite element modeling and the optimum solution is found by using the interior penalty function method. A sensitivity analysis is conducted to find the effects of changes in design variables about the optimum point on the response quantities of the wing structure. Author

A86-11945

DEVELOPMENT AND APPLICATION OF MATHEMATICAL MODELS OF AIRCRAFT [SOZDANIE I PRIMENENIE MATEMATICHESKIKH MODELEI SAMOLETOV]

A. S. BELOTSEKOVSKII, B. O. KACHANOV, I. U. B. KULIFEEV, and V. I. MOROZOV Moscow, Izdatel'stvo Nauka, 1984, 144 p. In Russian. refs

The book is concerned with the mathematical modeling of the motion of aircraft and with the use of mathematical models for

studying the aerodynamic and dynamic aircraft characteristics. Attention is given to current models of flutter and methods of flutter analysis with allowance for the nonstationary nature of flow. Models are examined which allow for the elasticity of the structure, various cargo arrangements, effects of the control system, and external perturbations. Examples illustrating the usefulness of mathematical modeling in studying the dynamics of aircraft and in improving the efficiency of onboard equipment are presented. V.L.

A86-11958

RUNWAY AND MANEUVERING PERFORMANCE ENHANCED

J. H. BRAHNEY Aerospace Engineering (ISSN 0736-2536), vol. 5, Oct. 1985, p. 12-18.

The U.S. Air Force has investigated approaches which might be used to minimize the degraded operational capability resulting from battle damaged runways. Some of these approaches involve a modification of the aircraft to make an operation from minimum operating strips possible. Until very recently, short takeoff and landing (STOL) tactical fighters were not considered feasible. However, the F-15 STOL demonstrator offers now the possibility of both enhanced maneuverability and improved takeoff and landing performance on the basis of a use of essentially the same devices. An American aerospace company is modifying a standard, two-seat F-15B fighter to investigate several technology areas which may achieve that two-fold objective. Aircraft modifications related to two-dimensional nozzles and canards, and to thrust vectoring are discussed. G.R.

A86-11959

HIGH ANGLE OF ATTACK MANEUVERING PROBED

D. J. HOLT Aerospace Engineering (ISSN 0736-2536), vol. 5, Oct. 1985, p. 20-22.

Extreme flight envelope research is particularly important for high-performance fighter aircraft which can fly in these regimes. Thus, problems arise in connection with aircraft which are to fly at high angles of attack (plus 70 degrees) and at high yaw rates. Such aircraft are susceptible to entering into a spin. In order to deal with these problems, a new program which involves high angle of attack research is being prepared. One of the early phases of this program will be concerned with obtaining a design methodology which will enable the design engineer to correlate in an accurate manner wind tunnel data in the high angle of attack regime with actual flight test data. A second phase of the program will deal with the actual flight testing of a high performance aircraft in the extreme areas of the flight envelope. G.R.

A86-11960

OBLIQUE WING - NEW APPROACH TO AN OLD PROBLEM

D. J. HOLT Aerospace Engineering (ISSN 0736-2536), vol. 5, Oct. 1985, p. 26-29.

Improvements in aircraft efficiency involve in practice the employment of approaches to reduce the drag. One popular approach involves the use of a variable wing sweep. A NASA program is now concerned with an improved way to achieve variable sweep. This program is referred to as the 'oblique wing research aircraft' (OWRA) program. The oblique wing concept was first explored in the 1940s. Studies conducted by NASA include wind tunnel tests with an aircraft constructed of foam and fiberglass. The results from various investigations have been so promising that NASA and the Navy have entered into a joint research program to resolve remaining uncertainties. If this program is successful, the option to use the oblique wing will be made available in the 1990s. G.R.

A86-11961

OPTIMUM WING - FOR ALL FLIGHT CONDITIONS?

J. H. BRAHNEY Aerospace Engineering (ISSN 0736-2536), vol. 5, Oct. 1985, p. 36-40.

The present paper is concerned with a mission adaptive wing which will automatically adjust its camber to achieve optimum performance throughout the flight envelope. It is pointed out that such a wing is nearing reality. The mission adaptive wing (MAW)

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installed on the AFTI/F-111 (Advanced Fighter Technology Integration) test bed will soon be proving the concept. Eventually, the mission adaptive wing will operate in four automatic modes, each of which can be selected individually or combined. These modes include the 'cruise camber control', the 'maneuver camber control', the 'maneuver load control', and the 'maneuver enhancement and gust control mode'. G.R.

A86-12008

JETSTAR SMOOTHS THE WAY

G. WARWICK Flight International (ISSN 0015-3710), vol. 128, Sept. 21, 1985, p. 32-34.

The development of laminar flow control technology by NASA is examined. Advances which have led to reduced fuel consumption and cost are discussed. The use of laminar flow control to reduce skin-friction drag 25-40 percent is explained. The two test sections developed to evaluate laminar flows, the suction technique used to provide laminar flow control, and the procedure utilized for protection against insects are described. The test aircraft, JetStar, is provided with a Kollenberg probe, a charge patch, and a cockpit display; the instruments functions are explained. The testing of the aircraft in simulated airline operations is described. The use of the F-14 to collect data on pressure distributions over laminar flow aerofoils at different sweep angles, and a DC-9-sized test bed to display suction over the wing leading-edge using the laminar flow aerofoil section to maintain laminar flow is examined. I.F.

A86-12009

B-1B - BORN AGAIN BOMBER

N. LYNN Flight International (ISSN 0015-3710), vol. 128, Sept. 21, 1985, p. 39-42.

The development of the B-1B bomber is discussed. The production and delivery schedule, and the flight testing of the aircraft are described. The crash of the B-1A aircraft and the new warning light system developed after the crash are explained. The stability enhancement function added to the stability control augmentation system, and the stall inhibitor system added to the aircraft are examined. An example of foreign object damage to the flapper doors of the B-1B bomber is provided. The offensive avionics system is explained and its proposed production and delivery schedule are given. I.F.

A86-12013

AHRENS TO BUILD TURBOPROP-POWERED TRANSPORT PROTOTYPES IN SWEDEN

D. A. BROWN Aviation Week and Space Technology (ISSN 0005-2175), vol. 123, Oct. 7, 1985, p. 61, 62, 64, 69.

The present article is concerned with the KM-180 four-turboprop transport which is being developed by the former head of an American aerospace company. The 40-seat aircraft has been designed as a low-cost, slow-speed, unpressurized transport which can be used profitably by major air carriers on routes on which now 25 persons are carried by a 737. The KM-180 is limited to 200 kt., and has a relatively short range. It is expected that airlines will be able to use the aircraft to provide feeder service on routes which do not provide sufficient traffic to warrant the cost of a jet operation or even a pressurized turboprop. Thus, it would take about 45 min. To fly the route from Malmo to Hamburg, West Germany, in the KM-180. G.R.

A86-12530

A TECHNICAL-ECONOMICAL ANALYSIS OF AIRSHIPS OF VARIOUS SIZES, SHAPES, AND GAS PERMEABILITY OF THE SHELL [TEKNIKO-EKONOMICHESKII ANALIZ DIRIZHABLEI RAZLICHNYKH RAZMEROV, FORM I GAZOPRONITSAEMOSTI OBOLOCHEK]

E. V. GOLDOBEEV Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1985, p. 18-21. In Russian.

Dimensions and performance characteristics are presented for helium airships, and the effect of the aspect ratio of the airship on its mass and aerodynamic characteristics is discussed. A model is then presented for assessing the specific cost (cost per unit area) of aluminum airship shells with a reinforcing structure.

Expressions are also presented for calculating the cost effectiveness of airship operation with allowance for the gas permeability of the shell. V.L.

A86-12545

CHARACTERISTICS OF THE DESIGN AND FABRICATION OF LARGE AIRCRAFT COMPONENTS IN COMPOSITE MATERIALS [OSOBENOSTI PROEKTIROVANIIA I IZGOTOVLENIIA KRUPNOGABARITNYKH AGREGATOV LETATEL'NYKH APPARATOV IZ KOMPOZITSIONNYKH MATERIALOV]

A. A. DUDCHENKO, V. I. REZNICHENKO, V. A. KOZLOV, and O. N. KOCHETKOVA Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1985, p. 77-79. In Russian.

A procedure for the design of thin-walled reinforced composite structures of the wing and tail unit type is presented. The approach used here involves separating the stress-strain state into the main, slowly varying stress-strain state and the edge effect. The main stress-strain state is analyzed using an updated version of the beam theory; the edge effect is treated on the basis of the Vlasov method. The design procedure is illustrated by a specific example. V.L.

N86-10004# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

OPTIMUM DESIGN OF AN AIRCRAFT WING STRUCTURE WITH MULTIPLE CONSTRAINTS BY THE DIRECT-VISION CRITERIA METHOD

L. LINANG (Shenyang Aircraft Corp.) *In its* Acta Aeron. et Astronautica Sinica (FTD-ID(RS)T-1120-84) p 34-52 4 Oct. 1984 refs Transl. into ENGLISH from Hangkong Xuebao (China), v. 4, no. 4, 1983 p 39-47

Avail: NTIS HC A04/MF A01 CSCL 01A

An optimized computer program (SAFDOP) is introduced which uses the direct vision criteria method for a wing surface structure with multiple constraints. This program can separately carry out analysis, optimization and synthetic optimization calculations of stress, displacement, flutter and static aeroelasticity. The alternate constraint method was used for synthetic optimization calculations. Aside from the stress constraints using the full stress method, each of the other constraints used the uniform derivative criteria. For practical purposes, the element linking weight was used as an independent design variable, in the optimum design the automatic sieve selection design variable and other methods were used and the automatic generation of initial numerical data was considered. This program was used to calculate a typical fighter wing and it proved to be feasible. Author

N86-10032 Department of the Air Force, Washington, D.C.

ATTACHMENT METHOD-CERAMIC RADOME TO METAL BODY Patent

J. S. PERRY, inventor (to Air Force) 28 May 1985 6 p Supersedes AD-D010270

(AD-D011778; US-PATENT-4,520,364;

US-PATENT-APPL-SN-486603; US-PATENT-CLASS-343-872)

Avail: US Patent and Trademark Office CSCL 13H

A radome assembly for an airframe and a method for attaching the assembly to an airframe are provided. The radome assembly comprises a ceramic shell with a polymeric transition section bonded thereto, which shell is adapted for mounting to a metal airframe. The transition section has a coefficient of thermal expansion intermediate between that of the ceramic shell and that of the metal airframe. The method of this invention comprises preloading the transition section in circumferential compression when the radome assembly is attached to the airframe.

Author (GRA)

N86-10033*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Chemistry.
A FUNDAMENTAL STUDY OF THE STICKING OF INSECT RESIDUES TO AIRCRAFT WINGS Annual Technical Report
 N. S. EISS, JR., J. P. WIGHTMAN, D. R. GILLIAM, and E. J. SIOCHI Apr. 1985 191 p refs
 (Contract NAG1-300)
 (NASA-CR-176231; NAS 1.26:176231) Avail: NTIS HC A09/MF A01 CSDL 01C

The aircraft industry has long been concerned with the increase of drag on airplanes due to fouling of the wings by insects. The present research studied the effects of surface energy and surface roughness on the phenomenon of insect sticking. Aluminum plates of different roughnesses were coated with thin films of polymers with varying surface energies. The coated plates were attached to a custom jig and mounted on top of an automobile for insect collection. Contact angle measurements, X-ray photoelectron spectroscopy and specular reflectance infrared spectroscopy were used to characterize the surface before and after the insect impact experiments. Scanning electron microscopy showed the topography of insect residues on the exposed plates. Moments were calculated in order to find a correlation between the parameters studied and the amount of bugs collected on the plates. An effect of surface energy on the sticking of insect residues was demonstrated.

Author

N86-10034# Air Command and Staff Coll., Maxwell AFB, Ala.
THE DIRIGIBLE: A CATALYST FOR RESOURCE EXPLOITATION IN REMOTE AREAS?
 J. C. MURPHY Apr. 1985 80 p
 (AD-A156518; ACSC-85-1950) Avail: NTIS HC A05/MF A01 CSDL 01C

Many developing nations have considerable wealth in natural resources, but are unable to exploit it. Located in remote areas, the countries simply cannot afford to invest the enormous amounts required to build roads, railroads, or airfields to access the regions. The dirigible--modern day blimp--offers a potentially inexpensive, flexible, and capable method of transporting minerals, timber, or crops in areas without traditional transportation support. Even more important, they can stimulate agricultural or industrial development a significant distance from principal roads thereby unlocking the wealth of the land for a nation. The airship can be the catalyst for colonization at the same time it strengthens the economy. This study provides a cost/benefit model to evaluate the relative benefits of different transportation systems in the exploitation of resources.

Author (GRA)

N86-10035# Naval Postgraduate School, Monterey, Calif.
CONSTRUCTION AND USE OF A RADIO CONTROLLED MODEL HELICOPTER FOR RESEARCH M.S. Thesis
 C. J. HINTZE Mar. 1985 67 p
 (AD-A156547) Avail: NTIS HC A04/MF A01 CSDL 01C

This thesis examines the relationship that exists between a radio controlled model helicopter and a full-size helicopter. The construction of a radio controlled model helicopter and flight training involved is discussed. Initial hover performance testing of a radio controlled helicopter is evaluated.

Author (GRA)

N86-10036# Aeronautical Research Labs., Melbourne (Australia).
A REVIEW OF AUSTRALIAN INVESTIGATIONS ON AERONAUTICAL FATIGUE DURING THE PERIOD APRIL 1983 TO MARCH 1985
 G. S. JOST Mar. 1985 93 p
 (AD-A156602; ARL/STRUC-TM-399) Avail: NTIS HC A05/MF A01 CSDL 01C

A summary is presented of the aircraft fatigue research and associated activities which form part of the programs of the Aeronautical Research Laboratories, the Department of Aviation and the Australian aircraft industry. The major topics discussed include the fatigue of both civil and military aircraft structures, fatigue damage detection, analysis and repair and fatigue life monitoring and assessment.

Author (GRA)

N86-10038# Air Command and Staff Coll., Maxwell AFB, Ala.
RETROFIT OF SAC EC-135C AND RC-135 AIRCRAFT WITH CFM-56 ENGINES
 W. N. STOOKE, JR. Apr. 1985 42 p
 (AD-A156688; ACSC-85-2630) Avail: NTIS HC A03/MF A01 CSDL 15E

This report is an analysis of the advantages and disadvantages of retrofitting SAC's EC-135C and RC-135 fleet with the CFM-56 engine package being used to convert the KC-135As to KC-135Rs. It reviews selected components of the modification package and compares the performance capabilities of current and modified aircraft during takeoff, cruise, receiver aerial refueling, and landing. The projected fuel savings on the investment dollar are calculated in Af Regulation 173-13, USAF Cost and Planning Factors, and could pay for the retrofit of the 31 aircraft in 18 years. Finally, the advantage of logistics commonality among all three aircraft is assessed.

GRA

N86-10039# Aeronautical Research Labs., Melbourne (Australia).
PROPOSED MODIFICATIONS FOR THE RAAF AIRTRAINER CT-4A COCKPIT
 K. W. ANDERSON and K. C. HENDY Dec. 1984 23 p
 (AD-A156808; ARL/SYS-TM-75) Avail: NTIS HC A02/MF A01 CSDL 01C

The design of the CT-4A Airtrainer cockpit is known to breach numerous ergonomics principles and several ASCC Air Standards. As a result, pilots report problems such as inadequate reach envelopes and obstruction of the control column by the left pilot's left knee. Consequently, the RAAF asked ARL to study the cockpit design and recommend simple changes. An anthropometric model was developed and used to evaluate several patterns of seat adjustment. The best of these (a ramp at 40 degrees to the fuselage reference line) was evaluated in practical trials with an experimental seat in a CT-4A fuselage. For each of the thirty pilot subjects, a sitting position with acceptable view, reach and clearance was found with the experimental arrangement. The ARL recommendations for cockpit modifications include: a smaller left side throttle quadrant with external pushrods, a seat adjustable along a 40 degree ramp, improved instrument lighting, pedals moved forwards, control column modifications, lowered lap belt anchor points, dual fuel gauges and a center transponder location. Incorporation of these recommendations is expected to enhance training effectiveness and improve flying safety.

GRA

N86-10040# Air Command and Staff Coll., Maxwell AFB, Ala.
THE QUEST FOR A HELICOPTER SUITABLE FOR COMBAT RESCUE, 1967 - 1983
 T. O. JAHNKE Apr. 1985 30 p
 (AD-A156842; AD-E301723; ACSC-85-1330) Avail: NTIS HC A03/MF A01 CSDL 01C

This paper provides a concise, historical perspective of the quest for a helicopter suitable for combat rescue. Concentrating on the period 1967 to 1983, this report looks at the historical development, roles and missions, and analyzes the selection process of four different combat rescue helicopters. The study concludes that the unique mission requirements of combat rescue require aircraft designed from the ground on as pure rescue helicopters.

Author (GRA)

N86-10041# Naval Postgraduate School, Monterey, Calif.
A COMPARATIVE ANALYSIS OF A CV HELICOPTER AND A JVX (JOINT SERVICES ADVANCED VERTICAL LIFT) TILT-ROTOR AIRCRAFT IN AN AIRCRAFT CARRIER BASED ASW (ANTI-SUBMARINE WARFARE) M.S. Thesis
 R. L. WILDE Mar. 1985 134 p
 (AD-A156871) Avail: NTIS HC A07/MF A01 CSDL 01C

This thesis analyzes the environmental compatibility and the potential performance capabilities of two proposed types of vertical flight capable aircraft in an aircraft carrier Anti-Submarine role. The aircraft compared are the CV Helicopter(SH-60F) and an ASW variant of the Joint Services Advanced Vertical Lift (JVX) tilt-rotor aircraft. This thesis compares their adaptability and relative

05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

expected mission effectiveness by analyzing their physical dimensions and characteristics and their projected flight performance parameters. Their expected performance in a specific scenario, an ASW pouncer mission employing active dipping sonar, is analyzed using a simulation model. GRA

N86-10042*# Texas Technological Univ., Lubbock. Dept. of Electrical Engineering.

ELECTROMAGNETIC RESONANCES OF CYLINDERS AND AIRCRAFT MODEL WITH RESISTIVE WIRES Final Report, Apr. 1983 - Apr. 1984

G. W. WOOD and T. F. TROST Apr. 1985 61 p

(Contract NAG1-28; DA PROJ. 376-3)

(NASA-CR-176250; NAS 1.26:176250; AD-A156960;

AFWL-TR-84-90) Avail: NTIS HC A04/MF A01 CSCL 01C

Laboratory experiments were done to determine the natural frequencies of the electromagnetic resonances of conducting bodies with attached wires. The bodies include two cylinders and an approximate scale model of the NASA F-106B aircraft. All are three feet in length. Time-domain waveforms of B-dot and D-dot were obtained from a sampling oscilloscope, and Prony analysis was used to extract the natural frequencies. This work is an extension of previous work, but smaller, more resistive wires have been used. The first four natural frequencies of the cylinders (and wires) were determined, and a comparison with calculated results of other investigators show reasonable agreement. Seven natural frequencies were determined for the F-106B model (wire wires), and these have been compared with results obtained by NASA in 1982 during direct lightning strikes to the aircraft. The agreement between the corresponding natural frequencies of the model and the aircraft is fairly good and is better than that obtained in the previous work using wires with less resistance. The frequencies lie between 6.5 MHz and 41 MHz, and all of the normalized damping rates are between 0.14 and 0.27. GRA

N86-10043# European Space Agency, Paris (France).

SYSTEM MODELING AND IDENTIFICATION OF EQUIVALENT SYSTEMS WITH AND WITHOUT COMPENSATING TIME DELAY FOR CONTROL-AUGMENTED AIRCRAFT

J. SKUDRIDAKIS Oct. 1985 104 p refs Transl. into

ENGLISH of "Systemmodellierung und Identifizierung von aquivalenten Systemen mit und ohne Ersatztotleit fuer reglergestuetzte Flugzeuge" Rept. DFVLR-FB-83-36, DFVLR, Brunswick, 1983 Original language document was previously announced as N84-24570

(ESA-TT-852; DFVLR-FB-83-36) Avail: NTIS HC A06/MF A01; original German version available from DFVLR, Cologne DM 34

The identification of the aerodynamic and equivalent derivatives in the longitudinal and lateral motions of modern fighter aircraft is described. Determination of handling qualities parameters through reduced evaluation methods in order to fulfill the requirements of the MIL-F-8785 C calculation is discussed. To accomplish that goal, the highly complex method of observing aircraft motion was reduced by goal-oriented simplifications to a lower order system. The mathematical modeling for various control inputs with and without compensating time-delay, their influence on the results, and their accuracy are outlined. Author (ESA)

N86-10044# Fraunhofer-Inst. fuer Betriebsfestigkeit, Darmstadt (West Germany).

REVIEW OF INVESTIGATIONS ON AERONAUTICAL FATIGUE IN THE FEDERAL REPUBLIC OF GERMANY Review Period, May 1983 - April 1985

O. BUXBAUM and H. HUTH 1985 86 p refs Presented at 19th Intern. Comm. on Aeron. Fatigue (ICAF) Conf., Pisa, 1985

(LBF-S-173; ISSN-0721-5320) Avail: NTIS HC A05/MF A01;

Fachinformationszentrum, Karlsruhe, West Germany DM 95

Measurement and analysis of operational loads on aircraft; metal fatigue (notch strength, low cycle fatigue, crack propagation and fracture mechanics); composites (fatigue, environmental influences, damage mechanisms); joints; fatigue life prediction; and component and full scale tests are summarized. Author (ESA)

N86-10045# Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.

FATIGUE, STATIC TENSILE STRENGTH AND STRESS CORROSION OF AIRCRAFT MATERIALS AND STRUCTURES

J. SCHIJVE Oct. 1982 203 p refs Presented at Summer School Course, Bandung, Indonesia, Aug. 1982 Sponsored by Netherlands and Indonesian Governments

(VTH-LR-360-PT-1) Avail: NTIS HC A10/MF A01

Failure modes in aircraft structures; stress concentration at notches; plastic deformation and residual stress; stress intensity factors of cracks; failure in tension; stress corrosion; material fatigue; fatigue under constant and variable amplitude loading; joint fatigue; fatigue loads on aircraft structures; and fatigue of aircraft structures are discussed. Author (ESA)

N86-11181# Joint Publications Research Service, Arlington, Va. **WORLD'S LARGEST AIRPLANE NOW BEING TESTED**

N. DOMBKOVSKIY *In its USSR Rept.:* Transportation (JPRS-UTR-85-011) p 17-20 7 Oct. 1985 Transl. into ENGLISH from TRUD (Moscow), 23 May 1985 p 3

Avail: NTIS HC A06

Unique design features of the newly developed AN-124 aircraft are described. Factors such as weight, cargo capacity, and wing configuration are discussed. Problems encountered in the construction of the AN-124 are also discussed. B.W.

N86-11194*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

EXPERT SYSTEMS DEVELOPMENT AND APPLICATION

E. L. DUKE and V. A. REGENIE Oct. 1985 8 p Presented at the IEEE Symp. on Expert Systems in Govt., McLean, Va., 23-25 Oct. 1985

(NASA-TM-86746; H-1310; NAS 1.15:86746) Avail: NTIS HC A02/MF A01 CSCL 01C

Current research in the application of expert systems to problems in the flight research environment is discussed. In what is anticipated to be a broad research area, a real time expert system flight status monitor has been identified as the initial project. This real time expert system flight status monitor is described in terms of concept, application, development, and schedule. Author

N86-11195*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

DESCRIPTION OF AN EXPERIMENTAL EXPERT SYSTEM FLIGHT STATUS MONITOR

E. L. DUKE and V. A. REGENIE Oct. 1985 11 p refs Presented at the 5th AIAA Computers in Aerospace Conf., Long Beach, Calif., 21-23 Oct. 1985

(NASA-TM-86791; H-1317; NAS 1.15:86791; AIAA-85-6042-CP)

Avail: NTIS HC A02/MF A01 CSCL 01C

This paper describes an experimental version of an expert system flight status monitor being developed at the Dryden Flight Research Facility of the NASA Ames Research Center. This experimental expert system flight status monitor (ESSFSM) is supported by a specialized knowledge acquisition tool that provides the user with a powerful and easy-to-use documentation and rule construction tool. The EESFSM is designed to be a testbed for concepts in rules, inference mechanisms, and knowledge structures to be used in a real-time expert system flight status monitor that will monitor the health and status of the flight control system of state-of-the-art, high-performance, research aircraft. Author

N86-11196* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

COMPARISON OF CALCULATED AND MEASURED VELOCITIES NEAR THE TIP OF A MODEL ROTOR BLADE AT TRANSONIC SPEEDS

M. E. TAUBER, F. K. OWEN (Complere, Inc.), R. G. LANGHI (Informatics General Corp., Palo Alto, Calif.), and G. E. PALMER Aug. 1985 81 p refs
(NASA-TM-86697; REPT-85158; NAS 1.15:86697) Avail: NTIS HC A05/MF A01 CSCL 01C

The ability of the ROT22 code to predict accurately the transonic flow field in the crucial region around and beyond the tip of a high speed rotor blade was assessed. The computations were compared with extensive laser velocimetry measurements made at zero advance ratio and tip Mach numbers of 0.85, 0.88, 0.90, and 0.95. The comparison between theory and experiment was made using 300 scans for the three orthogonal velocity components covering a volume having a height of over one blade chord, a width of nearly two chords, and a length ranging from about 1 to 1.6 chords, depending on the tip speeds. The good agreement between the calculated and measured velocities established the ability of the code to predict the off blade flow field at high tip speeds. This supplements previous comparisons where surface pressures were shown to be well predicted on two different tips at advance ratios to 0.45, especially at the critical 90 deg azimuth blade position. These results demonstrate that the ROT22 code can be used with confidence to predict the important tip region flow field including the occurrence, strength, and location of shock waves causing high drag and noise. Author

N86-11197# Air Command and Staff Coll., Maxwell AFB, Ala.
EVALUATION OF FAULT REPORTING/FAULT ISOLATION FOR F-15 AIRCRAFT

C. A. MUSSARI Apr. 1985 26 p
(AD-A156516; ACSC-85-1955) Avail: NTIS HC A03/MF A01 CSCL 01C

The author set out to see if the accuracy of the FR/FI manuals is a factor in their non-use. Accuracy of the manuals was determined by analyzing actual reported inflight discrepancies. Fault code accuracy was obtained by comparing each discrepancy as written on the TAC Form 122 (Debriefing Record) with the discrepancy depicted in the FR manual. Accuracy of repair actions was obtained by tracking the repair action recommended by the fault isolation manual and comparing it with that shown on the TAC Form 122. Analysis revealed the F-15 fault reporting manual can accurately represent a random inflight malfunction 83.8% of the time, and these malfunctions can be accurately isolated in the fault isolation manual 77.7% of the time. These accuracy levels are acceptable and not a major factor in the non-use of the manuals. Observation of the debriefing and maintenance process, and interviews with aircrews and maintenance technicians, revealed a general lack of understanding and confidence in the FR/FI system. This lack of understanding and confidence, exhibited by both aircrews and maintenance personnel is the primary reason for the system's non-use. Recommended actions to show the effectiveness of using the system as designed are provided. GRA

N86-11198# Naval Air Development Center, Warminster, Pa. Aircraft and Crew Systems Technology Directorate.

A COMPARISON OF THE NAVTOLAND (NAVY VERTICAL TAKEOFF AND LANDING) SH-2F HELICOPTER MODEL WITH THE REQUIREMENTS OF MIL-H-8501A AND WITH FLIGHT DATA Final Report

R. L. NAVE 31 Jan. 1984 78 p
(Contract F41-400)
(AD-A157297; NADC-84166-60) Avail: NTIS HC A05/MF A01 CSCL 01D

This report compares the dynamic response characteristics of an SH-2F simulator model with available flight test data and with the requirements of MIL-H-8501A, Helicopter Flying and Ground Handling Qualities; General Requirements for. The Navy Vertical Takeoff and Landing (NAVTOLAND) simulator model was

developed to facilitate the design of an automatic approach and landing guidance control systems for helicopters and V/STOL aircraft. The simulation was validated by comparing the model response with all available flight test data. In addition, the model was used to examine some of the requirements of MIL-H-8501A. Considerable insight was gained in the application of the specification and in understanding techniques needed to determine compliance with the requirements. The original model was developed and installed on the NASA Ames Vertical Motion Simulator. Numerous modifications were made to the software based on test pilot evaluations. A version of this simulation model including all empirical adjustments was installed on the NAVAIRDEVCCEN computer system. Further evaluation of the model was carried out using this batch version of the helicopter model. This study found that it is difficult if not impossible to satisfactorily tune a helicopter simulation based on pilot opinions without a complete flight test data base. The requirements of MIL-H-8501A need to be defined in more detail and in some cases be revised. An altitude excursion limit should be added to the current quick stop maneuver. Analysis indicates that the current 2-second pilot response delay following engine failure may be excessive. GRA

N86-11199# McDonnell Automation Co., St. Louis, Mo.
FLIGHT WORTHINESS OF FIRE RESISTANT HYDRAULIC SYSTEMS: VOLUME 1 Final Report, Jan. 1981 - Dec. 1984

J. R. JEFFERY, R. B. MERRELL, N. J. PIERCE, M. J. STEVENS, and R. E. YOUNG Dec. 1984 307 p
(Contract F33615-80-C-2074)
(AD-A157618; AFWAL-TR-84-2085-VOL-1) Avail: NTIS HC A14/MF A01 CSCL 13G

This volume reports a study to select a flight worthy hydraulic system in which to test the chlorotrifluoroethylene (CTFE) hydraulic fluid. Aircraft selection, hardware and concept definition, system and weight analysis, and reliability, maintainability and life cycles costs (LCC) studies are reported in volume 1. The F-15 and KC-10A were selected for comparison between the present fluid and system configuration and CTFE fluid at 8,000 psi plus various energy conservation and water hammer control concepts. The results show the weight penalty of the nonflammable fluid (CTFE) can be overcome by use of 8,000 psi operating pressures. Performance, water hammer transients, fluid pumpability, sealing, null leakage control, and demonstration system effects were investigated during Phases 2 and 3 of this contract. GRA

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AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A86-10369
MAGNETICS AND GUIDANCE SYSTEMS

D. C. M. MATTHEWS and I. H. BELL (Domain Micro-Systems, Ltd., Stafford, England) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings. Bristol, University of Bristol, 1984, p. 23.1-23.7.

The product line of a British manufacturer of magnetic guidance systems for RPV applications is described. Among the products discussed are: magnetic measurement systems; degaussing ranges; fluxgate heading sensors; and magnetic weapons sensors. Consideration is also given to: flux meters; general purpose magnetic instrumentation; and vehicle detection equipment. Black and white photographs of the different devices are provided. I.H.

06 AIRCRAFT INSTRUMENTATION

A86-10944*# IBM Federal Systems Div., Owego, N. Y. A HELICOPTER TERRAIN FOLLOWING SYSTEM FOR TERMINAL AREA OPERATIONS

F. G. KILMER, R. L. KILMER (IBM Corp., Federal Systems Div., Owego, NY), H. N. SWENSON (NASA, Ames Research Center, Moffett Field, CA), and A. C. WOODWARD (Texas Instruments, Inc., Dallas) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 8 p.

(AIAA PAPER 85-3092)

This paper discusses the terminal area guidance and terrain following system developed for the USAF HH-60A Night Hawk Search and Rescue Helicopter. A Multi-Mode Radar and three-cue Flight Path Vector Director provide a terrain following capability at all airspeeds, allowing a decelerating approach to a hover over varying terrain to a designated point. Properties of the terrain following design are discussed. Simulation results using the NASA Ames piloted Vertical Motion Simulator are presented. Author

**A86-10945*# National Aeronautics and Space Administration.
Ames Research Center, Moffett Field, Calif.**

SIMULATION EVALUATION OF DISPLAY/FLIR CONCEPTS FOR LOW-ALTITUDE, TERRAIN-FOLLOWING HELICOPTER OPERATIONS

H. N. SWENSON, C. H. PAULK, JR. (NASA, Ames Research Center, Moffett Field, CA), R. L. KILMER, and F. G. KILMER (IBM Corp., Federal Systems Div., Owego, NY) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 11 p. refs

(AIAA PAPER 85-3093)

Trials were run on a six degree of freedom combat helicopter simulator to evaluate head-down displays with integrated FLIR imagery for terrain-following, course-steering, and transition to approach and hover helicopter pilot tasks. Three display formats were tested, providing varying levels of symbology for, e.g., the flight path angle, pitch-attitude data, vertical speed, altitude, etc. The pilots were also furnished flight director guidance, i.e., terrain-following, course steering, airspeed hold, and approach to hover. All the displays permitted the pilots to fly satisfactory mission in the CGI scenarios. The results revealed that the pilots preferred a nonconformal FLIR display superposition. M.S.K.

A86-11410# TRANSPARENT CONTENTION BUSES CAN IMPROVE ARCHITECTURES

L. C. KLOS and J. S. HEWELL (General Dynamics Corp., Fort Worth, TX) IN: Computers in Aerospace Conference, 5th, Long Beach, CA, October 21-23, 1985, Technical Papers. New York, AIAA, 1985, p. 64-74.

(AIAA PAPER 85-5051)

This paper discusses some of the unique architectural aspects of the integration of new systems on aircraft. The paper also describes a data channel approach that meets the diverse and unique requirements of modern avionics. The approach is called 'token passing with transparent contention' and combines a token passing approach for normal operation with a transparent contention approach to handle power-up and bus reconfiguration. The protocol can be used equally well with coaxial cable, fiber optics, or mixed media systems. It provides true distributed control and easily and rapidly overcomes problems due to lost tokens or newly added terminals. Further, it allows a single bus to be dynamically divided into independently operating subnets and supports their smooth reintegration into a single network. Author

A86-11425# MULTIPROCESSOR APPLICATION IN FLIGHT MANAGEMENT SYSTEMS

M. K. DEJONGE and T. WILLIAMS (Lear Siegler, Inc., Instrument Div., Grand Rapids, MI) IN: Computers in Aerospace Conference, 5th, Long Beach, CA, October 21-23, 1985, Technical Papers. New York, AIAA, 1985, p. 172-177. refs

(AIAA PAPER 85-5079)

The Flight Management Computer System (FMCS) for the 737-300 has a three-processor architecture with fixed task allocations divided primarily into the navigation, performance, and input/output functions. The computer architecture uses controlled communication protocol through a global memory accessible to all processors. Advantages of this architecture are in functional separation for testing and validation, and in increased throughput by parallel processing of several system functions. The disadvantage is in the inefficiency of fixed task allocation when a high demand for several tasks allocated to the same processor occur simultaneously, thus limiting the system response time to a single processor's throughput. An alternative multiprocessor architecture for future systems may consider variable task allocation to the processing elements, depending on the availability and capability of each element. A system controller is required to assign tasks as a function of the response priority. In this way, a higher effective throughput is achieved since each processing element is more fully utilized. Issues such as internal bus control, memory access, and priority assignment methods are explored for this type of architecture. Author

A86-11427# IS THERE A RISC IN THE AVIONIC COMPUTER FUTURE?

H. SCHMID and T. D. GASKA (General Electric Co., Binghamton, NY) IN: Computers in Aerospace Conference, 5th, Long Beach, CA, October 21-23, 1985, Technical Papers. New York, AIAA, 1985, p. 185-194. refs

(AIAA PAPER 85-5081)

It has been claimed that Reduced Instruction Set Computers (RISC) offer not only much smaller chips than Complex Instruction Set Computers (CISC) but also more throughput, shorter design time, better support for high level languages, and the ability to emulate other instruction sets. This paper examines these claims and evaluates the possibility of using RISC in real-time avionic control systems that are compatible with MIL-STD-01750. Several methods of translating from 1750 to RISC codes are discussed, and throughput predictions for a VHSIC MIPS are compared with those for the VHSIC 1750 CPUs. B.J.

A86-11428# WIT - TEST SYSTEM FOR THE MD-80S

D. R. SWANSON (Douglas Aircraft Co., Long Beach, CA) IN: Computers in Aerospace Conference, 5th, Long Beach, CA, October 21-23, 1985, Technical Papers. New York, AIAA, 1985, p. 195-201.

(AIAA PAPER 85-5082)

The paper examines the system and hardware for the wire integrity test (WIT) system used to verify the integrity of MD-80 aircraft wiring prior to power-up of critical and expensive avionics hardware. Particular consideration is given to the test plan, the aircraft and WIT data bases, the required hardware, the WIT system, types of tests that may be programmed and test results. The success achieved with WIT is noted. B.J.

A86-11762 PRECISE VERTICAL SPEED RECONSTRUCTION BASED ON VERTICAL ACCELERATION AND BAROMETRIC ALTITUDE

A. REDEKER and P. VOERSMANN (Braunschweig, Technische Universitaet, Brunswick, West Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X), vol. 9, July-Aug. 1985, p. 243-251. refs

The use of two filter algorithms to determine optimum vertical speed estimation is discussed. The equations and diagram explaining the complementary filter and the Luenberger observer are described. The relationship between an estimation of

gravitational acceleration and altitude using Newton's gravitational model is provided; vertical acceleration is measured on the Schuler stabilized platform of the inertial navigation system. The hydrostatic equilibrium equation used to measure static pressure is examined. Error models for a vertical accelerometer and a barometric altimeter are presented. The required optimization of the filter parameters is achieved by system simulation; the flight conditions and optimization process are described. The test reveals that the observer is less sensitive than the complementary filter to parametric changes. I.F.

A86-12572
AIRCRAFT STRUCTURE SURVEILLANCE IN-FLIGHT USING ACOUSTIC EMISSION

P. H. HUTTON (Battelle Pacific Northwest Laboratories, Richland, WA) *Journal of Acoustic Emission, Supplement (ISSN 0730-0050), vol. 4, Apr.-Sept. 1985, p. S138-S141. refs*

For a long time, an application of acoustic emission (AE) techniques to the surveillance of critical components in aircraft structures has been considered, taking into account possibilities to detect cracking. The amount of research devoted to such an application, however, has been comparatively small, although there have been some significant development results. The present paper provides a description of a number of cases of such research with the objective to give a perspective of the level of accomplishment. The reported results show the basic feasibility of an in-flight AE monitoring approach. The application of in-flight AE monitoring is being considered in a context of cost effectiveness which results on the basis of the reduction of conventional inspection requirements. G.R.

A86-12574
IN-FLIGHT MONITORING FOR INCIPIENT CRACKS IN AN AERO ENGINE MOUNT - AN APPROACH THROUGH PATTERN RECOGNITION

C. R. L. MURTHY, M. A. MAJEED, S. C. PATHAK, and A. K. RAO (Indian Institute of Science, Bangalore, India) *Journal of Acoustic Emission, Supplement (ISSN 0730-0050), vol. 4, Apr.-Sept. 1985, p. S147-S150. Research supported by the Aeronautical Research and Development Board.*

In-flight monitoring for incipient cracks in critical structural members of an aircraft is a vital need for ensuring safety and operational reliability. A nondestructive, dynamic technique with the capability for in-service monitoring is required. Such a technique can be based on a utilization of acoustic emission (AE). However, the development of a suitable, reliable procedure requires a number of investigations to overcome certain difficulties. Thus, in addition to growing cracks, there are several other pseudosources which give rise to signals which are identical in appearance to acoustic emissions. The present study is concerned with the applicability of principles for source characterization in-flight, taking into account an example involving the testing of a simulated aircraft engine mount in the laboratory as a first step. Attention is given to the design of the mount, the experimental program, a cluster analysis of AE data, software development, and data analysis. G.R.

07

AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

A86-10143#
PROPFANS GEAR UP

R. DEMEIS (Aerospace America (ISSN 0740-722X), vol. 24, Oct. 1985, p. 22, 24.

The use of a gearbox or a direct-drive engine to power the propfan is examined. The advantages of a gearbox which allows

for maximum efficiency are discussed. The smaller direct-drive engine requires 9 percent more hp, weighs 3 percent more, and is 3-5 percent less fuel efficient. The one major advantage of the direct-drive engine is that the elimination of the complex gearbox will permit easier maintenance. The mean time between unscheduled removal of the gearbox for military and commercial aircraft and the types of problems encountered are explained. The material improvements and advanced design techniques, which will reduce all nonmaintenance removal of gearboxes, are described. The use of counter-rotating blades, tapered roller bearing, multispool engine cores, and a hub-mounted electronic pitch change controller to simplify the gearbox is examined. The specific aircraft configuration and its use strongly influence the choice between a geared or gearless propfan. I.F.

A86-10360
VERSATILE, LOW COST TURBOJET PROPULSION FOR UNMANNED VEHICLES

D. E. BARBEAU (Teledyne CAE, Toledo, OH) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings . Bristol, University of Bristol, 1984, p. 12.1-12.11.

The advantages of a 'family' approach to the design of turbojet engines for unmanned vehicles are discussed. Attention is given to the family of engine designs based on the J402-CA-400 engine of the Harpoon anti-ship missile which serves as the basis for today's low cost propulsion systems in ALCMs, SLCMs, targets, and decoys. The salient features of the J402-CA-400 engine are described, and examples of tailoring to the design requirements of other unmanned vehicles are presented. Among the specific systems considered are: the J402-CA-700 engine for the MQM-107 target drone; the J402-CA-401 engine of the Medium Range Air-to-Surface Missile (MRASM); and the 374-8 engine of the BQM-PI target drone of the U.S. Navy. Some cost factors associated with tailored engine designs are also discussed, including acquisition costs; development costs; and production costs. I.H.

A86-10361
PRESENT AND FUTURE TRENDS IN TURBOJETS AND TURBOFANS FOR R.P.V'S

R. W. CROSS and C. GREGORY (Ames Industrial, Ltd., Fareham, England) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings . Bristol, University of Bristol, 1984, p. 13.1-13.12.

Future market trends and design concepts for low-cost turbojet and turbofan engines for RPV applications are discussed. Emphasis is given to the development of gas turbines for missiles, decoys, and target drones. Some of the performance requirements of next generation turbo engines are discussed, including turbofan engines for LRSOMs, small engines for low-profile surveillance RPVs; and supersonic engines for target drones. The product line of a British turboengine manufacturer is described and line drawings of the different engine designs are provided. I.H.

A86-10362
THE STATUS OF A LOW COST GAS TURBINE PROGRAMME

A. J. PURCHASE (Normalair-Garrett, Ltd., Yeovil, England), D. W. ARTT, and N. F. ADAMS (Belfast, Queen's University, Northern Ireland) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings . Bristol, University of Bristol, 1984, p. 14.1-14.8.

British efforts to develop a low-cost turbine engines unmanned vehicles are described. Attention is given to the engineering program associated with the design of a turbocharger-based engine having 600 N of static thrust. The turbocharger core of the engine was based on existing turbocharger designs. The vaneless diffuser was replaced by an island diffuser and a plenum which also housed the airstart jets and the combustor. The combustor was a conventional reverse flow single can unit made of stainless steel. An electronically controlled fuel system was used to supply oil to the spill burner, with fuel flow controlled by a motor actuated valve in the spill control line. Results of 20 hours of continuous

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testing of the engine at speeds up to 75000 rpm are preserved. A photograph of the engine on its test-bed is provided. I.H.

A86-10477# **THE EFFECT OF ACOUSTICALLY LINED WALLS ON CASCADE FLUTTER**

S. KAJI (Tokyo, University, Japan) and T. WATANABE JSME, Bulletin (ISSN 0021-3764), vol. 28, July 1985, p. 1359-1366. refs

A linear three-dimensional cascade is modelled using a semiactuator disk. The model takes the effects of both the steady flow turning and the total pressure loss across the cascade into account. The flow field disturbed by the bending oscillation of blades is divided into three regions, the upstream, inside, and downstream of the cascade. In each flow region, the governing equations are solved separately to satisfy the boundary conditions at both tip and hub walls. The regions are then connected to each other to meet the boundary conditions on the leading edge plane and the trailing edge plane of the cascade. The aerodynamic forces acting on the blades can be calculated by applying the momentum principle. It is shown that an acoustically lined wall can stabilize as well as destabilize blade oscillation, depending on its acoustic admittance. C.D.

A86-10500# **AIRCRAFT TURBOFANS - NEW ECONOMIC AND ENVIRONMENTAL BENEFITS**

F. R. SAMPL and M. E. SHANK (United Technologies Corp., Pratt and Whitney Engineering Div., East Hartford, CT) Mechanical Engineering (ISSN 0025-6501), vol. 107, Sept. 1985, p. 47-53.

The reduction of fuel consumption has a great economical significance for the operation of aircraft, because fuel costs account for approximately 50 percent of the direct operating expenses in commercial aircraft engines. Much progress with respect to such a reduction has already been made, and modern jets burn 40 percent less fuel than early turbojets. However, the introduction of advanced turbofan and turboprop engines is expected to reduce fuel consumption by another 40 percent. NASA's Engine Component Improvement (ECI) and Energy Efficient Engine (EEE) programs represent two of the most notable programs dedicated to the reduction of fuel consumption. A number of developments leading to decreased fuel consumption are discussed, taking into account controlled diffusion airfoils, advances in aircraft engine technology, mechanics and electronics, and new materials. G.R.

A86-10927# **INTEGRATED FLIGHT/PROPULSION CONTROL - METHODOLOGY, DESIGN, AND EVALUATION**

K. L. SMITH (General Dynamics Corp., Fort Worth, TX), W. B. KERR (United Technologies Corp., Pratt and Whitney Aircraft Div., West Palm Beach, FL), G. L. HARTMANN (Honeywell, Inc., Minneapolis, MN), and C. SKIRA (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 24 p. refs (AIAA PAPER 85-3048)

Details of the activities performed during each of four phases of the U.S.A.F. Design Methods for Integrated Control Systems program which produced a set of integrated flight/propulsion control laws are summarized. Phase I produced the integrated control system design requirements for STOL, terrain following/threat avoidance/obstacle avoidance, air-to-air combat maneuvering, air-to-surface combat maneuvering, and supersonic cruise. Phase II work yielded a nonlinear simulation model for steady-state and dynamic characteristics of the aircraft, inlet, engine and nozzle, using a modified F-16XL as the testbed. The design and development of the control logic for each mission segment were accomplished in Phase IV, with the logic being evaluated with the Phase III simulation model. M.S.K.

A86-10941*# General Dynamics Corp., Fort Worth, Tex. **STUDY OF TURBINE BYPASS REMOTE AUGMENTOR LIFT SYSTEM FOR V/STOL AIRCRAFT**

A. E. SHERIDAN (General Dynamics Corp., Fort Worth, TX) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 14 p. NASA-sponsored research. refs (AIAA PAPER 85-3086)

The airframe design and engine/aircraft integration were emphasized in a NASA comparative study of turbofan and turbine bypass engine (TBE) with remote augmentor lift systems (RALS) for supersonic V/STOL aircraft. Functional features of the TBE are reviewed, noting the enhanced cycle efficiency and reduced afterbody drag compared to the turbojets. The present studies examined performance levels for aircraft with fleet defense and secondary anti-surface warfare roles, carrying AMRAAM and AIM missiles. TBE engine cycles were configured for hover and up-and-away flight from deck launch, and all tests were done from a conceptual design viewpoint. The results indicate that the TBE-RALS is superior to turbofan-RALS aircraft in both gross take-off weight and life cycle cost. M.S.K.

A86-10969*# National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

NET THRUST CALCULATION SENSITIVITY OF AN AFTERBURNING TURBOFAN ENGINE TO VARIATIONS IN INPUT PARAMETERS

D. L. HUGHES, R. J. RAY (NASA, Flight Research Center, Edwards, CA), and J. T. WALTON AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 9 p. (AIAA PAPER 85-4041)

The calculated value of net thrust of an aircraft powered by a General Electric F404-GE-400 afterburning turbofan engine was evaluated for its sensitivity to various input parameters. The effects of a 1.0-percent change in each input parameter on the calculated value of net thrust with two calculation methods are compared. This paper presents the results of these comparisons and also gives the estimated accuracy of the overall net thrust calculation as determined from the influence coefficients and estimated parameter measurement accuracies. Author

A86-10971# **DESIGN AND DEVELOPMENT OF A POWER TAKEOFF (PTO) SHAFT FOR THE X-29 FORWARD SWEEP WING (FSW) DEMONSTRATOR AIRCRAFT**

D. J. GARGIULO (Grumman Aerospace Corp., Bethpage, NY) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 9 p. (AIAA PAPER 85-4045A)

The X-29 Forward Swept Wing (FSW) aircraft required a power takeoff (PTO) shaft to transmit power from the starter to the engine during engine starting and to transmit power from the engine to the remote gearbox during ground and flight operations for aircraft accessories. Shaft design requirements of high speed and great length could not be met with off-the-shelf designs. Meeting adequate critical speed margin posed a significant design problem. Various shaft concepts were studied. The final selection was a graphite epoxy center shaft utilizing metal flexible end assemblies. Extensive testing at unit, subsystem, and system levels proved the adequacy of the design. Author

A86-11601 **INTERNATIONAL SYMPOSIUM ON AIR BREATHING ENGINES, 7TH, BEIJING, PEOPLE'S REPUBLIC OF CHINA, SEPTEMBER 2-6, 1985, PROCEEDINGS**

Symposium sponsored by the Chinese Society of Engineering Thermophysics and International Society for Air Breathing Engines. New York, AIAA, 1985, 826 p. For individual items see A86-11602 to A86-11698.

The symposium presents general topics on nozzle and external flows; gas turbine combustor developments; inlets; mechanical aspects; ramjets; controls, diagnostics, and instrumentation;

turbomachinery; combustion stability and modeling; and propulsin systems and test facilities. Other topics include inviscid flow in turbomachinery, operations and monitoring, fuel injection, viscous effects in turbomachinery, unsteady effects in turbomachinery, and combustor performance correlations. Papers are presented on aero gas turbine engines for commercial application, combustion research for gas turbine engines, numerical simulation of self-excited oscillations in a ramjet inlet-diffuser flow, some recent advances in the instrumentation of airbreathing engines, and numerical modeling of afterburner combustion. In addition, consideration is given to procedures for trending aircraft gas turbine engine performance, simultaneous measurement of velocities and particle sizes for injection systems and ramjet combustors, and energy losses of equilibrium three-dimensional boundary layer.

I.S.

A86-11603#

THE ROLE OF COMPUTATIONAL TECHNIC IN THE DEVELOPMENT OF HIGH PERFORMANCE AIRBREATHING ENGINES

J. ROSSIGNOL (SNECMA, Paris, France) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings . New York, AIAA, 1985, p. 25-32.

The effect of advanced computational techniques on the development and design of aircraft engines is reviewed with reference to specific examples. In particular, attention is given to the computation of airfoils and of subsonic and transonic flow around airfoils and coupling with the boundary layer; analysis of secondary aerodynamic phenomena; computation of off-design performance and analytical assessment of the compressor map; and compressor stability analysis. The discussion also covers the application of finite element methods and three-dimensional models to mechanical design; combustion modeling; manufacturing process improvement and computerization of the links between design engineering and manufacturing engineering.

V.L.

A86-11604#

AERO GAS TURBINE ENGINES FOR COMMERCIAL APPLICATION

A. G. NEWTON (Rolls-Royce, Ltd., Derby, England) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings . New York, AIAA, 1985, p. 33-41.

The progress made in improving the standard of gas turbine engines for commercial applications is briefly reviewed. It is then shown that further gains are possible with the tools that are currently available. Some of these gains could come from the direct applications of available technology to the components of the current configuration of engines or they may be associated with different configurations. Either new versions of the turbo fan engine or even the propeller may come back into use if some significant problems are resolved. These problems include the development of a high-power gearbox, suppression of noise and vibration in the cabin, the development of an advanced propeller, and the development of a suitable gas generator. The economic aspects of such developments are also examined.

V.L.

A86-11608#

COMBUSTION ENGINEERING AND RESEARCH FOR GAS TURBINES

W. W. WAGNER (U.S. Navy, Naval Air Propulsion Test Center, Trenton, NJ) and S. N. B. MURTHY (Purdue University, West Lafayette, IN) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings . New York, AIAA, 1985, p. 87-91. refs

The continuing and emerging engineering concerns in gas turbine combustors and several research needs arising from them are reviewed. In particular, improvements are required in compactness, loading, injector performance, linear temperature distribution, uniformity of product composition and temperature both along the chamber and at the exit plane, and manufacture and life. The research that can be expected to bring about such

improvements is discussed under the following headings: air supply, design and scales, fuel effects, heat transfer and durability, and control of combustor and engine performance.

V.L.

A86-11609*# Army Propulsion Lab., Cleveland, Ohio.

COMBUSTION RESEARCH FOR GAS TURBINE ENGINES

E. J. MULARZ (U.S. Army, Propulsion Laboratory, Cleveland, OH) and R. W. CLAUS (NASA, Lewis Research Center, Cleveland, OH) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings . New York, AIAA, 1985, p. 92-100. Army-supported research. Previously announced in STAR as N85-21164. refs

Research on combustion is being conducted at Lewis Research Center to provide improved analytical models of the complex flow and chemical reaction processes which occur in the combustor of gas turbine engines and other aeropropulsion systems. The objective of the research is to obtain a better understanding of the various physical processes that occur in the gas turbine combustor in order to develop models and numerical codes which can accurately describe these processes. Activities include in-house research projects, university grants, and industry contracts and are classified under the subject areas of advanced numerics, fuel sprays, fluid mixing, and radiation-chemistry. Results are high-lighted from several projects.

Author

A86-11610#

DEVELOPMENT OF NEW COMBUSTOR TECHNOLOGIES AT SNECMA

G. B. LABOURE (SNECMA, Villaroche, France) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings . New York, AIAA, 1985, p. 101-108. refs

Major steps of the evolution in the design of the aircraft engine combustors are presented, with discussion of the available design techniques and their advantages, drawbacks and limitations. In particular, the evolution of technology and possible future design trends concerning the combustor injection system, efficiency/pollution performance, reduction in size, cooling technology, and the control and optimizing of the mechanical systems are discussed. The design principles of various combustor features are illustrated graphically.

I.S.

A86-11618#

DETERMINATION OF HIGH CYCLE FATIGUE LIFE OF AXIAL COMPRESSOR BLADES OF TURBOJET ENGINES FITTED IN MILITARY AIRCRAFT

M. L. SIDANA, R. V. NARAYANA MURTHY, and K. SRINIVASA (Defence Research and Development Organization, Directorate of Aeronautics, Bangalore, India) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings . New York, AIAA, 1985, p. 173-177.

Results are presented of a study on fatigue life usage rates at various intervals of service hours of the rotor blades in a seven-stage axial compressor that was used in three types of aircraft (fighter, interceptor, and trainer). The rotor blades, made of aluminum alloy RR 58, were tested by means of an electromagnetic exciter linked to a blade-holding block. It was found in the initial studies that from the point of view of the high cycle fatigue (HCF) the second and the third stage rotor blades are the critical ones. The HCF life was highly dependent upon the initial fatigue strength and was a function of vibration environment in terms of the 'af' level in the particular engine installation. The 'af' level in turn depends on the pressure/velocity distortion factors at the engine intake face.

I.S.

07 AIRCRAFT PROPULSION AND POWER

A86-11623#

DIAGNOSIS AND CURE FOR A FATIGUE PROBLEM IN THE TURBINE ROTOR OF A SMALL TURBO-ENGINE

A. J. VAN WYK and G. V. HOBSON (Council for Scientific and Industrial Research, National Institute for Aeronautics and Systems Technology, Pretoria, Republic of South Africa) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 207-211.

Computed and measured blade vibration characteristics of a turbine wheel are discussed in conjunction with engine speed starting characteristics of an integrally cast impulse turbine that failed during its first test. All the turbine blades of the gas generator broke off at their roots causing extensive damage to the exhaust/diffuser housing. The blade vibration and the impulse starter system characteristics were analysed and related to the failure, and the corrective actions recommended. These include static measurement of all modes and their frequencies, with a stress on the usefulness of nonintrusive techniques like laser holography, keeping the historical records of all parameters in a suitable format for a quick backtracking, and a full aeroelastic investigation of turbine blades in simulated rig tests or, ultimately, under real operating conditions. I.S.

A86-11624#

RAMJET RESEARCH IN FRANCE - REALITIES AND PERSPECTIVES

R. MARGUET and PH. CAZIN (ONERA, Chatillon-sous-Bagneux, France) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 215-224. refs (ONERA, TP NO. 1985-108)

Thirty years of ramjet research in France are presented, which can be divided into three historical periods: tests on conventional configurations, with the front air intakes and jettisoned boosters (1955-1965), theoretical and experimental research on the hypersonic ramjet for flights at over Mach 6 (1965-1972), and, since 1972, return to moderate supersonic speed ramjets with new designs, more competitive and compatible with operational requirements. Various architectural ramjet configurations, ramjet combustors with the integral booster, compact engine using liquid fuels with high volumetric energy and with solid fuel, and ramrockets with solid fuel containing oxidizer are discussed together with test methods and facilities. Future trends in the ramjet research and development are outlined, stressing the orientation towards military applications. I.S.

A86-11641#

NUMERICAL MODELING OF AFTERBURNER COMBUSTION

X. ZHANG (Shenyang Aeroengine Research Institute, People's Republic of China) and H.-H. CHIU (Illinois, University, Chicago) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 359-369. refs

A numerical method and a computer code for modeling the afterburner and gas phase combustion processes in turbofan or turbojet afterburners were developed on the basis of the Navier-Stokes equation and a finite difference method. The computer code was shown to be effective and versatile. The numerical analysis revealed that the recirculation zone in the combustor flow is much shorter than in the noncombusting afterburner flow. The multiphase combustion efficiency depends on the principal spray combustion processes. All phenomena reflected by the numerical results coincided with some known experimental data. I.S.

A86-11646#

REAL-TIME ENGINE TESTING IN THE AEROPROPULSION SYSTEMS TEST FACILITY

N. W. HAARS and J. G. MITCHELL (USAF, Arnold Engineering Development Center, Arnold Air Force Station, TN) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 401-407.

The design and development of the Aeropropulsion Systems Test Facility (ASTF) is discussed. The real-time-test (RTT) capability provided by the facility is explained. The advantages and disadvantages of steady-state testing procedures are described and compared with RTT capabilities. The improved testing provided by the control and data systems of the ASTF are discussed. Inlet/engine testing, maneuver transient simulation, and the testing of engine power transients, which are new procedures provided by the ASTF, are explained. The trends in aviation that were studied during the planning of ASTF and the development schedule for the facility are examined. The low cost, time saving testing possible with the RTT at ASTF is explained. I.F.

A86-11648#

A STUDY ON PERFORMANCES OF VARIABLE GEOMETRY TURBOFAN ENGINES UTILIZING AN APPROXIMATED ANALYTICAL METHOD

C. SANCHEZ TARIFA (Madrid, Universidad Politecnica, Spain) and M. A. LOPEZ AGUILAR (Iberia Lineas Aereas de Espana, Madrid, Spain) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 413-417.

The influence of varying exhaust nozzle areas and specific work of the fan on the fuel consumption of turbofan engines is examined. The analytical expressions used in the approximation method to calculate the performance of both compressors and fan are provided. The actual and calculated data on engine performance are compared and show good correlation. The test parameters are described. The results obtained for specific fuel consumption at take-off and cruise conditions are graphically explained; the data reveals that an increase of exhaust areas will reduce fuel consumption. The data obtained from varying fan flows are discussed. I.F.

A86-11649#

DESIGN CHARACTERISTICS OF A NEW GENERATION TURBOSHAFT ENGINE

K. TRAPPMANN (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, West Germany) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 418-425. refs

Design considerations for a helicopter turboshaft engine are discussed. The functional and economic requirements for engine designs are explained. A diagram of a 900 kW turboshaft engine for a twin engine helicopter and the advantages of its axial/radial compressor and combustion chamber are described. The evaluation of the engine design and the improvements required are examined. A new engine design, which was developed because of major advances in compressor and turbine aerodynamics, is described. A comparison of the combustion chamber, and compressor turbine and cooling system of the two engine designs is provided; the improvements required in the new design are explained. I.F.

A86-11650#

THE AERODYNAMIC AND THERMODYNAMIC DESIGN OF A SMALL TURBOJET

C. MASSARO, S. COLANTUONI, P. DI MARTINO, G. LIOTTI (Alfa Romeo Avio S.p.A., Naples, Italy), and G. TORELLA (Italian Air Force Academy, Italy) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 426-432. refs

This paper deals with the activities carried out during the AR/TJ140 small turbojet design and development. The theoretical,

experimental and numerical methods that have been set up are based on the experiences made during the design of ESM 600 turboshaft and AR318 turboprop engines. The problems connected with the different phases of the project are considered here. The paper deals with design choice, compressor and turbine aerodynamic problems and with performance predictions. For each argument the problems that have been met and the selected solutions are shown. Author

A86-11661#**ENGINE PERFORMANCE MONITORING IN HELICOPTERS**

D. E. GLENNY (Aeronautical Research Laboratories, Melbourne, Australia) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 513-519.

Methods to monitor the performance of helicopter engines are described. The first method, manual In-Flight Monitoring (IFM) relies solely on data manually recorded by the pilot and interpretations by maintenance personnel. The second method, a computerized engine performance monitoring system, consists of a set of automatically recorded data and a gas flow analysis routine to diagnose performance trends in flight. The data screening requirements of the automatic system are described, and some preliminary results of 300 hours of tests on a T53-L13 helicopter engine are presented. It is shown that, except for obvious instrument malfunctions, torque drop-outs, and speed fluctuations, consistent trends in engine performance parameters can be accurately predicted using the automatic system. Trend plots of the torque of the T53-L13 engine are given in a table. I.H.

A86-11662#**PROCEDURES FOR TRENDING AIRCRAFT GAS TURBINE ENGINE PERFORMANCE**

D. A. FRITH and P. C. FRITH (Aeronautical Research Laboratories, Melbourne, Australia) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 520-527. refs

A procedure is proposed to extract information from aircraft engine performance measurements. The condition parameters used in the procedure include: blade erosion, seal wear, and deterioration in the gas path regions of the engine. Some sources of noise error in performance measurements are discussed, and the use of an uncertainty interval to identify hidden biases in predicted trends is described. A flowchart for the procedure is provided. I.H.

A86-11663#**JT9D ENGINE/MODULE PERFORMANCE DETERIORATION RESULTS FROM BACK TO BACK TESTING**

O. SASAHARA (Japan Air Lines, Co., Ltd., Tokyo, Japan) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 528-535.

The results of back-to-back performance testing of JT9D-7A gas turbine commercial aircraft engines are presented. Specific performance losses were computed for individual engine modules using a Module Analysis Program (MAP). The performance deterioration data for individual gas-path modules are derived and some damage mechanisms are examined. A list of the dependent and independent variables in the performance data is obtained on the basis of the computer analysis. A detailed line drawing of the JT9D engine is provided. I.H.

A86-11664#**CERTAIN ALGORITHMS RELATED TO 'ENGINE CONDITION MONITORING' SYSTEMS**

TH. TH. PANIDIS and D. D. PAPAIOU (Patras, University, Greece) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 536-539.

The algorithms used to predict gas turbine engine performance in conjunction with the Gas Path Analysis (GPA) technique are described. The function of the algorithms is to relate engine

parameter derivations from their normal values to corresponding cases of engine failure. Deviating parameters are compared to sets of parameter matrices which describe the possible sources of engine defect using a Set of Deviating Parameters Algorithm (SPDA). Existing faults are identified using Condition Vector Algorithms (CVAs) to provide quantitative information regarding the parameter deviations. An Engine Monitoring (ECM) system integrating the two algorithms is described and its application to defect analysis in a three-spool turbofan engine is discussed. I.H.

A86-11665#**HOSTILE ATMOSPHERIC ENVIRONMENT EFFECTS ON JET ENGINES**

W. TABAKOFF and A. HAMED (Cincinnati, University, OH) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 540-549. refs (Contract DAAG29-82-K-0029)

The dynamics of solid particles ingested through a helicopter turbine engine having an inlet particle separator have been investigated, theoretically. The distribution of the unseparated particles and the locations of particle-blade impacts were determined by computing the particle trajectories through the five stage axial compressor. It is shown that the distribution of particle impacts is not uniform between the blade pressure surfaces and the blade section surfaces in the compressors and stators. The patterns of blade erosion due to particle impacts are illustrated in a series of line drawings. I.H.

A86-11666#**INITIAL DISPERSION OF JET ENGINE EXHAUST PLUME**

T. SAWADA (Osaka Prefecture, University, Sakai, Japan) and A. NISHI (Miyazaki University, Kirishima, Japan) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 550-557. refs

Experiments were carried out using a laboratory model in order to study the physical characteristics of a co-axial jet engine exhaust plume near the ground. Estimates are obtained of the velocity, temperature, and chemical composition of the model jet, and the results are compared with field measurements collected at Chitose Airport in Hokkaido, Japan. The combined data are used to predict the deflection of the jet axis due to cross winds and the different buoyancies of the jet flow in the idle mode and during takeoff. I.H.

A86-11693#**A STUDY OF THE FREQUENCY RESPONSE OF A TURBOJET ENGINE TO TURBULENCE-TYPE DYNAMIC DISTORTION**

F. CHEN, W. LI, Z. WANG, M. CONG (Northwestern Polytechnical University, Xian, People's Republic of China), and S. LIU IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 765-771. refs

A study of frequency response of a turbojet engine to turbulence-type dynamic inlet distortion (TTDD) was studied, analyzing the input/output compressor signals by means of a statistical analysis technique for stochastic processes. The TTDD was generated by a plate with 180 deg extent and 50 percent blockage ratio at the engine face. The results indicate that the engine compressor system is most sensitive to the intermediate frequency fluctuations just before the onset of surge. I.S.

A86-11697#

TRANSPORTATION AND IMPINGEMENT/EFFUSION COOLING OF GAS TURBINE COMBUSTION CHAMBERS

G. E. ANDREWS, A. A. ASERE, C. I. HUSSAIN, and M. L. MKPADI (Leeds, University, England) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 794-803. refs

(Contract SERC-GR/B/67827; SERC-B/00336; SERC-GR/C/59192)

The overall cooling effectiveness of a combined impingement plate (IP)-full coverage discrete hole effusion (E) cooling system for cooling gas turbine chambers was compared to the transpiration (T), or porous wall cooling. The phenomenon of heating the IP by the impingement air was also investigated. At low coolant flow rates, the E cooling could match the film cooling effectiveness of a fully porous wall. The lower overall cooling effectiveness performance consequently results from inferior internal wall cooling. Although the combination of IP with E led to a major improvement in the overall cooling effectiveness, it remained inferior to the T cooling system. Heating of IP by the reflected impingement jets is maximized at low coolant flow rates and small impingement hole diameter, but is not influenced by the distance between the IP and the air source in the distance range of 3-12 mm. I.S.

A86-11757

DEPOSITS IN AIRCRAFT ENGINES. I - TYPE OF DEPOSITS AND TEST METHODS [ABLAGERUNGEN IN FLUGTRIEBWERKEN. I - ERSCHEINUNGSFORMEN UND TESTMETHODEN]

K. MAIER (Motoren- und Turbinen-Union Muenchen GmbH, Munich, West Germany) and E. JANTZEN (DFVLR, Institut fuer technische Physik, Stuttgart, West Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X), vol. 9, July-Aug. 1985, p. 211-217. In German. refs

Oil-reaction-product deposit formations in the oil systems of aircraft engines are examined. The location and the types of deposits detected and the factors which influence their formation are explained and diagrams of deposit formations are provided. The characteristics of the deposits, which are used to classify them, are described. The laboratory techniques used to study deposit formations, which include static and dynamic electric stress tests in the liquid phase, droplet phase tests, and oil steam phase tests, are analyzed and examples of specific equipment utilized are presented. The specifications which must be followed when using these techniques are presented and the effect of temperature on deposit formation is discussed. I.F.

A86-11955

AEROJET TECHSYSTEMS DEVELOPS HYPERSONIC AIRCRAFT ENGINE

J. T. MERRIFIELD Aviation Week and Space Technology (ISSN 0005-2175), vol. 123, Oct. 14, 1985, p. 57, 59, 60, 65.

An American aerospace company is developing the Airturboramjet engine for hypersonic transatmospheric vehicles. It is believed that the engine could be ready for a flight demonstration within four years. The Airturboramjet, designed to operate like a turbojet at subsonic speeds and like a fan-boosted ramjet at supersonic and hypersonic speeds, could provide the necessary propulsion for hypersonic transport which has been proposed. A three-year project is to prove the concept of a hydrogen-fueled Airturboramjet. The project includes design, fabrication, and testing of a subscale engine at simulated Mach 5 and 100,000-ft altitude conditions. G.R.

A86-12010

TAY FOR TWO

J. MOXON Flight International (ISSN 0015-3710), vol. 128, Sept. 28, 1985, p. 21-26.

The development of a turbofan, Tay, is described. The Spey Mk 555 was used as the basis for the Tay engine. The use of the engine in two aircraft and the need for the engine to be produced at reasonable cost are explained. The reduction of the

high jet velocity by raising the bypass ratio is discussed. The development of a low-pressure spool, and an intermediate-pressure compressor are described; the functions of the intermediate-pressure compressor are discussed. A new combustor, a 12-lobe exhaust mixer, an acoustic liner to reduce noise, and an all-composite bypass duct used in the design of the turbofan are explained. A diagram of the Tay engine is provided. I.F.

A86-12365

PROPELLER POWER

M. HIRST Air International (ISSN 0306-5634), vol. 29, Oct. 1985, p. 190-194.

The evolution of the propeller due to advances in turboprop technology is discussed. The development of variable-pitch propellers and examples of aircraft utilizing them are described. The need to reduce the rotation speed between the gas turbine and the propeller drive shaft, in the variable pitch propeller, led to a turboprop engine; the characteristics of this engine type are explained. The problems encountered with gearboxes and the use of turboshaft engines are examined. A comparison of turboprop and turbofan engines is presented. The development and testing of a propfan engine, which is a turbofan engine that can achieve a higher turbine operating temperature, are described. I.F.

A86-12531

THE EFFECT OF THE INITIAL TEMPERATURE NONUNIFORMITY AND EXCESS AIR RATIO OF THE AFTERBURNER OF A GAS-TURBINE ENGINE ON THE SPECIFIC PULSE OF THE NOZZLE [VLIANIE NERAVNOMERNOSTI NACHAL'NOI TEMPERATURY I KOEFFITSIENTA IZBYTKA VOZDUKHA V FORSAZHNOI KAMERE GTD NA UDEL'NYI IMPUL'S SOPLA]

V. N. GRUZDEV Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1985, p. 21-24. In Russian. refs

The specific pulse reduction factor of a nozzle is calculated for the maximum temperature nonuniformity at the nozzle inlet that is possible for the afterburner of a bypass engine. It is shown that the observed discrepancy between the effective and 'chemical' heat release ratios is largely determined by the effect of the nonuniformity of the temperature field on the specific pulse of the nozzle. V.L.

A86-12532

A STUDY OF THE SWIRLING OF A LIQUID BY POROUS ROTORS [ISSLEDOVANIE ZAKRUTKI ZHIDKOSTI PORISTYMI KOLESAMI]

IU. V. DRONOV, A. A. PANCHENKO, and V. F. PRISNIAKOV Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1985, p. 25-28. In Russian.

The swirling of a liquid by the porous rotors of centrifugal pumps is investigated experimentally as a function of the inlet diameter and of the porosity factor. An empirical expression for estimating the swirling of a liquid at the outlet side of the rotor is obtained. Experimental results are presented for water. V.L.

A86-12541

A METHOD FOR DESIGNING A SURGE PROTECTION DEVICE FOR GAS TURBINE ENGINES [OB ODNOM SPOSOBE POSTROENIIA USTROISTVA ZASHCHITY GTD OT POMPAZHA]

M. M. SHAKIRIANOV Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1985, p. 64-68. In Russian. refs

The possibility of recognizing the unstable operation of an aircraft engine using the Van der Pol equation is investigated. The conditions defining the gasdynamic stability region of a gas-turbine engine are then obtained and implemented in an automatic surge protection system. The general design and the principle of operation of the system are described. V.L.

A86-12544

A STUDY OF THE EFFECT OF ROTOR BLADING PARAMETERS ON THE REGION OF ACCEPTABLE DESIGN SOLUTIONS FOR THE ATTACHMENT OF AIRCRAFT COMPRESSOR BLADES [ISSLEDOVANIE VLIANIYA PARAMETROV PROTOCHNOI CHASTI KOLESNA NA OBLAST' DOPUSTIMYKH PROEKTNYKH RESHENII PO UZLAM KREPLENIIA LOPATOK AVIATIONNYKH KOMPRESSOROV]

B. M. ARONOV and V. A. KAMYNNIN Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1985, p. 75-77. In Russian.

In order to assess the possibility of using particular types of blade-root fastenings at an early stage of design, the knowledge of the effect of rotor blading parameters on the region of acceptable design solutions for the fastenings is required. Here, the relationship between the parameters of the rotor blading and the region of acceptable design solutions is analyzed using a full factorial experimental design. Results are presented for blades and a rotor made of VT-9 alloy. V.L.

A86-12546

DETERMINATION OF THE THRUST OF A BYPASS ENGINE UNDER OPERATING CONDITIONS [OPREDELENIE TIAGI TRDD V USLOVIAKH EKSPLOATSII]

A. D. KOZITSKII and V. T. SHEPEL Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1985, p. 79-81. In Russian.

A method for determining the thrust of a bypass engine is proposed which uses as the initial data the rotor rpm and fuel consumption, i.e., parameters that can be easily measured during the operation of the engine, rather than the full gas pressure behind the turbine. The method is simple to implement and sufficiently accurate. For a plus or minus 2-sigma variance, the maximum relative error of thrust determinations is plus or minus 1.7 percent; with a correction for the individual compressor output, the maximum relative error is reduced to plus or minus 1.2 percent. V.L.

A86-12548

A STUDY OF A TURBINE STAGE WITH A TWISTED VANED DIFFUSER [ISSLEDOVANIE TURBINNOI STUPENI S ZAKRUCHENNYM LOPATOCHNYM DIFFUZOROM]

S. M. LANGOVOI and I. I. MITIUSHKIN Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1985, p. 83-85. In Russian. refs

Tests have been carried out on a turbine stage with cylindrical blading to determine the effect of a twisted vaned diffuser on the turbine performance. It is shown that a diffuser with twisted vanes reduces the maximum efficiency of the turbine stage by about 0.6 percent, while significantly decreasing the optimum value of the velocity characteristic (from 0.625 to 0.54). It is also shown that the use of a twisted vaned diffuser has little effect on the thrust characteristics and improves the economy of the turbine stage by approximately 1 percent in the velocity characteristic range 0.43-0.53. V.L.

A86-12549

UNSTEADY OPERATION OF THE FUEL NOZZLES OF THE MAIN COMBUSTION CHAMBER OF A GAS-TURBINE ENGINE [O NESTATSIONARNOI RABOTE TOPLIVNYKH FORSUNOK OSNOVNOI KAMERY SGORANIYA GTD]

E. I. MARCHUKOV Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1985, p. 86-88. In Russian. refs

The mechanisms of acoustic wave generation in the centrifugal fuel nozzles of the combustion chamber of a gas-turbine engine are investigated experimentally and found to be of hydrodynamic nature. In particular, the phenomenon of self-oscillatory flow in centrifugal fuel nozzles with nonsubmerged outflow is identified. The unsteady operation of fuel nozzles significantly intensifies mixing processes but, at the same time, can lead to combustion instability in the combustion chamber. The need for further studies of the phenomenon described here is emphasized. V.L.

A86-12555

HIGH-SPEED LASER PHOTORECORDING OF A FUEL NOZZLE JET [LAZERNAIA SKOROSTNAIA FOTOREGISTRATSIYA FAKELA FORSUNKI]

V. P. SHORIN, O. A. ZHURAVLEV, L. N. MEDINSKAIA, A. G. OSADCHUK, and V. V. TOKAREV Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1985, p. 100-102. In Russian. refs

The existing methods of monitoring the structure of a fuel jet injected into the combustion chamber of a gas-turbine engine are briefly reviewed, and the advantages of high-speed laser photorecording (the laser knife method) are examined. This method makes it possible to visualize the structure of the jet and to determine the velocity distributions of gas flow by injecting monodisperse particles with specified optical properties. Experimental results for a fuel jet injected by a pneumatic nozzle are presented which show that reliable recording of the jet structure is achieved with an energy density in the laser knife of 250 J/sq m, which can be provided by an unamplified ruby laser. V.L.

A86-12599

ASSURING THE RELIABILITY OF AIRCRAFT ENGINES [OBESPECHENIE NADEZHNOI AVIATIONNYKH DVIGATELEI]

N. D. KUZNETSOV Akademiia Nauk SSSR, Vestnik (ISSN 0002-3442), no. 8, 1985, p. 85-92. In Russian.

The problem of the reliability of aircraft engines is examined with emphasis on the methodology of optimum design. In particular, attention is given to the optimization of the initial factors and principal gasdynamic parameters, mathematical description of physical processes occurring in gas turbines, and the role of computers in optimum design. The discussion also covers special tests for gas-turbine engines, the effect of process variables on the fatigue behavior of turbine blades, surface treatment techniques for hardening gas-turbine components, and new engine diagnostic methods and equipment. V.L.

N86-11148# Lockheed-Georgia Co., Marietta. Advanced Concepts Dept.

A REVIEW OF ADVANCED TURBOPROP TRANSPORT ACTIVITIES

R. H. LANGE In AGARD Aerodyn. and Acoustics of Propellers 16 p Feb. 1985 refs

Avail: NTIS HC A20/MF A01

The application of advanced technologies shows the potential for significant improvement in the fuel efficiency and operating costs of future transport aircraft envisioned for operation in the 1990s time period. One advanced turboprop concept originated by Hamilton Standard and NASA is known as the propfan. The concept features a highly loaded, multibladed, variable pitch propeller geared to a high pressure ratio gas turbine engine. The blades have high sweepback and advanced airfoil sections to achieve 80 percent propulsive efficiency at $M = 0.80$ cruise speed. Aircraft system studies have shown improvements in fuel efficiency of 15 to 20 percent for propfan advanced transport aircraft as compared to equivalent turbofan transports. Beginning with the Lockheed C-130 and Electrica turboprop aircraft, an overview of the evolution of propfan aircraft design concepts and system studies is presented. These system studies include possible civil and military transport applications and data on the performance, community and far field noise characteristics and operating costs of propfan aircraft design concepts. NASA Aircraft Energy Efficiency (ACEE) program propfan projects with industry are reviewed with respect to system studies of propfan aircraft and recommended flight development programs. Author

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N86-11149# Office National d'Etudes et de Recherches Aérospatiales, Paris (France).

AERODYNAMIC METHOD USED IN FRANCE FOR ADVANCED FAST PROPELLER STUDY

J. M. BOUSQUET *In* AGARD Aerodyn. and Acoustics of Propellers 15 p Feb. 1985 refs *In* FRENCH; ENGLISH summary Original language document previously announced in IAA as A85-15840

Avail: NTIS HC A20/MF A01

Computational techniques and programs currently in use in the design analysis of aircraft propellers are surveyed and illustrated with diagrams and graphs of typical results. Methods examined include lifting line, incompressible lifting surface, three dimensional compressible, and three dimensional Euler; both classical and advanced propeller designs are considered. The Euler analysis of the experimental propeller HT1 being developed for ONERA is explored in detail, evaluating the effects of tip speed ratio, Mach number, number of blades, hub diameter, and a tapered diameter hub shroud. T.K.

N86-11150# Centre National de la Recherche Scientifique, Orsay (France).

DESIGN CONCEPT AND PERFORMANCE PREDICTION TECHNIQUE FOR POTENTIAL FLOWS AROUND ADVANCED PROPELLERS

T. S. LUU and R. COLLERCANDY *In* AGARD Aerodyn. and Acoustics of Propellers 12 p Feb. 1985 refs

Avail: NTIS HC A20/MF A01

The design concept and performance prediction technique for potential flows around advanced propellers is presented. The design of propellers is based on the panel method, applied to the lifting surface theory in which the flow is supposed to be incompressible. A transonic performance prediction technique is developed where the resulting potential equation is solved by a finite difference approximate factorization method in a body fitted grid system. Both two and three dimensional results are presented. Author

N86-11151# Aircraft Research Association Ltd., Bedford (England).

A REVIEW OF ARA RESEARCH INTO PROPELLER AERODYNAMIC PREDICTION METHODS

A. J. BOCCI and J. I. MORRISON *In* AGARD Aerodyn. and Acoustics of Propellers 19 p Feb. 1985 refs

Avail: NTIS HC A20/MF A01

An improved wake method involving a numerical solution to Goldstein's wake flow model was developed and the effects of removing Goldstein's limiting assumptions are illustrated. The representation of ARA-D airfoil data for use with the wake methods is considered, covering the wide range of geometry and flow conditions likely to be encountered on operating blades. The importance of finite blade effects is discussed and a tip relief correction is shown to improve predictions of experimental blade pressures and loadings. A method was developed to calculate the flow induced by a prescribed wake vortex sheet and some of the issues arising in calculating the flow development from the propeller disc downstream are illustrated. A three dimensional method involving solution of the compressible potential flow equation was developed, capable of predicting the blade flow in some detail for general multiblade configurations. Comparisons with experiment are shown for two blade cases. Author

N86-11152# Office National d'Etudes et de Recherches Aérospatiales, Paris (France).

MODERN PROPELLER PROFILES

A. M. RODDE, J. J. CUNY (Societe Ratier Figeac, France), and J. J. THIBERT *In* AGARD Aerodyn. and Acoustics of Propellers 12 p Feb. 1985 refs *In* FRENCH Original language document previously announced in IAA as A85-15841

Avail: NTIS HC A20/MF A01

The design of a family of advanced profile composite aircraft propellers is presented, and the results of wind tunnel tests performed at the ONERA Modane S3 and CEATY S10 facilities

are reported. The design specifications are outlined; the definition of profiles with relative thicknesses 4, 7, 12, and 20 percent is explained; and the test results are presented in graphs and diagrams. Significant performance improvements (relative to a NACA 16707 reference profile) are observed, including 43 and 8 percent better lift/drag ratios for cruising and ascent, respectively, 15 percent better C_z max, and equivalent critical Mach number at lower drag. The first planned application is to the Transall C160 two engine turboprop transport aircraft. T.K.

N86-11153# National Aerospace Lab., Amsterdam (Netherlands).

AERODYNAMICS OF WIDE-CHORD PROPELLERS IN NON-AXISYMMETRIC FLOW

J. B. H. M. SCHULTEN *In* AGARD Aerodyn. and Acoustics of Propellers 10 p Feb. 1985 refs

Avail: NTIS HC A20/MF A01

A lifting surface analysis is presented for propellers in nonaxisymmetric flow. In the analysis the Euler equations linearized about a uniform subsonic main flow are solved after separation of variables in cylindrical coordinates. This solution is obtained via an integral equation for the force distribution over the upper and lower surfaces of the blades which replaces the action of the propeller on the surrounding fluid. The boundary condition of vanishing normal velocity is applied at the actual blade surfaces, thus leading to a nonhelical, unsteady lifting surface theory for propellers. Since the integral equation is solved most efficiently per circumferential Fourier component of the inflow distortion field, symmetric inflow is included naturally as the zeroth term of the Fourier series. General blade shapes can be handled as the blades may be swept both axially and azimuthally. There is no inherent limitation to the propeller tip Mach number. Apart from the calculation of the unsteady blade loading, expressions for the velocity and pressure fields are derived, in which the propeller slipstream appears explicitly as part of the complete velocity field in a form perfectly suited for wing interference calculations. Author

N86-11154# Cranfield Inst. of Tech., Bedford (England). Coll. of Aeronautics.

ON THE AERODYNAMICS OF INSTALLED PROPELLERS

M. E. ESHELBY *In* AGARD Aerodyn. and Acoustics of Propellers 15 p Feb. 1985 refs

Avail: NTIS HC A20/MF A01

When the propeller is installed on the aircraft there will be mutual influence between the airframe and the propeller and its slipstream, two sources of that interference are examined. First, as the aircraft angle of attack changes with forward speed the angle of attack of the propeller also changes giving rise to forces and moments other than thrust and torque. Second, the high energy slipstream may pass over the tailplane and so affect the tail lift force, and in consequence a pitching moment due to power may be produced. These two effects are considered separately and means are suggested to estimate their magnitude and their effect on the handling qualities of the aircraft. Author

N86-11155# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Entwurfsaerodynamik.

A UNIFIED APPROACH FOR THE AERODYNAMICS AND ACOUSTICS OF PROPELLERS IN FORWARD MOTION

A. DAS *In* AGARD Aerodyn. and Acoustics of Propellers 28 p Feb. 1985 refs

Avail: NTIS HC A20/MF A01

The aerodynamics and the acoustics of moving bodies or surfaces follow the same basic laws of disturbance propagation and hence can be treated in a unified way. Further advancements of the propeller theories have two objectives: attaining better propulsive efficiency and producing less noise at high forward speeds. A unified aerodynamic and acoustic theory of propeller in forward motion is formulated and analyzed in detail describing the aspect of disturbance propagation from singularities in arbitrary motion, derivation of the spatial and temporal dilatations concerned

with the propagation process, generalized exposition of the solution method for aerodynamics and acoustics and an extended sweep technique to determine the inducing effect of moving surfaces. In view of the flow field of a propeller being not completely irrotational the use of pressure potential proves to be more suitable in the numerical methods. The results of the analysis are illustrated by diagrams. Author

N86-11156*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

THEORETICAL ANALYSIS OF LINEARIZED ACOUSTICS AND AERODYNAMICS OF ADVANCED SUPERSONIC PROPELLERS
F. FARASSAT *In* AGARD Aerodyn. and Acoustics of Propellers 15 p Feb. 1985 refs

Avail: NTIS HC A20/MF A01 CSCL 01A

The derivation of a formula for prediction of the noise of supersonic propellers using time domain analysis is presented. This formula is a solution of the Ffowcs Williams-Hawkings equation and does not have the Doppler singularity of some other formulations. The result presented involves some surface integrals over the blade and line integrals over the leading and trailing edges. The blade geometry, motion and surface pressure are needed for noise calculation. To obtain the blade surface pressure, the observer is moved onto the blade surface and a linear singular integral equation is derived which can be solved numerically. Two examples of acoustic calculations using a computer program are currently under development. Author

N86-11157# Lockheed-California Co., Burbank.

A GENERAL THEORY OF ARBITRARY MOTION AERODYNAMICS USING AN AEROACOUSTIC APPROACH

L. N. LONG and G. A. WATTS *In* AGARD Aerodyn. and Acoustics of Propellers 12 p Feb. 1985 refs

Avail: NTIS HC A20/MF A01

The theoretical aspects of a new unsteady aerodynamics method that uses time domain aeroacoustic integral equations is described. Recent advances in theoretical aeroacoustics permit the development of general unsteady aerodynamics methods. The effects of thickness, compressibility, and arbitrary motions may be calculated for subsonic and supersonic flows. Most linearized unsteady aerodynamics methods today are limited to zero thickness effects and sinusoidal motion. The equations presented will make it possible to develop computer codes for complex three dimensional bodies, including not only complete aircraft configurations, but rotating propellers and helicopter blades as well. Panel methods for steady aerodynamics are widely used in the aircraft industry for such configurations, the present method should permit equally general configurations to be solved in unsteady motion, using a time stepping procedure. Author

N86-11158*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

SUMMARY OF RECENT NASA PROPELLER RESEARCH

D. C. MIKKELSON, G. A. MITCHELL, and L. J. BOBER *In* AGARD Aerodyn. and Acoustics of Propellers 24 p Feb. 1985 refs Previously announced as N84-32344

Avail: NTIS HC A20/MF A01 CSCL 01A

Advanced high speed propellers offer large performance improvements for aircraft that cruise in the Mach 0.7 to 0.8 speed regime. At these speeds, studies indicate that there is a 15 to near 40 percent block fuel savings and associated operating cost benefits for advanced turboprops compared to equivalent technology turbofan powered aircraft. Recent wind tunnel results for five eight to ten blade advanced models are compared with analytical predictions. Test results show that blade sweep was important in achieving net efficiencies near 80 percent at Mach 0.8 and reducing nearfield cruise noise about 6 dB. Lifting line and lifting surface aerodynamic analysis codes are under development and some results are compared with propeller force and probe data. Also, analytical predictions are compared with some initial laser velocimeter measurements of the flow field velocities of an eight bladed 45 swept propeller. Experimental aeroelastic results indicate that cascade effects and blade sweep

strongly affect propeller aeroelastic characteristics. Comparisons of propeller nearfield noise data with linear acoustic theory indicate that the theory adequately predicts nearfield noise for subsonic tip speeds, but overpredicts the noise for supersonic tip speeds.

B.W.

N86-11159# Societe Nationale Industrielle Aerospatiale, Marignane (France).

DYNAMIC BEHAVIOR OF A PROPFAN

J. M. BESSON and D. PETOT (ONERA, Paris) *In* AGARD Aerodyn. and Acoustics of Propellers 15 p Feb. 1985 refs *In* FRENCH Original language document previously announced in IAA as A85-15842

Avail: NTIS HC A20/MF A01

The dynamic behavior of a 1 m diameter 12 blade propfan model is investigated analytically and experimentally. Both the propfan and its individual blades are analyzed using two versions of a simplified beam model and the finite element codes ASTRONEFF and SAMCEF, considering blades of Dural alloy, CFRF, and foam filled CFRP. The modeling techniques are illustrated, and results are presented in graphs and tables. The single blade findings are compared with the results of wind tunnel tests performed at the ONERA Mondane S1 facility, and the errors of the models are found to be of the order 10 percent. The ASTRONEFF procedure is shown to be best adapted to the foam filled ribbed CFRP blade to be used in the actual propfan model. Preliminary computations of the aerodynamics and static deformation of the propfan are also presented. T.K.

N86-11160# De Havilland Aircraft Co. of Canada Ltd., Downsview (Ontario).

PERFORMANCE EVALUATION OF FULL SCALE PROPELLERS BY WIND TUNNEL TEST

D. J. BARBER *In* AGARD Aerodyn. and Acoustics of Propellers 12 p Feb. 1985 refs

Avail: NTIS HC A20/MF A01

A large propeller test facility was developed for the nine meter wind tunnel. The facility is described along with the propeller test rig features and associated drive system. Propeller performance measurement philosophy, test procedures and calibrations are discussed. In cooperation with Dowty Rotol Ltd. and Hartzell Inc., two currently available propeller designs were tested. The two 8.5 foot diameter propeller suitable for a DHC Twin Otter size of aircraft provided an evaluation of alternative airfoil applications: the ARA-D series and NACA 16 series. Results have demonstrated propeller efficiencies close to manufacturers estimates for clean well finished blades. Forward and reverse thrust testing results are discussed with respect to aircraft application. Prediction methods tend to over estimate efficiencies due to hardware features encompassing blade finish, blade root/spinner juncture, spinner openings, erosion protection and deicer equipment. Typical results illustrating the influence on propeller performance of such features is given. Author

N86-11161# Institut de Mecanique des Fluides de Marseille (France).

STUDY OF THE 3D WAKE OF AN AERIAL PROPELLER [ETUDE DU SILLAGE 3D D'UNE HELICE AERIENNE]

D. FAVIER and C. MARESCA *In* AGARD Aerodyn. and Acoustics of Propellers 22 p Feb. 1985 refs *In* FRENCH

Avail: NTIS HC A20/MF A01

An analysis of the near and far wake of a four blade aerial propeller, operated under various working parameters and following various adjustments, was carried out with hot wire anemometry. Empirical laws were synthesized which provide the axial translation velocity of the tip vortices, the rate of wake radial contraction, in such a way that the stability limit of the vortex system is established as a function of azimuth rotation and as an extended range of the working parameters active in the range from null to maximum thrust. For a given functional regime, the determination of the three dimensional induced velocity field is effective in different sections downstream of the wake and conducted in a detailed characterization of the geometry and associated vortex intensity,

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in the azimuth function and the axial distance to the downstream of the plane of rotation. E.A.K.

N86-11162# Dornier-Werke G.m.b.H., Friedrichshafen (West Germany).

INVESTIGATIONS OF MODERN GENERAL AVIATION PROPELLERS

H. ZIMMER, R. HOFFMANN (Hoffmann-Propellers, Rosenheim, West Germany), and K. H. HORSTMANN (DFVLR, Brunswick) *In* AGARD Aerodyn. and Acoustics of Propellers 14 p Feb. 1985 refs

Avail: NTIS HC A20/MF A01

After a period of stagnation in the years following WW2 an accelerated movement towards propeller propulsion has taken place in recent years. Because of its inherent propulsive advantages the propeller propulsion has a considerable development potential. Initial analyses of the state of the art of propeller technology in the General Aviation field by means of flight and wind tunnel tests as well as by aerodynamic and acoustic calculations have shown possibilities for improvement, mainly in the lower and medium speed range. Improved propellers were designed and analyzed theoretically and experimentally. Newly designed supercritical airfoils with high lift to drag ratios at high lift were used. To find the optimum blade shapes associated with minimum supersonic velocities, also several tip shapes were analyzed. After wind tunnel tests the best of the propeller designs was selected for full scale flight test. A set of experimental propellers for the Do 228 Experimental aircraft was developed, constructed and tested. Improvements were achieved in the whole flight regime. The experience of this propeller development program was used to design a high performance high speed General Aviation propeller for $M = 0.6$ flight. Author

N86-11163# Dowty Rotor Ltd., Gloucester (England).

AERODYNAMIC AND STRUCTURAL ASPECTS OF PROPELLER AND DRIVE FOR A 1/5 SCALE WIND TUNNEL PROGRAMME

R. M. BASS, B. MUNNIKSMAN (National Aerospace Lab., Amsterdam), and J. VANHENGST (Royal Netherlands Aircraft Factories Fokker, Schiphol-Oost) *In* AGARD Aerodyn. and Acoustics of Propellers 18 p Feb. 1985 refs

Avail: NTIS HC A20/MF A01

The paper describes the development of a model propeller and its calibration in association with an axisymmetric nacelle in the National Aerospace Laboratory low speed tunnel in Amsterdam before testing on a complete 1/5 scale model of the Fokker in the DNW (German-Dutch wind tunnel). The calibration so obtained, allowed the required operating propeller conditions to be set up on the complete F50 model. The influence of Reynolds number on correction for scale effects, between experimental model results and full scale prediction. A previously unsuspected and unavoidable vibration originating in the reduction gear train of the drive unit gave rise to high propeller blade stresses, ultimately leading to a blade failure. In order to continue running with minimum delay, new propeller blades with high internal damping were manufactured from composite materials, and the program was successfully concluded. Author

N86-11164# De Havilland Aircraft Co. of Canada Ltd., Downsview (Ontario).

SOME CONSIDERATIONS IN PROPELLER AND AIRFRAME INTEGRATION

B. EGGLESTON *In* AGARD Aerodyn. and Acoustics of Propellers 11 p Feb. 1985 refs

Avail: NTIS HC A20/MF A01

The paper review elected items of R and D limited in support of propeller driven transport aircraft. The topics include the design of new propeller airfoils, two dimensional tests of selected airfoils, and estimates are presented of the resulting benefits in propeller performance. The application of numerical optimization to the aerodynamic design of propeller is also reviewed. Some results from wind tunnel tests of airframe/propeller installations are presented showing the benefits of alternative nacelle shape and

the merits of high versus low wing locations on a transport aircraft. Author

N86-11165# Avions Marcel Dassault, Saint-Cloud (France). Div. des Etudes Avancees.

PROBLEMS OF THE INTEGRATION OF PROPELLERS IN AIRFRAMES, ESPECIALLY FOR HIGH PERFORMANCE TWIN-ENGINE AIRCRAFT [LES PROBLEMES D'INTEGRATION DE HELICES A LA CELLULE D'UN AVION ET, PLUS PARTICULIEREMENT, D'UN BIMOTEUR DE FORTE PUISSANCE]

R. TAISSERIE *In* AGARD Aerodyn. and Acoustics of Propellers 10 p Feb. 1985 *In* FRENCH

Avail: NTIS HC A20/MF A01

This report presents studies conducted on the integration of aircraft propellers with the airframe for general aircraft, as well as for high performance twin engine propeller aircraft. The effect of engine dimensions on the aerodynamic characteristics of the aircraft in all flight situations, including low speed flight, is presented. It is shown that detailed model tests will have to be conducted before accurate results can be obtained. The objective of these studies is to examine possible configurations for future maritime reconnaissance twin engine propeller aircraft. T.M.

N86-11166# Lockheed-Georgia Co., Marietta.

WIND TUNNEL INVESTIGATION OF THE INTERACTION OF PROPELLER SLIPSTREAM WITH NACELLE/WING/FLAP COMBINATIONS

A. S. ALJABRI and A. C. HUGHES *In* AGARD Aerodyn. and Acoustics of Propellers 10 p Feb. 1985 refs

Avail: NTIS HC A20/MF A01

Until recently it was sufficient to define the propeller slipstream by the average velocity induced across the propeller disk. With the advent of the highly loaded program and the accompanying concern for the effect of the slipstream and its interaction with aircraft components be known. This paper describes a series of wind tunnel tests performed to improve the understanding of this complex aerodynamic interaction. The tests were conducted using a conventional propeller operating at low subsonic speeds. Complementary theoretical and experimental studies were used to investigate the interaction effects. Results from wind tunnel tests on propeller/nacelle/wing, and propeller/nacelle/wing/flap combinations are presented here. Force, pressure, and wake survey data from the test allow the slipstream characteristics, including its distortion by the wing and flap, to be obtained. The important parameters which govern the slipstream shape and induced velocities are identified and techniques are developed for estimating slipstream drag and the torque absorbed by a wing immersed in the slipstream. An improved understanding of the effects of wind tunnel walls on propeller powered testing is also presented. Author

N86-11167*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

AN ASYMPTOTIC THEORY FOR THE INTERFERENCE OF LARGE ASPECT RATIO SWEEPED WINGS AND MULTIPLE PROPELLER SLIPSTREAMS

R. K. PRABHU (Old Dominion Univ.), C. H. LIU, and S. N. TIWARI (Old Dominion Univ.) *In* AGARD Aerodyn. and Acoustics of Propellers 17 p Feb. 1985 refs

Avail: NTIS HC A20/MF A01 CSCL 01A

This paper presents an asymptotic method for the analysis of the interference of multiple tractor propeller slipstream with large aspect ratio swept wings. It is assumed that the height of the slipstream is of the order of the wing chord and its spanwise extent is of the order of the wing span. Three different flow regions are identified by employing different stretching transformations. Asymptotic expansions are made in each of the three regions, using the chord to span ratio as the small expansion parameter. The details of the nonuniform flow in the slipstream enter into the wing sectional analysis. In the outer limit, the wing shrinks to a swept lifting line, and the slipstream reduces to a thin sheet of jet carrying the momentum gain from the propeller. The curvature of

this jet sheet results in a pressure difference which is represented by a vortex sheet. The governing equations are solved by discretization. Several examples are considered for which experimental data are available. Comparison of the present results with the experimental data as well as other numerical solutions showed generally good agreement. Author

N86-11168# Carleton Univ., Ottawa (Ontario). Dept. of Mechanical and Aeronautical Engineering.

DEVELOPMENT OF MODERN TURBOPROP ENGINES

H. I. H. SARAVANAMUTTOO *In* AGARD Aerodyn. and Acoustics of Propellers 9 p Feb. 1985 refs

Avail: NTIS HC A20/MF A01

Proposals for propfan commercial aircraft operating at high cruise speeds pose requirements for advanced turboprops of high power. The history of turboprops for long range operation is briefly reviewed and the requirements for future engines are discussed. Considerable gains in the thermodynamic cycle can be realized, and the development of high performance gas generators should be a straightforward process. Transmission designs for high power engines may be extremely difficult and may result in novel engine configurations. It appears likely that a more modest goal of $M = 0.7$ cruise for shorter haul aircraft could be attained with much less risk while still achieving major gains. Author

N86-11170# Royal Aircraft Establishment, Farnborough (England). Aerodynamics Dept.

SOME AEROACOUSTIC WIND TUNNEL MEASUREMENTS, THEORETICAL PREDICTIONS, AND FLIGHT-TEST CORRELATIONS ON SUBSONIC AIRCRAFT PROPELLERS

W. J. G. TREBBLE, J. WILLIAMS (Southampton Univ., England), and R. P. DONNELLY (Dowty Rotol Ltd, Gloucester, England) *In* AGARD Aerodyn. and Acoustics of Propellers 21 p Feb. 1985 refs

Avail: NTIS HC A20/MF A01

Aeroacoustic experiments using the full scale propeller nacelle rig in the 24 ft anechoic tunnel were first made in 1979/80 on three alternative propellers also tested in flight on the Short's 330 aircraft. The Hartzell five bladed propeller of the production aircraft has conventional NACA 64 series sections and standard tips, the Hartzell Q-tip version of this has its tips bent as lower surface end plates in the direction of rotation, and the Dowty four bladed propeller has modern ARA-D sections and standard tips (D sub p = 2.8 m). Later complementary tunnel/flight experiments also included the Dowty four bladed R.212 propeller with classical NACA 16 series sections as fitted to the B.Ae. HS 748 aircraft (D sub p = 3.7 m). Author

N86-11512*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

COMBUSTION HOT SECTION TECHNOLOGY

D. B. ERCEGOVIC *In* its Turbine Eng. Hot Sect. Technol. (HOST) p 129-133 Oct. 1983 refs

Avail: NTIS HC A11/MF A01 CSCL 21E

The overall objective of the Turbine Engine Hot Section Technology Combustion Project is to develop and verify improved and more accurate analysis methods for increasing the ability to design with confidence the combustion system for advanced aircraft turbine engines. The analysis methods developed will be generically applicable to combustion systems and not restricted to one specific engine or manufacturer. This project's approach was to first assess and evaluate existing combustor aerothermal analysis models by means of a contracted effort initiated during FY 1982. This evaluation effort has assessed and quantified known models' strengths and deficiencies. During FY 1984 the Aerothermal Modeling Program, Phase 2 will be initiated, which is expected to have contracted model development efforts in the areas of improved numerical methods for turbulent viscous flows, flow interactions, and fuel spray flow foekd interactions. A Phase 3 effort is planned to address remaining model deficiencies. The primary inhouse effort in this area will be the determination of high pressure flame radiation characteristics in a full annular combustor. This experiment will be conducted in the NASA LeRC

High Pressure Facility with the results compiled into a comprehensive flame radiation and liner heat flux model. Author

N86-11513*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

HOST STRUCTURAL ANALYSIS PROGRAM OVERVIEW

R. H. JOHNS *In* its Turbine Eng. Hot Sect. Technol. (HOST) p 153-158 Oct. 1983

Avail: NTIS HC A11/MF A01 CSCL 21E

Hot section components of aircraft gas turbine engines are subjected to severe thermal structural loading conditions, especially during the start up and take off portions of the engine cycle. The most severe and damaging stresses and strains are those induced by the steep thermal gradients induced during the start up transient. These transient stresses and strains are also the most difficult to predict, in part because of the temperature gradients and distributions are not well known or readily predictable, and also because the cyclic elastic viscoplastic behavior of the materials at these extremes of temperature and strain are not well known or readily predictable. A broad spectrum of structures related technology programs is underway to address these deficiencies. One element of the structures program is developing improved time varying thermal mechanical load models for the entire engine mission cycle from start up to shutdown. Another major part of the program is the development of new and improved nonlinear 3-D finite elements and associated structural analysis programs, including the development of temporal elements with time dependent properties to account for creep effects in the materials and components. Author

N86-11515*# General Electric Co., Cincinnati, Ohio.

COMPONENT-SPECIFIC MODELING

M. L. ROBERTS *In* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 165-173 Oct. 1983 (Contract NAS3-23687)

Avail: NTIS HC A11/MF A01 CSCL 21E

The overall objective of this program is to develop and verify a series of interdisciplinary modeling and analysis techniques which have been specialized to address three specific hot section components. These techniques will incorporate data as well as theoretical methods from many diverse areas, including cycle and performance analysis, heat transfer analysis, linear and nonlinear stress analysis, and mission analysis. Building on the proven techniques already available in these fields, the new methods developed through this contract will be integrated to provide an accurate, efficient, and unified approach to analyzing combustor burner liners, hollow air cooled turbine blades, and air cooled turbine vanes. For these components, the methods developed will predict temperature, deformation, stress, and strain histories throughout a complete flight mission. Author

08

AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

A86-10160

AN ANALYSIS OF TWO METHODS FOR ANALYSIS OF DYNAMIC FLIGHT TEST MANOEUVRES

M. H. VERHAEGEN and J. VANDEWALLE (Leuven, Katholieke Universiteit, Heverlee, Belgium) International Journal of Modelling and Simulation (ISSN 0228-6203), vol. 5, no. 3, 1985, p. 94-99. Research supported by the Instituut tot Aanmodediging van het Wetenschappelijk Onderzoek in Nijverheid en Landbouw. refs

New, reliable flight test instrumentation systems and accurate data analysis methods are needed for the conduction of dynamic flight tests. The present study is concerned with the required data analysis methods, taking into account problems related to the

08 AIRCRAFT STABILITY AND CONTROL

reconstruction of the aircraft motion (state), and to aircraft system model identification. Attention is given to two different methods for solving these problems in the case of linear aircraft model structures. The first method, referred to as the 'one-step method', is based on postflight data analysis. The second method relies on accurate measurements of specific aerodynamic forces and moments. Using the measurements of these aerodynamic quantities, the state of the aircraft is obtained on the basis of the solution of linear equations. The reconstructed state is used in a second step, involving the aerodynamic model identification.

G.R.

A86-10371

DIGITAL FLIGHT CONTROL SYSTEMS FOR UMA

D. J. DYER (Cranfield Institute of Technology, England) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings. Bristol, University of Bristol, 1984, p. 25.1-25.9. Research supported by the Ministry of Defence (Procurement Executive).

The evolution of two microprocessor-based flight control systems for unmanned aircraft (UMA), the MACHAN, and the CRANFIELD Digital Flight Control System (DFCS) is described. The design goals for both systems are discussed in connection with the operating environment of next generation UMAs. Consideration is given to durability in the presence of EMI; versatility; and low-weight for maximum endurance. The CRANFIELD DFCS is currently under development for a next generation UMA system having applications in the fields of battlefield surveillance; weapons delivery; and target drones. The estimated volume, weight, and power consumption of the DFCS were 1/3 lower in comparison with the MACHAN system. A schematic diagram of the DFCS control loop is provided. I.H.

A86-10931#

MODELING VEHICLE DYNAMICS FOR FLYING QUALITIES STUDIES

H. T. BREUL, T. L. KELLER, and R. C. WESTON (Grumman Corp., Bethpage, NY) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 11 p.

(AIAA PAPER 85-3062)

A convolution and superposition approach is described for defining numerical models for examining modern aircraft flying quality problems. The simulations are limited to small variations in speed and attitude about fixed, trimmed flight conditions. A main research goal is to evaluate pilot acceptance of control system performance in reference flight conditions. Linear models are used for the vehicle/system dynamics, yielding geometric outputs for the time responses to a unit step input of pilot control. The resulting motion signatures provide graphic data on the motion a pilot experiences in response to control actions. Convolution and superposition mathematical techniques form the bases for the CONVO code for the control qualities simulation-based research, which is illustrated by assessing the adverse lateral control responses of a hovering VTOL aircraft. M.S.K.

A86-10942#

DIGITAL FLIGHT CONTROL OF LONGITUDINALLY UNSTABLE AIRCRAFT

A. BRADSHAW, A. T. DAVIS, and M. A. WOODHEAD (Salford, University, England) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 8 p. refs

(AIAA PAPER 85-3088)

A numerical examination is made of the effects of a gradual relaxation of stability of a YF-16 aircraft from an s-plane pole value of +1.18 at Mach 0.6 at sea level to a value of +5.0. The study is carried out in terms of the frequency response and root locus characteristics to which flight control systems must be retuned to maintain adequate response characteristics in unstable flight. Comparisons are made with the AFTI/F-16 response at Mach 0.6 at 3000 ft altitude, wherein the unstable pole has a value of +5.45. The results indicate that a single-input, pitch-rate controller will

not be able to maintain longitudinal stability using current technologies. A faster iteration rate and a concomitant increase in the on-board processing power will ameliorate some of the control problems.

M.S.K.

A86-10943#

ADAM - AN AEROSERVOELASTIC ANALYSIS METHOD FOR ANALOG OR DIGITAL SYSTEMS

T. NOLL, M. BLAIR, and J. CERRA (USAF, Flight Dynamics Laboratory, Wright-Patterson AFB, OH) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 10 p. refs

(AIAA PAPER 85-3090)

Coupling of the elastic modes and the high-gain automatic flight control systems of the aircraft can result in unstable interactions within the flight envelope. These instabilities are any undamped structural oscillations sensed by the flight controller and driven by the control surface motions. This paper highlights the activities pursued by the Flight Dynamics Laboratory (FDL) in developing analysis tools for performing independent audits of proposed flight systems and for conducting research in the area of aeroservoelasticity (ASE). ADAM (Analog and Digital Aeroservoelasticity Method) combines the technologies of unsteady aerodynamics, multiinput/multioutput (MIMO) controls and structural dynamics into an interactive analysis package. The governing equations and the results of several examples that were used to verify the credibility of ADAM are discussed in the paper. Lessons learned are included to help engineers avoid the unexpected. Author

A86-11061#

MISSION-ADAPTIVE WING CAMBER CONTROL SYSTEMS FOR TRANSPORT AIRCRAFT

J. H. RENKEN (Messerschmitt-Boelkow-Blohm GmbH, Bremen, West Germany) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 10 p. BMFT-sponsored research. refs

(AIAA PAPER 85-5006)

Based on the results of a current research program concerning variable wing camber control in future transport aircraft, the paper discusses some aspects of wing profile shaping and mechanical verification, which are essentially dominated by the aerodynamic requirements. A principle of chordwise and spanwise camber variation is exemplified and some targets and constraints relevant to variable camber schedules are outlined. Finally, some comments on integrating variable camber into an automatic flight control/management system are made. Author

A86-11437#

SPECIFICATION AND REVIEW OF FLIGHT CRITICAL DIGITAL SYSTEMS

J. Y. HUNG (USAF, Aeronautical Systems Div., Wright-Patterson AFB, OH) and H. HECHT (SoHaR, Inc., Los Angeles, CA) IN: Computers in Aerospace Conference, 5th, Long Beach, CA, October 21-23, 1985, Technical Papers. New York, AIAA, 1985, p. 252-258. refs

(AIAA PAPER 85-5097)

A synopsis of several sections of the Air Force Computer Resources Handbook for Flight Critical Systems is presented, including sections dealing with activities during the requirements phase, contractor surveillance, and the evaluation of flight critical systems. The handbook covers both management and technical concerns in the development of flight critical digital systems. It emphasizes the need for a precise definition of the scope of flight critical systems and calls attention to the cost impact if noncritical functions are made a part of the flight critical system.

B.J.

A86-11439#

FAULT EFFECT PROTECTION AND PARTITIONING FOR FLY-BY-WIRE/FLY-BY-LIGHT AVIONICS SYSTEMS

L. J. YOUNT, K. A. LIEBEL, and B. H. HILL (Sperry Corp., Commercial Flight Systems Div., Phoenix, AZ) IN: Computers in Aerospace Conference, 5th, Long Beach, CA, October 21-23, 1985, Technical Papers. New York, AIAA, 1985, p. 275-284. refs (AIAA PAPER 85-6002)

This paper discusses the special problems involved in developing full-time critical, (i.e., fly-by-wire/fly-by-light) fully digital, control systems for commercial transport aircraft. The starting point will be a discussion of critical (Category III) automatic landing systems, beginning with early, fully analog implementations and continuing through to current digital implementations, some of which are capable of tolerating generic software errors. Fault effects partitioning for both hardware and software will be discussed relative to perceived need, and several available techniques will be described. The emphasis of this paper will be an architectural solution to safety validation problems. The specific limitations of analysis-dependent validation techniques, such as RTCA/DO-178, will be discussed. Special emphasis will be given to extensive generic fault protection for fly-by-wire/fly-by-light systems through the use of fault-tolerance mechanisms including 'multi-version software'. Author

A86-12294#

QUASI-OPTIMAL ON-LINE GUIDANCE LAWS FOR MILITARY AIRCRAFT

H. T. HUYNH and O. MOREIGNE (ONERA, Chatillon-sous-Bagneux, France) ONERA, TP, no. 1985-91, 1985, 13 p. refs

(AIAA PAPER 85-1977; ONERA, TP NO. 1985-91)

Quasi-optimal guidance laws for on-board computation application have been developed for minimum-time to climb and intercept manoeuvres in the vertical plane. The technique used is derived from singular perturbation theory with a realistic times scale decomposition of the aircraft dynamics. The control laws obtained are of closed-loop type, and can fulfill terminal constraints on altitude and or flight path angle. The validity is extended to a large flight envelope by taking into account an intermediate boundary layer in order to eliminate the altitude-jump in energy-climb profile. These control laws are further corrected by a pseudo-first order asymptotic expansion and are compared in numerical simulations with the exact open loop solutions given by a projected gradient numerical algorithm. A better than 1 percent accuracy is obtained for the performance index. The computation time of these quasi-optimal laws is very small, and is compatible with real-time on-board computer applications. Author

A86-12535

DETERMINATION OF THE ORDER AND STRUCTURE OF THE LINEAR DIFFERENTIAL EQUATIONS OF AIRCRAFT MOTION FROM EXPERIMENTAL RESULTS [OPREDELENIE PORIADKA I STRUKTURY LINEINYKH DIFFERENTSIAL'NYKH URAVNENII DVIZHENIIA SAMOLETA PO REZUL'TATAM EKSPERIMENTA]

V. A. LEONOV Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1985, p. 38-42. In Russian.

Decision rules for estimating the order and structure of a linear differential equation describing experimental results are obtained by using the Bayes approach. The decision rules for estimating the order of the 'inputs' and 'outputs' of a system are related to the Akaike criterion. It is also noted that the decision rules obtained can be extended to the case of the r-dimensional vector 'input'.

V.L.

A86-12539

THE PROBLEM OF DETERMINING THE OPTIMUM PARAMETERS OF AN AUTOPILOT [K ZADACHE OPREDELENIIA OPTIMAL'NYKH PARAMETROV AVTOPILOTA]

L. G. ROMANENKO Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1985, p. 56-60. In Russian. refs

The optimum parameters of an autopilot can be effectively determined by using the standard forms of characteristic polynomials. Here, algorithms are developed for determining the coefficients of characteristic polynomials corresponding to minimum integral quadratic estimates. The use of the results obtained for calculating the parameters of an autopilot is illustrated by an example. V.L.

A86-12540

THE PROBLEM OF SELECTING THE PARAMETERS OF A FLIGHT VEHICLE ON THE BASIS OF THE MOTION STABILITY REQUIREMENT [K VOPROSU VYBORA PARAMETROV LETATEL'NOGO APPARATA IZ USLOVIIA OBESPECHENIIA USTOICHIVOSTI EGO DVIZHENIIA]

T. K. SIRAZETDINOV and N. R. SURKIN Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1985, p. 61-64. In Russian. refs

The problem of selecting the parameters of a flight vehicle on the basis of the motion stability requirement is analyzed for the case where the flight vehicle motion is described by a system of linear differential equations with variable coefficients. The problem is treated as the main control problem, and a solution is obtained using the method of Liapunov functions. V.L.

A86-12552

MODELING OF THE VARIABLE FRONTAL STIFFNESS OF THE RUDDER OF A DYNAMICALLY SIMILAR EMPENNAGE MODEL [MODELIROVANIE PEREMENNOI LOBOVOI ZHESTKOSTI RULIA DINAMICHESKI PODOBNOI MODELI OPERENIIA]

A. V. STARIKOV Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1985, p. 94, 95. In Russian.

The use of a three-dimensional deformation model in solving the problem of the flexure-rudder flutter of the empennage has shown that the critical velocity depends to a large extent on the stiffness of the rudder in the chord (frontal) plane. Here, a method is described for modeling the variable frontal stiffness of a rudder in order to determine its effect on the dynamic stability of an empennage model. The method consists in fabricating a series of rudder spars for a dynamically similar empennage model and investigating the effect of the frontal stiffness of the rudder on the critical flutter parameters. V.L.

A86-12554

A DYNAMIC ANALYSIS OF THE DIMENSIONAL CHAINS OF AIRCRAFT CONTROL SYSTEMS [DINAMICHESKII ANALIZ RAZMERNYKH TSEPEI SISTEM UPRAVLENIIA LETATEL'NYKH APPARATOV]

V. S. KHUKHOREV and V. O. VRUBLEVSKAIA Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1985, p. 98-100. In Russian.

The kinematics of the mechanisms of aircraft control systems is described by a mathematical model based on the theory of dimensional chains. The mathematical model represents a dynamic analysis of the dimensional chain of a control system formed by consecutively coupled assembly elements. The principal types of assembly elements are identified. V.L.

A86-12557

A METHOD FOR THE MODAL SYNTHESIS OF AN AIRCRAFT LATERAL MOTION CONTROL LAW [METOD MODAL'NOGO SINTEZA ZAKONA UPRAVLENIIA BOKOVYM DVIZHENIEM SAMOLETA]

A. O. BROITMAN and A. N. OBOTNIN Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1985, p. 104-107. In Russian. refs

A modal procedure for the synthesis of a control law for the lateral motion of an aircraft is developed in which decoupling is achieved by selecting the desired eigenvectors of a closed system. The modal synthesis procedure proposed here is readily

08 AIRCRAFT STABILITY AND CONTROL

implemented in algorithms since all the steps of the procedure consist of solving systems of linear equations. The method can be used for the design of both analog and digital control systems.

V.L.

N86-10047# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Abt. Flaechenflugzeuge.

CONTROL CONCEPTS FOR IN-FLIGHT SIMULATION INCLUDING ACTUATOR NONLINEARITIES AND TIME DELAYS
F. HENSCHHEL Mar. 1985 69 p refs In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-948)

(DFVLR-FB-85-24; ISSN-0171-1342) Avail: NTIS HC A04/MF A01; DFVLR, Cologne DM 23.50

A model-following system was developed to study the dynamic behavior of transport aircraft with reduced longitudinal stability. The system is divided into two parts. The first consists of feedforward branches. If a linear description of the model and the basic aircraft is assumed an exact model-following is achieved by this part. For the control matrices algebraic expressions are derived. In the equations the influence of actuator dynamics is considered. A set of formulas in which all variables are assumed to be discretized for processing on a digital computer is developed. By the second subsystem an error suppression is achieved. The application of a cost vector method is demonstrated for one example. It is shown that nonlinearities and time lags can be included in the calculation of the feedback gains. Author (ESA)

N86-11203*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

PRELIMINARY DESIGN STUDY OF A LATERAL-DIRECTIONAL CONTROL SYSTEM USING THRUST VECTORING

F. J. LALLMAN Nov. 1985 51 p refs (NASA-TM-86425; L-15990; NAS 1.15:86425) Avail: NTIS HC A04/MF A01 CSCL 01C

A preliminary design of a lateral-directional control system for a fighter airplane capable of controlled operation at extreme angles of attack is developed. The subject airplane is representative of a modern twin-engine high-performance jet fighter, is equipped with ailerons, rudder, and independent horizontal-tail surfaces. Idealized bidirectional thrust-vectoring engine nozzles are appended to the mathematic model of the airplane to provide additional control moments. Optimal schedules for lateral and directional pseudo control variables are calculated. Use of pseudo controls results in coordinated operation of the aerodynamic and thrust-vectoring controls with minimum coupling between the lateral and directional airplane dynamics. Linear quadratic regulator designs are used to specify a preliminary flight control system to improve the stability and response characteristics of the airplane. Simulated responses to step pilot control inputs are stable and well behaved. For lateral stick deflections, peak stability axis roll rates are between 1.25 and 1.60 rad/sec over an angle-of-attack range of 10 deg to 70 deg. For rudder pedal deflections, the roll rates accompanying the sideslip responses can be arrested by small lateral stick motions. E.A.K.

N86-11204*# Calspan Advanced Technology Center, Buffalo, N.Y.

MISSION-ORIENTED REQUIREMENTS FOR UPDATING MIL-H-8501: CALSPAN PROPOSED STRUCTURE AND RATIONALE Final Report

C. R. CHALK and R. C. RADFORD Sep. 1985 294 p refs (Contract NAS2-11303; DA PROJ. 1L1-62209-AH-76-A) (NASA-CR-177371; USAAVSCOM-TR-85-A-7; NAS 1.26:177371; CALSPAN-REPT-7097-F-1) Avail: NTIS HC A13/MF A01 CSCL 01C

This report documents the effort by Arvin/Calspan Corporation to formulate a revision of MIL-H-8501A in terms of Mission-Oriented Flying Qualities Requirements for Military Rotorcraft. Emphasis is placed on development of a specification structure which will permit addressing Operational Missions and Flight Phases, Flight Regions, Classification of Required Operational Capability, Categorization

of Flight Phases, and Levels of Flying Qualities. A number of definitions is established to permit addressing the rotorcraft state, flight envelopes, environments, and the conditions under which degraded flying qualities are permitted. Tentative requirements are drafted for Required Operational Capability Class 1. Also included is a Background Information and Users Guide for the draft specification structure proposed for the MIL-H-8501A revision. The report also contains a discussion of critical data gaps and attempts to prioritize these data gaps and to suggest experiments that should be performed to generate data needed to support formulation of quantitative design criteria for the additional Operational Capability Classes 2, 3, and 4. Author

09

RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

A86-10366

A NOVEL LAUNCHER FOR R.P.V.S

D. GRIFFIN (Frazer-Nash, Ltd., Kingston-upon-Thames, England) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings. Bristol, University of Bristol, 1984, p. 20.1-20.11. Research supported by the Ministry of Defence (Procurement Executive).

A flywheel-powered catapult launch system for RPVs has been developed. The system is mounted on the back of a truck and can be prepared for use in a minimum of five minutes. The salient features of the launch system design are illustrated including the flywheel drum arrangement, the motor driving the flywheel, and the electromagnetic brake system. The torque of the flywheel is equal to 80 percent of the acceleration tolerance limit of the RPV. The predicted performance envelopes for a ramp-clutch-flywheel launcher configuration are presented. I.H.

A86-10367

LAUNCH AND RECOVERY OF AIRBORNE REMOTELY PILOTED VEHICLES

G. R. VEAZEY, SR. (All American Engineering Co., Newark, DE) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings. Bristol, University of Bristol, 1984, p. 21.1-21.8.

The principle technologies associated with airborne and ground based RPV recovery and launch systems are briefly reviewed. Consideration is given to hydraulic/pneumatic (HP) launchers; and rocket-based launch systems. Among the recovery systems described are: the STARS net recovery system and a net recovery system incorporating rotary hydraulic kinetic energy absorbers. Black and white photographs of the different launch and recovery systems are provided. I.H.

A86-10376

PORTABLE TACTICAL DISPLAY SYSTEMS FOR RPV'S

I. GUY (Israel Aircraft Industries, Ltd., Tel Aviv) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Supplementary Papers. Bristol, University of Bristol, 1984, p. 19.1-19.5.

The design of a tactical display system, the Mobile Receiving Unit (MRU)-1000, for the Scout Mini-RPV (MRPV) is discussed. The uses, launch and recovery capabilities, and the ground control station of the Scout MRPV are described. The MRU-1000 is to receive and display, in real time, data transmitted by the Scout MRPV. The functioning of the MRU-1000, which receives television picture and telemetric data, is explained. The MRU-1000 consists of four assemblies: (1) antenna assembly, (2) receiver, (3) decoder and display assembly, and (4) plotter assembly; the components

and functions of the assemblies are discussed. The use of the artillery adjustment mode is examined. I.F.

A86-10955*# Kansas Univ., Lawrence.
DESIGN OF STATIC REACTION GANTRY FOR AN ULTRALIGHT AIRPLANE DESTRUCTION TEST

H. W. SMITH (Kansas, University, Lawrence) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 7 p.

(Contract NAG1-345)
 (AIAA PAPER 85-4022)

The steel gantry superstructure needed to perform an airplane static test is described. Standard civil engineering design practices are used to react the loads generated by an airplane in flight. Reaction columns are mounted on a structural floor to carry the wing airloads and the downward acting fuselage loads are carried directly into the floor. The gantry can accommodate a general aviation airplane or rotorcraft. An immediate use for an ultralight airplane is shown as an example configuration of the four main steel frames. Author

A86-10966*# California State Polytechnic Univ., Pomona.
DEVELOPMENT AND USAGE OF A SMALL-SCALE V/STOL GROUND EFFECTS SIMULATOR

P. A. LORD (California State Polytechnic University, Pomona) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 12 p. refs
 (Contract NAG2-49)

(AIAA PAPER 85-4037)

A small scale ground effects simulator for V/STOL aircraft design testing has been built by an American university in association with NASA-AMES. The simulator is used to measure pressures and forces on a wide variety of V/STOL model configurations including generic models which do not represent any particular aircraft. The modes of operation and instrumentation of the simulator are described, and a survey of some recent test results are presented. The basic simulator consists of two parts, an aluminum disk ground plane and a model support. Instrumentation consists of pressure transducers, scanivalves, thermocouples and hot wire anemometers. Test results are presented for single and twin nozzle configurations; a generic V/STOL design, and the Harrier and Grumman 698 combat aircraft models. A black and white photograph of the simulator is provided. I.H.

A86-11174#
EVALUATION OF A LOAD CELL MODEL FOR DYNAMIC CALIBRATION OF THE ROTOR SYSTEMS RESEARCH AIRCRAFT

R. W. DU VAL, M. BAHRAMI (Advanced Rotorcraft Technology, Inc., Los Altos, CA), and B. WELLMAN (U.S. Army, Research and Technology Laboratories, Moffett Field, CA) IN: Decennial Specialists' Meeting on Rotorcraft Dynamics, 2nd, Moffett Field, CA, November 7-9, 1984, Proceedings. Alexandria, VA, AHS, 1984, 14 p. refs

The Rotor Systems Research Aircraft uses load cells to isolate the rotor/transmission system from the fuselage. An analytical model of the relationship between applied rotor loads and the resulting load cell measurements is derived by applying a force-and-moment balance to the isolated rotor/transmission system. The model is then used to estimate the applied loads from measured load cell data, as obtained from a ground-based shake test. Using nominal design values for the parameters, the estimation errors, for the case of lateral forcing, were shown to be on the order of the sensor measurement noise in all but the roll axis. An unmodeled external load appears to be the source of the error in this axis. Author

A86-11775

HELICOPTER MONTAGE OF A PATH ANTENNA SETUP FOR THE INSTRUMENTAL LANDING SYSTEM SP 70 AT DRESDEN AIRPORT [HUBSCHRAUBERMONTAGE DER KURSWEGANTENNENANLAGE DES INSTRUMENTENLANDESYSTEMS SP 70 AUF DEM FLUGHAFEN DRESDEN]

W. TREMPLENER Technisch-oekonomische Information der zivilen Luftfahrt (ISSN 0232-5012), vol. 21, no. 4, 1985, p. 126-131. In German.

N86-10048*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

MANNED FLIGHT SIMULATION: CHALLENGE AND RESPONSE

J. C. DUSTERBERRY Sep. 1985 10 p refs
 (NASA-TM-86827; REPT-85392; NAS 1.15:86827) Avail: NTIS HC A02/MF A01 CSCL 14B

Early AGARD papers on manned flight simulation describe the status of an emerging test technique and then offer suggestions of problems that should be solved to advance the technique and predictions of the results that will be obtained by its use. Later AGARD literature is examined to determine how these challenges have been met, both in ground-based and in-flight simulation and how AGARD has played an important role in advancing the technique so that it is now an integral part of the aerospace vehicle design process. Author

N86-10049# Sandia National Labs., Albuquerque, N. Mex.
SIMULATED DIRECT-STRIKE LIGHTNING TESTING AT SANDIA NATIONAL LABORATORIES

G. L. MAXAM 1985 10 p Presented at the Intern. Symp. on Electromagnetic Compatibility, Wakefield, Miss., 20 Aug. 1985
 (Contract DE-AC04-76DP-00789)
 (DE85-012033; SAND-85-0063C; CONF-850884-1) Avail: NTIS HC A02/MF A01

The design of the Sandia Lightning Simulator is described and its capabilities are summarized. The approach generally used in testing components and systems including the instrumentation used for test item diagnostics and for data acquisition is also described. Several applications of the simulator test capabilities are examined including Sandia systems, Navy aircraft and an ALCM missile. Some future directions now envisioned are discussed. DOE

N86-11205 Communications Research Centre, Ottawa (Ontario). Space Technology and Applications Branch.
CRC CONTROL SYSTEMS LABORATORY GYRO TEST FACILITY

W. S. MCMATH and S. K. YEUNG Apr. 1985 21 p
 (CRC-1385) Avail: Issuing Activity

The gyro test facility was developed to provide a high precision testing capability, with the versatility to simulate, monitor and analyze the performance of a wide variety of sensors. The technical features of the facility as it was developed in parallel with a Single-Degree-of-Freedom (SDOF) gyro test program are summarized. Some of the data from that test program is included as a working example of facility capability. However, the details of the complete gyro evaluation will be covered in a separate report. Author

N86-11207*# Boeing Aerospace Co., Seattle, Wash.
LASER ANGLE SENSOR

C. R. POND and P. D. TEXEIRA Sep. 1985 184 p refs
 (Contract NAS1-16546)
 (NASA-CR-172369; NAS 1.26:172369) Avail: NTIS HC A09/MF A01 CSCL 20E

A laser angle measurement system was designed and fabricated for NASA Langley Research Center. The instrument is a fringe counting interferometer that monitors the pitch attitude of a model in a wind tunnel. A laser source and detector are mounted above the model. Interference fringes are generated by a small passive element on the model. The fringe count is accumulated and displayed by a processor in the wind tunnel control room. This

report includes optical and electrical schematics, system maintenance and operation procedures. Author

N86-11208*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
VISUAL AND MOTION CUEING IN HELICOPTER SIMULATION
 R. S. BRAY Sep. 1985 19 p refs
 (NASA-TM-86818; REPT-85371; NAS 1.15:86818) Avail: NTIS HC A02/MF A01 CSCL 14B

Early experience in fixed-cockpit simulators, with limited field of view, demonstrated the basic difficulties of simulating helicopter flight at the level of subjective fidelity required for confident evaluation of vehicle characteristics. More recent programs, utilizing large-amplitude cockpit motion and a multiwindow visual-simulation system have received a much higher degree of pilot acceptance. However, none of these simulations has presented critical visual-flight tasks that have been accepted by the pilots as the full equivalent of flight. In this paper, the visual cues presented in the simulator are compared with those of flight in an attempt to identify deficiencies that contribute significantly to these assessments. For the low-amplitude maneuvering tasks normally associated with the hover mode, the unique motion capabilities of the Vertical Motion Simulator (VMS) at Ames Research Center permit nearly a full representation of vehicle motion. Especially appreciated in these tasks are the vertical-acceleration responses to collective control. For larger-amplitude maneuvering, motion fidelity must suffer diminution through direct attenuation through high-pass filtering washout of the computer cockpit accelerations or both. Experiments were conducted in an attempt to determine the effects of these distortions on pilot performance of height-control tasks. Author

N86-11210# Engineering and Economics Research, Inc., Vienna, Va.

ENHANCED AIRPORT SURFACE DETECTION EQUIPMENT APPLICATIONS

H. R. SCHRAMM 17 Apr. 1985 72 p
 (AD-A157641) Avail: NTIS HC A04/MF A01 CSCL 17G

The National Airspace Review (NAR) Enhancement Program is a cooperative government/industry effort to review airspace allocations and the procedural and regulatory aspects of scheduled improvements envisioned under the National Airspace System (NAS) Plan as well as other plans. Its purpose is to identify long-term operational considerations of enhanced systems as they evolve. Improved capabilities resulting from equipment already developed or in the process of development will be examined, with attention being focused on operational considerations rather than specific generation of system requirements. Task Group 4-6.1 of the NAR Enhancement Program convened in Washington, D.C., from January 8 to 10, 1985, and January 29, 1985. This task group was responsible for reviewing and analyzing operational considerations based on the development of enhanced airport surface detection equipment. The recommendations contained herein will be submitted to the Administrator, Federal Aviation Administration, through the NAR Enhancement Executive Steering Committee (EXCOM), for consideration and disposition. GRA

ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

A86-11768
AERODYNAMICALLY LANDING REENTRY VEHICLES
[AERODYNAMISCH WIEDEREINTRITTSFAHRZEUGE]
LANDENDE

I. WIDJAJA (ERNO Raumfahrttechnik GmbH, Bremen, West Germany) (Hermann-Oberth-Gesellschaft, Symposium ueber Gefluegelte Raumfahrzeuge, Hanover, West Germany, May 25, 1984) Astronautik (ISSN 0004-6221), vol. 22, no. 1, 1985, p. 16-19. In German.

The considered type of reentry vehicle has the capability to utilize aerodynamic forces and moments for achieving control over its flight path. It is, therefore, possible to reduce or limit the thermal and mechanical stresses to which the vehicle is subjected during its reentry in the atmosphere. The vehicle can be guided to a given landing location, and the reentry window can be enlarged. The considered capabilities are characterized by the lift drag ratio, and a certain price has to be paid for obtaining them. This price is related to a higher structural weight and more complex navigation and guidance systems. For this reason, the lift drag ratio represents a parameter which plays an important part in system optimization considerations. The effect of the lift drag ratio on parameters related to the flight path of the vehicle is considered along with the effect of this ratio on thermal flow phenomena. Attention is given to various reentry vehicle configurations, the results of experimental measurements, and aspects of longitudinal stability and controllability. G.R.

A86-11769
AERODYNAMICALLY LANDING REENTRY VEHICLES
[AERODYNAMISCH WIEDEREINTRITTSFAHRZEUGE]
LANDENDE

I. WIDJAJA (ERNO Raumfahrttechnik GmbH, Brémen, West Germany) (Hermann-Oberth-Gesellschaft, Symposium ueber Gefluegelte Raumfahrzeuge, Hanover, West Germany, May 25, 1984) Astronautik (ISSN 0004-6221), vol. 22, no. 2, 1985, p. 39-41. In German.

This article represents a continuation of a paper in the preceding edition of this journal. The longitudinal stability of the reentry vehicle configuration 24B is discussed, taking into account an evaluation of the possibilities for lateral control, aileron effectiveness, and rudder effectiveness. It is pointed out that regarding the selection of the characteristics of the descent trajectory, there are apparently no constraints related to stability or controllability limits. In the hypersonic range, large reciprocal lift drag ratios can also be obtained without positive flap displacement. Attention is given to angle of sideslip relations, a cylindrical body with flat nose and trim tabs, the flow characteristics in the case of a cylinder with a flat nose, graphical relations describing longitudinal stability and controllability in the hypersonic range, and relations involving lift, drag, and the lift drag ratio. G.R.

N86-10005# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THEORETICAL SPECIFIC IMPULSE FOR TWO-PHASE FLOW IN NOZZLE OF ROCKET-RAMJET ENGINE: A SIMPLE ESTIMATION METHOD

B. SHIGUAN (China Precision Machinery Co.) *In its Acta Aeron. et Astronautica Sinica* (FTD-ID(RS)T-1120-84) p 53-60 4 Oct. 1984 refs Transl. into ENGLISH from Hangkong Xuebao (China), v. 4, no. 4, 1984 p 101-104

Avail: NTIS HC A04/MF A01 CSCL 21H

A theoretical specific impulse formula is derived for two phase flow in nozzle rocket ramjet engine on the basis of similarity to that used for rocket engines. Theoretically, it is proved that the properties of two phase flow in nozzle for these two types of engines can be analyzed with a common combined parameter which is equivalent to the exhaust velocity. A simple estimation method is introduced for specific impulse losses of two phase flow with variable lag. An approximate solution is proposed to deal with the problem of singularity. Author

N86-11216*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.

HEAVY LIFT LAUNCH VEHICLES FOR 1995 AND BEYOND

R. TOELLE, comp. Sep. 1985 149 p refs (NASA-TM-86520; NAS 1.15:86520) Avail: NTIS HC A07/MF A01 CSCL 22B

A Heavy Lift Launch Vehicle (HLLV) designed to deliver 300,000 lb to a 540 n mi circular polar orbit may be required to meet national needs for 1995 and beyond. The vehicle described herein can accommodate payload envelopes up to 50 ft diameter by 200 ft in length. Design requirements include reusability for the more expensive components such as avionics and propulsion systems, rapid launch turnaround time, minimum hardware inventory, stage and component flexibility and commonality, and low operational costs. All ascent propulsion systems utilize liquid propellants, and overall launch vehicle stack height is minimized while maintaining a reasonable vehicle diameter. The ascent propulsion systems are based on the development of a new liquid oxygen/hydrocarbon booster engine and liquid oxygen/liquid hydrogen upper stage engine derived from today's SSME technology. Wherever possible, propulsion and avionics systems are contained in reusable propulsion/avionics modules that are recovered after each launch. Author

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CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

A86-10145#

NEW WORLD FOR AEROSPACE COMPOSITES

W. F. DEMARIO (Northrop Corp., Materials and Process Engineering Section, Ventura, CA) *Aerospace America* (ISSN 0740-722X), vol. 24, Oct. 1985, p. 36-40, 42.

The applications of composites in aerospace designs are discussed. A description and an explanation of the organic and metal-matrix composites and the reinforcements used in the spacecraft industry are presented. The structural applications for organic and metal-matrix composites for spacecraft are described. Examples of their use in a primary truss assembly, upper and lower cradle assemblies, tubular struts, forward adapter and the engine support of the structure of the Shuttle are provided. The composition and function of the forward adapters of the Shuttle/Centaur and the booms of the Shuttle's remote manipulator system are described. The advantages, applications, and design improvements of thin-ply carbon-carbon are examined. The characteristics of thermoplastic polymers are explained. The

development of a new composite which combines aramid and aluminum in a laminate is discussed. I.F.

A86-10364

SOME FABRICATION EXPERIMENTS TOWARDS A COMPOSITE RPV WING

K. A. JACOB, B. S. RANGASHAYI, J. JAYARAMAN, and R. PERAVALI (Aeronautical Development Establishment, Structures and Materials Div., Bangalore, India) IN: Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings. Bristol, University of Bristol, 1984, p. 16.1-16.10.

A study is made on the various aspects of composite wing construction. The criteria for employing new materials and new construction concepts are discussed. Experimental wings are fabricated using glass-epoxy skin and polyurethane rigid foam core and metallic inserts for load introduction. This fabrication process resulted in producing complex contoured wing with minimum investment in tooling and processing. Improved construction based on monolithic construction is also outlined. Author

A86-11397* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

EVALUATION OF EXPERIMENTAL EPOXY MONOMERS

W. T. HODGES, T. L. ST. CLAIR (NASA, Langley Research Center, Hampton, VA), J. R. PRATT, and R. FICKLIN (Mississippi University for Women, Columbus) *SAMPE Quarterly* (ISSN 0036-0821), vol. 17, Oct. 1985, p. 21-25. Previously announced in STAR as N85-26996. refs

Future generation aircraft need higher performance polymer matrices to fully achieve the weight savings possible with composite materials. New resins are being formulated in an effort to understand basic polymer behavior and to develop improved resins. Some polymer/curing agent combinations that could be useful are difficult to process. In the area of epoxies, a major problem is that some components have physical properties which make them difficult to utilize as matrix resins. A previous study showed that the use of ultrasonic energy can be advantageous in the mixing of curing agents into a standard epoxy resin, such as MY 720 (Ciba-Geigy designation). This work is expanded to include three novel epoxides. R.J.F.

A86-11645#

ON THE RELATIONSHIP BETWEEN FLAME STABILITY AND DRAG OF BLUFF-BODY FLAMEHOLDERS

N. K. RIZK and A. H. LEFEBVRE (Purdue University, West Lafayette, IN) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 393-398. refs

The main purpose of the investigation is to establish a relationship between the blowoff velocity of a bluff-body flameholder and its drag coefficient. To this end numerous measurements of blowoff velocity and drag coefficient are carried out on various forms of two-dimensional flameholder. They include conventional V-gutters of the type widely employed in turbojet afterburners, and also 'single-sided' flameholders which are characterized by a single-vortex flow pattern in their wake region. The test program covers wide ranges of effective pressure ratio, obtained using the water injection technique, and also includes variations in velocity, flameholder size and flameholder blockage. The results confirm previous findings in regard to the strong influence of drag coefficient on blowoff velocity. They also provide a satisfactory explanation for the previously-reported superior flameholding properties of single-vortex systems over double-vortex systems. Author

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A86-11694#

PROBLEMS OF IGNITION CORRELATIONS - AN ASSESSMENT OF APPLICATIONS TO REAL COMBUSTORS

J. ODGERS and D. KRETSCHMER (Universite Laval, Quebec, Canada) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 775-782. refs

The complexity of the ignition process as applied to gas turbine combustors is discussed with reference to the published experimental results and theoretical descriptions. All existing models can be subdivided into two processes: (1) the determination of the liberated spark energy, and (2) the progress of the spark kernel towards successful ignition, but no theoretical model can fully predict these processes quantitatively. The existing empirical and semiempirical ignition correlation formulas can be used for qualitative predictions only, unless a baseline can be established from experimental data. In this case quantitative predictions are sometimes possible within a standard deviation of about 20 percent. I.S.

A86-11698#

COMBUSTION AND EMISSIONS PERFORMANCE OF A RAPID FUEL AND AIR MIXING COMBUSTOR

N. A. AL-DABBAGH, G. E. ANDREWS, and A. R. SHAHABADI (Leeds, University, England) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 804-812. refs

(Contract SERC-GR/A/76894; SERC-GR/B/92812)

A rapid jet mixing combustion system for gas turbine primary zones, with characteristics of low NO(x) and high combustion efficiency, has been developed. This 'jet mix' combustor consists of an array of radial air jets which impinge into an equal number of axial air jets. Fuel is injected in the center of the radial jets. The influence of the proportion of radial air is investigated and shown to have a strong influence on the overall fuel and air mixing rates with a consequent influence on flame stability and NO(x) emissions. It is shown that for 30 percent of the total air in the radial jet, the NO(x) emissions with direct propane injection are at a minimum and close to the premixed situation. Author

A86-11734

A TYPE OF WIRE FOR COMPOSITES [VID PROVOLOKI DLIA KOMPOZITNYKH MATERIALOV]

A. A. KLEKOVKIN, A. G. CHUSOV, N. A. KLEKOVKINA, and S. A. OGOLIKHIN (Beloretskii Metallurgicheskii Kombinat, Beloretsk; Vsesoiuznyi Nauchno-Issledovatel'skii Institut Aviatsionnykh Materialov; AN SSSR, Institut Metallurgii, Moscow, USSR) Mekhanika Kompozitnykh Materialov (ISSN 0203-1272), July-Aug. 1985, p. 729, 730. In Russian.

Technical requirements are formulated for steel wire used as reinforcement in aluminum-matrix composites. A process for manufacturing stainless steel wire with a tensile strength in excess of 3500 MPa is then presented. The wire, which is made of 18Kh15N5AM3 steel, is used in composites with cold-curing adhesives for the fabrication of the torsion bar of the main rotor of helicopters. V.L.

A86-12311#

STATE-OF-ART AND PROSPECTS OF CASTING TURBINE BLADES

K. YUNG (Chinese Aeronautical Establishment, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 6, June 1985, p. 201-207. In Chinese, with abstract in English. refs

This paper reviews the state-of-art and history of superalloys and casting turbine blades of aircraft engines in China since 1956. During this time the materials technologists and foundrymen have met the demands of aircraft engines with ever-developing cast-alloys and casting processes for turbine blades. Remarkable successes have been made in fields such as cast rotor blades, ceramic core for hollow channel blades, dispersion-strengthening of Ni-base alloys, computer-based quality control, etc. In view of the prospective advanced gas turbines, ceramic and refractory

materials should be developed to meet the requirements of increased operating temperatures (1400 to 1600 C for metallic structure, enhanced surface stability, and superior mechanical properties. Super-alloys will serve in engine components at 550 to 1150 C in the foreseeable future; therefore, it is worth improving refractory metal molds and vacuum die casting to produce the advanced superalloy blades instead of conventional casting processes. Author

A86-12313#

APPROACHES TO DEVELOPMENT OF COMPOSITE MATERIALS FOR AVIATION INDUSTRY IN CHINA

T. FAN (Beijing Institute of Aeronautical Materials, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 6, June 1985, p. 223-229. In Chinese, with abstract in English. refs

The state-of-art of composite materials in China is reviewed. Emphasis is put on the technical problems to be studied preferentially for exploitation of composite materials in aviation industry, for example, the serialiation of intermediate materials production, the familiarization of fabrication techniques, the rationalization and optimization of composite design, and the establishment of quality assurance system. Principal tasks to be done in these fields and guidelines and directions to be followed are discussed in detail. Theoretical topics related closely to the solution of practical problems are suggested, and attention is called to research works on metal matrix composites. It is expected that the development of composite materials in China will be accelerated by way of proper use of successful foreign experience. Author

A86-12314#

DIRECTIONALLY SOLIDIFIED BLADE SUPERALLOY DZ-22

L. WANG, R. CHEN, and Y. WANG (Beijing Institute of Aeronautical Materials, People's Republic of China) Acta Aeronautica et Astronautica Sinica, vol. 6, June 1985, p. 236-242. In Chinese, with abstract in English. refs

The directionally solidified (DS) superalloy DZ-22 possesses rather high mechanical properties at both intermediate and high temperatures, for instance, its stress-rupture strength for 100 h at 760 C and 1040 C are 804 MPa and 139 MPa, respectively. Its properties are comparable with the well known DS superalloy PWA1422; therefore, it is applicable to advanced aircraft engine blades. The chemical composition of DZ-22 is based on the composition of PWA1422, but the content ranges of hafnium and carbon have been readjusted according to experimental results, so its hafnium content is limited in 1.2-2.0 wt pct instead of 1.5-2.5 wt pct and its carbon content is 0.12-0.16 wt pct rather than 0.08-0.14 wt pct. In addition, no zirconium is added intentionally in the alloy. The test results show that the shell-mold with drawn rate during the DS process affects the orientation of columnar crystals. The suitable drawn rate has been established about 7 mm/min. Enhancement of solution temperature during heat treatment can improve stress-rupture life at both 980 C and 1040 C, while the elongation decreases slightly. A pretreatment at 1150 C prior to the solution treatment can raise the incipient melting temperature. Author

A86-12584

TEMPERATURE DEPENDENCE OF INCLUSION-FRACTURE-RELATED ACOUSTIC EMISSIONS IN 7075-T651 ALUMINUM

S. L. MCBRIDE and J. HARVEY (Royal Military College of Canada, Kingston) Journal of Acoustic Emission, Supplement (ISSN 0730-0050), vol. 4, Apr.-Sept. 1985, p. S220-S223. Research supported by the Defence Research Establishment Pacific. refs

Variations in the acoustic emissions (AE) emitted by crack growth in aerospace Al alloys were studied over a temperature range of -40 C to 120 C, i.e., within the operational range of aircraft. The data recorded included peak AE amplitudes and crack lengths measured by the potential drop technique. The Al specimens were subjected to cyclic fatigue loading over the entire temperature range. The crack growth rate followed a quadratic equation with increasing temperature. Subsequent metallographic

examinations indicated that the increase in the number of AE events with crack lengthening was associated with misfit stress effects at the inclusion-matrix interface. M.S.K.

A86-12607**FULL-SCALE TESTING OF THE VNII NP-261 LUBRICANT [EKSPLOATATSIONNYE ISPYTANIYA SMAZKI VNII NP-261]**

S. L. SHADKINA, O. N. PUNKTOVA, and N. IA. CHERTKOVA (Gosudarstvennyi Nauchno-Issledovatel'skii Institut Grazhdanskoi Aviatsii, Moscow, USSR) *Khimiia i Tekhnologiia Topliv i Masel* (ISSN 0023-1169), no. 9, 1985, p. 29, 30. In Russian.

Flight test results are reported for a new lubricant, VNII NP-261, developed for use in the wheel bearings of the landing gear of aircraft instead of the lubricant NK-50, which no longer satisfies service requirements. An analysis of test results indicates that the new lubricant ensures satisfactory operation of the wheel bearings of the landing gear of commercial aircraft and helicopters at ambient temperatures from -55 to +45 C. V.L.

N86-11249*# Lockheed-Georgia Co., Marietta.**ADHESIVES FOR AEROSPACE**

L. E. MEADE *In* NASA. Langley Research Center Welding, Bonding and Fastening, 1984 p 339-349 Sep. 1985 refs
Avail: NTIS HC A21/MF A01 CSCL 11A

The industry is hereby challenged to integrate adhesive technology with the total structure requirements in light of today's drive into automation/mechanization. The state of the art of adhesive technology is fairly well meeting the needs of the structural designers, the processing engineer, and the inspector, each on an individual basis. The total integration of these needs into the factory of the future is the next collective hurdle to be achieved. Improved processing parameters to fit the needs of automation/mechanization will necessitate some changes in the adhesive forms, formulations, and chemistries. Adhesives have, for the most part, kept up with the needs of the aerospace industry, normally leading the rest of the industry in developments. The wants of the aerospace industry still present a challenge to encompass all elements, achieving a totally integrated joined and sealed structural system. Better toughness with hot-wet strength improvements is desired. Lower cure temperatures, longer out times, and improved corrosion inhibition are desired. Author

N86-11270*# American Cyanamid Co., Stamford, Conn. Chemical Research Div.**RECENT DEVELOPMENTS IN POLYIMIDE AND BISMALIMIDE ADHESIVES**

R. E. POLITI *In* NASA. Lewis Research Center High Temp. Polymer Matrix Composites p 125-136 Sep. 1985
Avail: NTIS HC A18/MF A01 CSCL 11B

Research on high temperature resin systems has intensified. In the Aerospace Industry, the motivation for this increased activity has been to replace heat resistant alloys of aluminum, stainless steel and titanium by lighter weight glass and carbon fiber reinforced composites. Applications for these structures include: (1) engine nacelles involving long time exposure (thousands of hours) to temperatures in the 150 to 300 C range, (2) supersonic military aircraft involving moderately long exposure (hundreds of hours) to temperatures of 150 to 200 C, and (3) missile applications involving only brief exposure (seconds or minutes) to temperatures up to 500 C and above. Because of fatigue considerations, whenever possible, it is preferable to bond rather than mechanically fasten composite structures. For this reason, the increased usage of high temperature resin matrix systems for composites has necessitated the development of compatible and equally heat stable adhesive systems. The performance of high temperature epoxy, epoxy phenolic and condensation polyimide adhesives is reviewed. This is followed by a discussion of three recently developed types of adhesives: (1) condensation reaction polyimides having improved processing characteristics; (2) addition reaction polyimides; and (3) bismaleimides. Author

N86-11281*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.**SURFACE PROTECTION OF GRAPHITE FABRIC/PMR-15 COMPOSITES SUBJECTED TO THERMAL OXIDATION**

M. P. HANSON and T. T. SERAFINI *In* its High Temp. Polymer Matrix Composites p 287-297 Sep. 1985 refs
Avail: NTIS HC A18/MF A01 CSCL 11D

Graphite fabric/PMR-15 laminates develop matrix cracks during long-term exposure in air at temperatures in the range of 500 to 600 F. This study was performed to demonstrate the effectiveness of incorporating graphite mat surface plies as a means of reducing the developing of matrix cracks. Celion 3000 graphite fabric/PMR-15 laminates were fabricated with graphite or graphite mat/325-mesh boron powder surface plies. Laminates without mat surface plies were also fabricated for control purposes. Composite flexural strength, flexural modulus, and interlaminar shear strength were determined at 288 C before and after long-term exposure (up to 1500 hr) in air at 316 C. The results of this study showed that the incorporation of graphite mat surface plies reduces matrix cracking and improves the elevated temperature mechanical property retention characteristics of the composites. Author

N86-11283*# General Dynamics/Convair, San Diego, Calif.**EFFECTS OF REAL-TIME THERMAL AGING ON GRAPHITE/POLYIMIDE COMPOSITES**

J. F. HASKINS and J. R. KERR *In* NASA. Lewis Research Center High Temp. Polymer Matrix Composites p 315-327 Sep. 1985 refs

(Contract NAS1-12308)

Avail: NTIS HC A18/MF A01 CSCL 11D

As part of a program to evaluate high-temperature advanced composites for use on supersonic cruise transport aircraft, two graphite/polyimide composites have been aged at elevated temperatures for times up to 5.7 years. Work on the first, HT-S/710 graphite/polyimide, was started in 1974. Evaluation of the second polyimide, Celion 6000/LARC-160, began in 1980. Baseline properties are presented, including unnotched and notched tensile data as a function of temperature, compression, flexure, shear, and constant-amplitude fatigue data at $R = 0.1$ and $R = -1$. Tensile specimens were aged in ovens where pressure and aging temperatures were controlled for various times up to and including 50,000 hours. Changes in tensile strength were determined and plotted as a function of aging time. The HT-S/710 composite aged at 450 F and 550 F if compared to the Celion 6000/LARC-160 composite aged at 350 F and 450 F. After tensile testing, many of the thermal aging specimens were examined using a scanning electron microscope. Results of these studies are presented, and changes in properties and degradation mechanisms during high-temperature aging are discussed and illustrated using metallographic techniques. Author

N86-11284*# Boeing Commercial Airplane Co., Seattle, Wash. ENVIRONMENTAL STABILITY GRAPHITE/PMR-15 COMPOSITES

C. H. SHEPPARD and D. MCLAREN *In* NASA. Lewis Research Center High Temp. Polymer Matrix Composites p 329-334 Sep. 1985 refs

Avail: NTIS HC A18/MF A01 CSCL 11D

During the past few years the Boeing Company was screening graphite composites for use in hot areas of engine nacelle structure. Structural and thermal analyses have shown that there is the potential for a 25 to 30 percent weight savings by using a graphite polyimide (Gr/PI) composite material in this type of structure. Work conducted on the NASA CASTS program (Composites for Advanced Space Transportation Systems) amply demonstrated the capability of Graphite/PMR-15 for short term service (125 hours) at temperatures up to 589 K (600 F). In addition, the CASTS program demonstrated that large structures could be fabricated using Gr/PMR-15. In commercial applications, however, the requirement exists for long term service capability (tens of thousands of hours) at temperatures ranging upwards from 449 K (350 F). The results of Graphite/PMR-15 materials characterization efforts conducted at Boeing are presented with emphasis on

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materials properties after isothermal aging at temperatures of 449 K (350 F) and above. Author

N86-11285*# Boeing Commercial Airplane Co., Seattle, Wash.
DEVELOPMENT OF DESIGN DATA FOR PROPULSION PMR-15 COMPOSITES

J. POSTLEWAITE and D. MCLAREN /in NASA. Lewis Research Center High Temp. Polymer Matrix Composites p 335-338 Sep. 1985

Avail: NTIS HC A18/MF A01 CSCL 11D

The continuing development of PMR-15 composite materials and their associated design properties is pacing the implementation of this technology on commercial aircraft. The guidelines that the FAA has issued regarding the certification of advanced composite structures are very significant with respect to future PMR-15 research and development activities. The FAA has issued an advisory circular dated 1-5-83 concerning guidelines for composite aircraft structures. Of particular significance to PMR-15 technology development is the reliance on combined environmental exposure and component testing, coupled with the stipulation that reliance on previous experience be limited to where common structures and materials have been used for a similar function. Critical environmental exposures for commercial propulsion structures include 50,000 cycle service life, exposure to skydrol, moisture and other fluids, and nacelle fire conditions. G.L.C.

N86-11289*# Boeing Commercial Airplane Co., Seattle, Wash.
APPLICATION OF GR/PMR-15 TO COMMERCIAL AIRCRAFT

J. POSTLEWAITE, K. PORTER, and D. MCLAREN /in NASA. Lewis Research Center High Temp. Polymer Matrix Composites p 393-400 Sep. 1985

Avail: NTIS HC A18/MF A01 CSCL 11D

Following from early experience with polyimides on the SST program and Shuttle aft flap studies the Boeing Company is now working on collaborative programs with its principal nacelle suppliers to pursue the development of Gr/PMR-15 nacelle components. Two programs are currently in effect. The first program is directed specifically towards the flight test and service evaluation at the earliest possible date of a 747 nacelle core cowl structure. The second program seeks to firmly establish the producibility and cost of a 757 thrust reverser C duct in a production environment. The near term objectives of these programs include: (1) the comparison of estimated cost and weight of Gr/PMR-15 versus metal structure, (2) the engine test of representative composite structure, (3) the preliminary design and analysis of the C duct structure, and (4) the preparation of cost data and time schedules for the development and producibility program. In addition to powerplant structure, the propulsion ducting system has shown to be a strong candidate for Gr/PMR-15 application. Currently, the Boeing 747 Organization is evaluating the use of PMR-15 matrix composites to replace nearly 800 lbs of titanium ducting per airplane. Author

N86-11290*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.

FABRICATION PROCESS OF A HIGH TEMPERATURE POLYMER MATRIX ENGINE DUCT

R. D. PRATT and A. J. WILSON /in NASA. Lewis Research Center High Temp. Polymer Matrix Composites p 401-407 Sep. 1985

Avail: NTIS HC A18/MF A01 CSCL 11D

The process that was used in the molding of an advanced composite outer by-pass duct planned for the F404 engine is discussed. This duct was developed as a potential replacement for the existing titanium duct in order to reduce both the weight and cost of the duct. The composite duct is now going into the manufacturing technology portion of the program. The duct is fabricated using graphite cloth impregnated with the PMR-15 matrix system. G.L.C.

N86-11291*# Pratt and Whitney Aircraft Group, West Palm Beach, Fla. Government Products Div.

CURRENT AND FUTURE ENGINE APPLICATIONS OF GR/PI COMPOSITES

P. J. CAVANO and T. E. SCHMID /in NASA. Lewis Research Center High Temp. Polymer Matrix Composites p 409-416 Sep. 1985

Avail: NTIS HC A18/MF A01 CSCL 11D

The application of organic matrix composites to gas turbine engine components has been the subject of numerous government and company funded programs since the 1960's. The possibility of significant weight reductions, performance improvements and lower component costs have made the organic matrix composites extremely attractive to aircraft engine designers. Very little of this potential was incorporated into production engines over the years even though a significant number of components were designed, fabricated and tested. Some of the reasons behind the slow rate of incorporation include the following: (1) criticality; (2) engine operating temperature; (3) small component size; (4) small production volume; (5) high production cost; and (6) interfacing with metal parts. G.L.C.

N86-11315# Department of the Navy, Washington, D. C.
CHEMICAL BONDING AGENT FOR SUPPRESSION OF RUSTY BOLT INTERMODULATION INTERFERENCE Patent Application

J. C. COOPER; inventor (to Navy) 23 Apr. 1985 20 p (AD-D011747; US-PATENT-APPL-SN-726563) Avail: NTIS HC A02/MF A01 CSCL 20C

Intermodulation interference (IMI) occurs when high frequency (HF) transmitters and receivers are placed in close proximity, particularly on ships and aircraft, due to non-linear conduction through metal-oxide-metal (MOM) junctions in the supporting structure. Welding or clamping straps cannot be used where there is a multiplicity of MOM junctions, such as in chains or twisted cable, or where dissimilar metals are involved. Additionally, the use of non-conductive materials or conductive straps is very expensive. To overcome these limitations while effectively reducing IMI, an inexpensive method that maintains the structural integrity of supporting hardware while providing a highly conductive current path is required. The chemical composition of the present invention used to overcome IMI contains compounds similar to rust removal compositions which have incorporated the general principles of chelating the ferric ion, incorporating the ion into a polymer material, and removing the rust with one polymer material. GRA

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ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

A86-10146*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

FILAMENT WINDING - WAKING THE SLEEPING GIANT

W. T. FREEMAN, JR. and B. A. STEIN (NASA, Langley Research Center, Hampton, VA) Aerospace America (ISSN 0740-722X), vol. 24, Oct. 1985, p. 44-46, 48, 49.

The use of filament winding (FW) in the production of aerospace composite structures is examined. The FW process applies spools of fiber and prepreg tow or prepreg tape to a male mandrel; the process is more efficient and cost effective than metallic construction. The fibers used in FW and the curing process are explained. The reduced storage and fabrication costs that result from FW are discussed. The use of FW to produce a filament-wound case for a solid rocket motor and the substructure and skin of an

aircraft fuselage are described. Areas which require further development in order to expand the use of FW are listed and discussed. I.F.

A86-10267
COMPUTATIONAL FLUID DYNAMICS - ITS PRESENT STATUS AND FUTURE DIRECTION

E. KRAUSE (Aachen, Rheinisch-Westfaelische Technische Hochschule, West Germany) *Computers and Fluids* (ISSN 0045-7930), vol. 13, no. 3, 1985, p. 239-269. DFG-supported research. refs

Developments and advances in numerical fluid dynamics are being reviewed with emphasis on physical aspects in preference to methodical questions. The governing equations of fluid dynamics, describing the conservation of mass, momentum, and energy are discussed first. Recent work on predictions of inviscid, and of boundary-layer flows is then described in the following two sections. Thereafter, computations of fully viscous flows by numerical solutions of the Navier-Stokes equations are elucidated with several examples of the recent literature. Author

A86-10372
THE DEVELOPMENT OF A VERTICAL GYROSCOPE FOR REMOTELY PILOTED VEHICLE (RPV) APPLICATIONS

D. W. ALFORD (Ferranti Instrumentation, Ltd., Bracknell, England) IN: *Remotely piloted vehicles; International Conference, 4th, Bristol, England, April 9-11, 1984, Proceedings*. Bristol, University of Bristol, 1984, p. 26.1-26.18. Research supported by the Ministry of Defence (Procurement Executive).

The development of gyroscope technology over the last forty years is reviewed with emphasis given to air-powered gyroscopes; hermetically sealed gyroscopes; and electrically powered attitude indicators. Some design improvements incorporated into the Type FS60A Vertical Gyroscope for RPV applications are considered. The gyroscope design consists of a motor stator, two gyro wheel halves, and the top and bottom gyro wheel housings. The stator is wound to accept the output of a 400-Hz three-phase static inverter. The outer gimbal axis is mounted vertical to the azimuthal axis, and azimuthal position are measured using a sine/cosine potentiometer. The angular momentum of the gyro is 11,000,000 g per sq cm, and the rotor speed is 22,500 r/min nominal. The gyro pendulum error loci for turning flight are shown in a line drawing. I.H.

A86-10476#
CORRECTION OF LIFT COEFFICIENT FOR TANDEM CIRCULAR-CASCADE DIFFUSERS

H. HAYAMI, Y. SENOO (Kyushu University, Fukuoka, Japan), and F. KITAYAMA JSME, *Bulletin* (ISSN 0021-3764), vol. 28, July 1985, p. 1354-1358. refs

The interaction between two rows of cascades is discussed quantitatively. The lift characteristics of each cascade of a tandem cascade are calculated numerically based on a two-dimensional potential theory, and the result is compared with the lift characteristics of the individual cascades without mutual interaction; then, the correction factors due to mutual interaction are obtained. The performance of a low-solidity circular tandem-cascade diffuser is predicted using those correction factors and compared with experimental results. The blade circulation of each cascade is also evaluated from the measured pressure distribution along the blade surface and compared with the prediction. C.D.

A86-10481#
PREDICTION OF OUTLET FLOW CHARACTERISTICS OF CENTRIFUGAL IMPELLERS. I - CONSIDERATION OF VELOCITY DISTORTION

J. KUROKAWA (Yokohama National University, Japan) and S. HODE (Mitsubishi Heavy Industries Co., Ltd., Kobe, Japan) JSME, *Bulletin* (ISSN 0021-3764), vol. 28, July 1985, p. 1423-1429. refs

An analytical method for predicting the outlet flow characteristics from a centrifugal impeller is proposed. The method takes hub-to-shroud and blade-to-blade velocity distortion into

consideration, and its usefulness is confirmed by measurements with pump impellers. It is concluded that, in calculating the theoretical head coefficient and the slip factor from the measured velocity of the absolute flow at the impeller outlet, the mass-averaged velocity of the section should be used. To get satisfactory prediction of the outlet flow characteristics, the increment of the wall shearing stress near the inlet of the parallel-walled diffuser channel due to the nonuniform flow must be considered. The influence of velocity distortion in the hub-to-shroud direction should be considered when the parallel-walled diffuser width is larger than the impeller exit width. C.D.

A86-10620#
APPLICATION OF THE LOCAL STRAIN METHOD TO FATIGUE LIFE ESTIMATION OF A WING MAIN BEAM SPECIMEN

Y. WU, X. JIANG, S. XU, and H. LI *Acta Mechanica Solida Sinica*, June 1985, p. 183-194. In Chinese, with abstract in English. refs

An elastic-plastic finite element analysis is performed on a wing main beam specimen. The crack formation life of the main beam specimen is estimated based on the local strain method, and a comparison is made between different damage calculating methods with the effect of notch two axis stress and average stress taken into account. The 25-level and six level program fatigue tests are performed. The calculated results are in agreement with test results, the coefficient of scatter being three. Author

A86-10822
THE LAMINAR-TURBULENT TRANSITION ZONE IN THE BOUNDARY LAYER

R. NARASIMHA (Indian Institute of Science; National Aeronautical Laboratory, Bangalore, India) *Progress in Aerospace Sciences* (ISSN 0376-0421), vol. 22, no. 1, 1985, p. 29-80. Research sponsored by the Aeronautics Research and Development Board. refs

The flow during transition from the laminar to a turbulent state in a boundary layer is best described through the distribution of the intermittency. In constant-pressure, two-dimensional flow, turbulent spots appear to propagate linearly; the hypothesis of concentrated breakdown, together with Emmons's theory, leads to an adequate model for the intermittency distribution over flow regimes ranging all the way from low subsonic to hypersonic speeds. However, when the pressure gradient is not zero, or when the flow is not two-dimensional, spot propagation characteristics are more complicated. The resulting intermittency distributions often show peculiarities that may be best viewed as 'subtransitions'. Previous experimental results in such situations are reviewed and recent results and models are discussed. The problem of predicting the onset of transition remains difficult, but is outside the scope of the present article. Although this paper is intended to be chiefly a survey, several new results in various stages of publication are also included. Author

A86-11232*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A MATHEMATICALLY SIMPLE TURBULENCE CLOSURE MODEL FOR ATTACHED AND SEPARATED TURBULENT BOUNDARY LAYERS

D. A. JOHNSON and L. S. KING (NASA, Ames Research Center, Moffett Field, CA) *AIAA Journal* (ISSN 0001-1452), vol. 23, Nov. 1985, p. 1684-1692. Previously cited in issue 08, p. 1079, Accession no. A84-21854. refs

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A86-11245*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

STRUCTURAL OPTIMIZATION BY MULTILEVEL DECOMPOSITION

J. SOBIESZCZANSKI-SOBIESKI (NASA, Langley Research Center, Hampton, VA), B. B. JAMES, and A. R. DOVI (Kentron International, Inc., Hampton, VA) (Structures, Structural Dynamics and Materials Conference, 24th, Lake Tahoe, NV, May 2-4, 1983, Collection of Technical Papers. Part 1, p. 124-143) AIAA Journal (ISSN 0001-1452), vol. 23, Nov. 1985, p. 1775-1782. Previously cited in issue 12, p. 1737, Accession no. A83-29741. refs

A86-11246#

THERMOELASTIC AND ELECTROMAGNETIC DAMPING ANALYSIS

U. LEE (Structures, Structural Dynamics and Materials Conference, 25th, Palm Springs, CA, May 14-16, 1984, and AIAA Dynamics Specialists Conference, Palm Springs, CA, May 17, 18, 1984, Technical Papers. Part 2, p. 183-191) AIAA Journal (ISSN 0001-1452), vol. 23, Nov. 1985, p. 1783-1790. USAF-supported research. Previously cited in issue 13, p. 1914, Accession no. A84-31705. refs

A86-11250#

EXTENSION OF THE BLASIUS FORCE THEOREM TO SUBSONIC SPEEDS

A. BARSONY-NAGY (Technion - Israel Institute of Technology, Haifa, Israel) AIAA Journal (ISSN 0001-1452), vol. 23, Nov. 1985, p. 1811, 1812. Research supported by the Technion V.P.R. Fund-L. Rogow Aeronautical Research Fund. refs

The theorem considered by Blasius (1910) represents a well-known method for calculating the force on a body situated in an incompressible, inviscid two-dimensional flow. The efficiency of the Blasius theorem is due to its quality of expressing the forces with the aid of contour integrals of analytic functions of complex variables. The present note has the objective to deduce an analog of Blasius theorem for the aerodynamic forces in subsonic flow. It is assumed that an approximate velocity potential of the subsonic flow has been calculated by using the Imai-Lamla method. It is pointed out that this method is a variant specially suited for the two-dimensionally flows of the Janzen-Rayleigh expansion method. The derived formula expresses the aerodynamic forces with the aid of contour integrals of analytic complex functions. It can be regarded as the Blasius theorem with first-order compressibility correction for the subsonic speed regime. G.R.

A86-11343#

MODE INTERACTION HOPF BIFURCATION IN AXISYMMETRIC SHELLS

A. MAEWAL (Yale University, New Haven, CT) IN: 1984 advances in aerospace sciences and engineering: Structures, materials, dynamics, and space station propulsion; Proceedings of the Winter Annual Meeting, New Orleans, LA, December 9-14, 1984. New York, ASME, 1984, p. 135-138. refs (Contract AF-AFOSR-82-076)

The Hopf bifurcation in axisymmetric shells is analyzed, taking into account the structural nonlinearities as well as the mode interaction between circumferentially traveling waves. Aerodynamic flutter is the most notable physical realization of Hopf bifurcation. The results obtained can form a basis for a computational algorithm for analysis of flutter of shells of revolution along the lines of the numerical schemes for nonlinear oscillations. F.J.

A86-11344#

SERVO-ELASTIC OSCILLATIONS - CONTROL OF TRANSIENT DYNAMIC MOTION OF A PLATE

S. N. ATLURI (Georgia Institute of Technology, Atlanta) and P. E. ODOGHOUE IN: 1984 advances in aerospace sciences and engineering: Structures, materials, dynamics, and space station propulsion; Proceedings of the Winter Annual Meeting, New Orleans, LA, December 9-14, 1984. New York, ASME, 1984, p. 139-147. refs

(Contract AF-AFOSR-84-0020)

The control of the transient dynamic response of an initially stressed flat plate representing the continuum model of a large space structure (LSS) is presented using a boundary-element approach. The discretization of the equation of motion of the plate, using a singular solution approach, the control of dynamic response, and the control spillover are discussed. The implementation of algorithms for an efficient solution of Riccati equations is accomplished. F.J.

A86-11416#

OPERATIONAL AND SUPPORT CONSIDERATIONS IN STANDARDIZATION

W. T. OREILLY (Westinghouse Defense and Electronics Center, Baltimore, MD) IN: Computers in Aerospace Conference, 5th, Long Beach, CA, October 21-23, 1985, Technical Papers. New York, AIAA, 1985, p. 115-119.

(AIAA PAPER 85-5063)

Military applications in the era of the 1990's and beyond, require capabilities beyond those available in most existing systems. These capabilities must be provided in a manner that will achieve a low logistic support cost and that can be maintained with relatively inexperienced personnel. This paper presents the design considerations that must be addressed in each of the standardized subsystems and modules that will provide the operational and support needs for tomorrow and beyond. Advanced maintenance concepts, such as two and one level maintenance, are described together with the operational and life cycle cost benefits that will be achieved. A new operation concept called deferred maintenance, which provides sustained operation without maintenance support, is presented. The fault tolerant architecture which will permit a standardized modular design to efficiently accommodate a variety of system applications is presented. The concerns discussed include combat damage survivability, fail safe and fail operational needs, as well as high availability for long life applications as is required for systems employed in the Space Defense Initiative (SDI). Author

A86-11457#

NEW DIRECTIONS IN AEROSPACE PACKAGING

J. W. KANZ (Hughes Aircraft Co., El Segundo, CA) IN: Computers in Aerospace Conference, 5th, Long Beach, CA, October 21-23, 1985, Technical Papers. New York, AIAA, 1985, p. 427-431. refs

(AIAA PAPER 85-6033)

The packaging of electronic devices for aerospace applications is discussed. Consideration is given to the problems encountered in dual-in-line packaging; surface mounting; and pin-grid-arrays. Some limitations of Leadless Chip Carrier (LCC) packages are discussed with respect to reliability; standardization; and handling and testing. I.H.

A86-11460#

RADIATION HARDENED CMOS TECHNOLOGY FOR FLIGHT SYSTEMS

B. PEARSON (Harris Semiconductor, Melbourne, FL) IN: Computers in Aerospace Conference, 5th, Long Beach, CA, October 21-23, 1985, Technical Papers. New York, AIAA, 1985, p. 449-452.

(AIAA PAPER 85-6040)

The techniques used to harden CMOS devices against the effects of radiation are examined, and the performance tradeoffs of hardened versus nonhardened devices are discussed. In particular, attention is given to the following three technologies

used in the manufacture of hardened CMOS: CMOS on EPI silicon, silicon on insulator, and dielectric isolation. Finally, the hardness levels attainable with these three technologies are compared with those of bipolar devices. V.L.

**A86-11461#
VISION-BASED ROAD FOLLOWING FOR AN AUTONOMOUS
LAND VEHICLE**

A. M. WAXMAN, J. LE MOIGNE, B. SRINIVASAN, L. S. DAVIS, and A. ROSENFELD (Maryland, University, College Park) IN: Computers in Aerospace Conference, 5th, Long Beach, CA, October 21-23, 1985, Technical Papers. New York, AIAA, 1985, p. 453-458.
(Contract DAAK70-83-0018; DAAK76-84-C-0004; DARPA ORDER 3206; DARPA ORDER 5096)
(AIAA PAPER 85-6047)

An approach to visual navigation developed under the Autonomous Land Vehicle project is presented. The approach includes a bootstrap phase and a feed-forward phase, with visual processing in each phase executed in three modules: an image processing module, a geometry module, and a rule-based reasoning module. Process control for road following is described, with particular attention given to the image processing algorithms for the bootstrap phase. Guidelines for future work are briefly discussed. V.L.

**A86-11554
AIRCRAFT GAS-TURBINE ENGINES IN GROUND-BASED
APPLICATIONS [AVIATIONNYE GTD V NAZEMNYKH
USTANOVKAKH]**

S. P. IZOTOV, V. V. SHASHKIN, V. M. KAPRALOV, M. G. KALASHNIKOV, O. A. RUDAKOV et al. Leningrad, Izdatel'stvo Mashinostroenie, 1984, 232 p. In Russian. refs

The general design and the principle of operation of aircraft gas-turbine engines are reviewed, and their possible ground-based applications are discussed, including surface transport, compressor plants, power-generating plants, and pumping equipment. In particular, attention is given to the reliability and service life of gas-turbine engines used in ground equipment. The discussion also covers the problem of noise abatement, environmental factors, safety engineering, and algorithms for selecting the principal parameters of ground-based gas-turbine plants. V.L.

**A86-11617#
OPTIMISATION OF RECESS-ACTION CONFORMAL PROFILES
FOR AERO GAS-TURBINE ENGINE GEARS - A COMPUTER
BASED ANALYTICAL APPROACH**

K. RAMACHANDRA, N. NAGARAJ, and R. PADMANABHAN (Gas Turbine Research Establishment, Bangalore, India) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 165-172. refs

Profile parameters of recess-action gears and the factors influencing contact stress are discussed. A single profile parameter, the tooth thickness, was optimized with respect to the ratio of the allowable contact to bending stress. It is concluded that the tooth-profile parameters can be independently optimized so that the ratio of contact to induced bending stress equals the allowable stress ratio for the type of gear material used. It is shown that, for helix angles lower than 20 deg, the thickness of the pinion tooth can be reduced without reducing the load-carrying capacity, and the conventional thickness of the wheel tooth must be increased to make optimum use of the material strength. I.S.

**A86-11621#
A SIMPLE METHOD FOR EVALUATING THERMAL STABILITY
OF LABYRINTH SEALS**

S. PATHAK (Hindustan Aeronautics, Ltd., Engine Design Bureau, Bangalore, India) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 191-198. refs

A relatively simple criterion is defined for a quick check of thermal stability of labyrinth seals in gas turbine engines following

rub in service. In spite of its simplicity, the criterion agrees well with the results obtained from the established sophisticated program. The criterion and the defined considerations apply to both stable and unstable designs, successfully predicting either stability or instability. The parameters of influence lay down guidelines for the designer in considering configurations of stable seals. I.S.

**A86-11696#
EXPERIMENTAL RESULTS FROM A REVERSE FLOW ANNUAL
COMBUSTOR**

F. M. JOUBERT and H. V. HATTINGH (Stellenbosch, University, Republic of South Africa) IN: International Symposium on Air Breathing Engines, 7th, Beijing, People's Republic of China, September 2-6, 1985, Proceedings. New York, AIAA, 1985, p. 787-793. refs

Computer-predicted temperature distributions in the wall liners of a combustion chamber were compared to the experimentally obtained values from combustion tests carried out in a small, full-scale reverse-flow annular combustor at sea level take-off conditions. The largest discrepancies between the measured and predicted linear temperatures occurred in the primary zone, with most of the predictions falling above the measured values, and with neither of the two computer programs satisfying the accuracy of 4 percent (of the experimental values) needed for making estimates on the life of a combustor. On the other hand, the correlation between the measured and predicted liner pressure drop was satisfactory. The validity and usefulness of simple computer models as aids in the design of gas turbine combustion chambers are discussed. I.S.

**A86-11755
ON FLAW SIZE AND DISTRIBUTION IN LAP JOINTS**

C. L. CHOW and C. W. WOO (University of Hong Kong, Hong Kong) Theoretical and Applied Fracture Mechanics (ISSN 0167-8442), vol. 4, Aug. 1985, p. 75-82. refs

The effect of internal flaw size and its distribution along the adhesive layer on the fracture behavior of an adhesive-bonded lap joint is investigated; adhesive lap joints are often used in both aircraft and aerospace applications. The finite element method is used to examine the localized shear stress distribution developed in the lap joint with or without bonding flaws. It is found that the shear stress distribution for adhesive joints without internal defects resembles that of an 'ideal' lap model with high stress concentrations at the lap ends and relatively low stresses over the major central portion of the lap length. It is also found that a central internal lap flaw has little effect on the overall stress distribution. However, an internal flaw close to the lap end increases the maximum shear stress. In addition, adhesively bonded aluminum specimens are analyzed, noting their fracture strength reduction when an internal flaw is present. F.J.

**A86-11774
THE INFLUENCE OF THICKNESS IN PREDICTIONS OF
LIFETIME AND CRACK PROPAGATION IN CASES INVOLVING
DYNAMICALLY LOADED AERONAUTICAL METAL SHEETS
[DICKENEINFLUSS BEI DER LEBENSDAUER- UND
REISSFortschrittsvorhersage DYNAMISCH
BEANSPRUCHTER LUFTFAHRTBLECHE]**

P. MAKRIS and K. STEIN (Athens, National Technical University, Greece) Materialpruefung (ISSN 0025-5300), vol. 27, Aug. 1985, p. 228-233. In German. Research supported by the Aluminium Hellas. refs

Makris and Stein (1984) have discussed a procedure for predicting crack propagation and lifetime in the case of metal sheets used in aircraft construction, taking into account dynamic stresses on the basis of engineering model concepts. The present paper is concerned with the effect of the thickness of the specimens on their lifetime. The reported investigation includes an evaluation of experiments which have been conducted with specimens consisting of the material AlCuMg2. The mechanisms involved in the effects produced by differences in specimen thickness are examined, giving attention to statistical size effects,

stress-mechanical size effects, technological size effects, and fracture-mechanics thickness effects. Possibilities for taking into account thickness effects in a lifetime prediction based on the model considered by Makris and Stein are also discussed. G.R.

A86-11937*# Arizona State Univ., Tempe.
CONCENTRATION DISTRIBUTIONS IN CYLINDRICAL COMBUSTORS

S. A. AHMED and R. M. C. SO (Arizona State University, Tempe) IN: Experimental measurements and techniques in turbulent reactive and non-reactive flows; Proceedings of the Winter Annual Meeting, New Orleans, LA, December 9-14, 1984. New York, ASME, 1984, p. 91-106. refs
(Contract NAG3-260)

Experimental studies have been conducted with the aim to obtain a better understanding of the fluid dynamics of mixing in gas turbine combustors, and solid fuel ramjet combustors subject to spin. The present investigation represents a continuation of studies conducted by So et al. (1984). It is also concerned with the verification of some conclusions reported by Ahmed et al. (1984). Attention is given to the experimental facility and instrumentation, centerline concentration measurements, mean concentration profiles, and a comparison of concentration and axial velocity results in the case of swirling flow. G.R.

A86-11938*# United Technologies Research Center, East Hartford, Conn.

SCALAR AND MOMENTUM TURBULENT TRANSPORT EXPERIMENTS WITH SWIRLING AND NONSWIRLING FLOWS

B. V. JOHNSON, R. ROBACK (United Technologies Research Center, East Hartford, CT), and J. C. BENNETT (Connecticut, University, Storrs) IN: Experimental measurements and techniques in turbulent reactive and non-reactive flows; Proceedings of the Winter Annual Meeting, New Orleans, LA, December 9-14, 1984. New York, ASME, 1984, p. 107-119. refs
(Contract NAS3-22771)

Combustor models for the aircraft gas turbine industry have been obtained because of the need to reduce the costs of developing improved performance and more durable engines. A few years ago, it became apparent that the mass concentration and velocity predictions provided by the computer codes were not representing the data measured in some confined recirculating flows. It is pointed out that errors in the mass concentration distribution are an especially serious problem because of their influence on the heat release, temperature, and reactant distributions. Combined mass and momentum turbulent transport experiments with swirling and nonswirling flow have been conducted with the objective to obtain an experimental data base which can be used to evaluate and improve the turbulent transport submodels employed in the aerothermal models. The present paper is mainly concerned with the overall characteristics of the mass turbulent transport processes in complex flows with recirculation and the deficiencies of the conventional models. G.R.

A86-12074

AN OVERVIEW OF EMP EFFECTS AND THEIR CONTROL

A. J. CULLIGAN (Plessey Assessment Services, Ltd., England) (Society of Environmental Engineers, International Symposium on Product Design Assurance in Engineering, Wembley, England, June 11-13, 1985) Society of Environmental Engineers, Journal (ISSN 0374-356X), vol. 24-3, Sept. 1985, p. 9-11. refs

The environments associated with a nuclear detonation are probably the most extreme of all the environments to which an electronic equipment system may be exposed. One of these environments is related to the electromagnetic pulse (EMP) which represents an intense pulse of radiated electromagnetic energy. The endo-atmospheric EMP is generally not considered a major threat in comparison with other nuclear weapon effects related to blast, thermal phenomena, neutrons, and gamma rays. The situation is different with respect to the exo-atmospheric EMP which has the potential to simultaneously damage communication and allied networks over many thousands of square miles. The present paper is concerned with these EMP effects and the possibilities for

protecting equipment from EMP. For such a protection, an understanding of the system's electronic topology is essential, and component/circuit susceptibility levels must be specified. Attention is given to the wire grid model of a strike aircraft, and the simulation of the EMP environment. G.R.

A86-12272#

AERODYNAMIC RESISTANCE OF PERFORATED PLATES IN NATURAL CONVECTION

M. ISHIZUKA, Y. MIYAZAKI, and T. SASAKI (Toshiba Corp., Research and Development Center, Kawasaki, Japan) JSME, Bulletin (ISSN 0021-3764), vol. 28, Aug. 1985, p. 1697-1702.

This paper describes some experimental results about aerodynamic resistance of perforated plates in natural convection, which are useful for designing casings of electronic equipment. Since velocity through a perforated plate and pressure loss are very small in the case of natural convection, the conventional method can not be used to measure the resistance of the plate with reasonable accuracy. Therefore, a new method was developed to obtain resistance coefficients of plates by temperature measurement, since differential temperature between the upstream flow of a perforated plate and the downstream one is related to its aerodynamic resistance. Using the proposed method, further experiments were performed to study the influence of various parameters, such as Reynolds number, porosity coefficient, and plate thickness/hole diameter on resistance coefficients of perforated plates. Author

A86-12276#

A MEASUREMENT METHOD TO EVALUATE FLUID FORCE ON BLADES

H. ISHII and N. HAGIWARA (Hitachi, Ltd., Mechanical Engineering Research Laboratory, Tsuchiura, Japan) JSME, Bulletin (ISSN 0021-3764), vol. 28, Aug. 1985, p. 1741-1748. refs

The purpose of this study is to establish a measurement method for the fluid force acting on axial turbo machines. The method aims to evaluate the fluid forces as divided into two components, i.e., exciting force and damping force. This method is found to be satisfactory in comparison with other ordinary methods of estimating the fluid force acting on a column test piece in a wind tunnel. According to the results of a test using an axial compressor model with flat blades, the method can quantitatively predict the fluid force acting on rotating blades. Moreover, it is applicable to actual machines. Author

A86-12528

FLUTTER ANALYSIS OF A THIN-WALLED LIFTING SURFACE [RASHET NA FLATTER TONKOSTENNOI NESUSHCHEI POVERKHNOSTI]

M. B. VAKHITOV, A. S. SAFONOV, and I. A. KUZNETSOV Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1985, p. 11-14. In Russian.

A numerical method is proposed for the flutter analysis of thin-walled lifting surfaces, such as an aircraft wing. The method is based on Odinov's (1948) theory in which differential equations are solved using integrating matrices. Aerodynamic loads acting on the wing are calculated using the discrete vortex method. Results are presented for a model structure. V.L.

A86-12536

AN ASSESSMENT OF THE EFFECT OF CORROSION WEAR ON THE STRESSED STATE AND DURABILITY OF PLATES AND SHELLS [OTSENKA VLIANIYA KORROZIONNOGO IZNOSA NA NAPRIAZHENNOE SOSTOIANIE I DOLGOVECHNOST' PLASTINOK I OBOLOCHEK]

I. G. OVCHINNIKOV and KH. A. SABITOV Aviatsonnaia Tekhnika (ISSN 0579-2975), no. 2, 1985, p. 42-45. In Russian. refs

Methods for including the effect of corrosion wear in the analysis of nonlinear elastic plates and shells are examined with particular reference to the method of consecutive parameter perturbations. The effect of material nonlinearity on the deformation behavior of a corroding plate is discussed. An analysis is also made of the

effect of material nonlinearity on the durability of a cylindrical shell. V.L.

A86-12561**AE MONITORING OF JET ENGINE BREECH CHAMBERS**

N. DHOND and D. M. EGGLE (Oklahoma, University, Norman) *Journal of Acoustic Emission, Supplement* (ISSN 0730-0050), vol. 4, Apr.-Sept. 1985, p. S30, S31. refs

It is pointed out that a breech chamber is an important component of the emergency or quick starting mechanism in jet engines. The hot gases produced from a rapidly burning cartridge drives a turbine which rotates the engine. Premature failures in these chambers, which may occur occasionally, can have serious consequences. It is believed that one of the causes of failure is related to stress corrosion cracking (SCC). For this reason, an investigation was conducted concerning the possibility to use acoustic emission (AE) as a means of detecting the presence of SCC and/or participating critical flaws. A commercially available AE system was used to monitor the chambers. Aspects of AE activity in breech chambers are discussed, and approaches for distinguishing a growing crack from other sources of AE are considered. G.R.

A86-12562**ACOUSTIC EMISSION STUDIES FOR DETECTION AND MONITORING INCIPIENT CRACKS IN A SIMULATED AERO ENGINE MOUNT UNDER FATIGUE**

S. C. PATHAK and C. R. L. MURTHY (Indian Institute of Science, Bangalore, India) *Journal of Acoustic Emission, Supplement* (ISSN 0730-0050), vol. 4, Apr.-Sept. 1985, p. S32-S34. Research supported by the Aeronautical Research and Development Board.

Fatigue crack growth in critical structural members affects safety, operational availability, and maintenance of an aircraft. A long felt need exists, therefore, for a procedure involving the remote detection and monitoring of incipient fatigue cracks in critical aircraft structures. A dynamic nondestructive testing (NDT) technique which continuously monitors critical assemblies is required, taking into account early warning before the cracks reach limits of criticality. Acoustic emission (AE) appears to be most suited for this application. However, the AE technique requires further development for the considered employment. The present investigation represents the first step in such a development. An attempt is made to develop a criterion for establishing correlation between true AE data and crack initiation and growth in the presence of typical noise sources. G.R.

A86-12573**IN-FLIGHT AE MONITORING**

G. G. MARTIN and I. G. SCOTT (Department of Defence, Aeronautical Research Laboratories, Melbourne, Australia) *Journal of Acoustic Emission, Supplement* (ISSN 0730-0050), vol. 4, Apr.-Sept. 1985, p. S142-S146. refs

In August 1978, acoustic emission (AE) monitoring equipment was installed in a Royal Australian Air Force Macchi jet trainer aircraft to assess the feasibility of using AE for in-flight monitoring of crack growth. Aircraft of the considered type are flown under a safety-by-inspection procedure involving the monitoring of growing fatigue cracks in the center-section assembly tension spar with the aid of a magnetic rubber inspection (MRI) technique. Attention is given to the employed AE monitoring system, the test program, and a discussion of the test results. These results establish the feasibility of monitoring crack growth, during flight of a jet trainer aircraft. However, further work is needed before AE sources can be identified. G.R.

A86-12575**ACOUSTIC EMISSION MONITORING OF AIRCRAFT STRUCTURES**

S. L. MCBRIDE (Royal Military College of Canada, Kingston) and J. W. MACLACHLAN (Johns Hopkins University, Baltimore, MD) *Journal of Acoustic Emission, Supplement* (ISSN 0730-0050), vol. 4, Apr.-Sept. 1985, p. S151-S154. Research supported by the Defence Research Establishment Pacific. refs

Since the mid-1970s, several studies have explored the feasibility of using acoustic emission to monitor the integrity of aircraft structural components. This paper provides a summary of the principal findings of the program of the Canadian Department of National Defence in this area. In phase I of this program, a single-channel recording system was used to record data in-flight from a wing attachment component on the CF100 jet interceptor aircraft during a period of about a year. It was found that the transient burst signals detected varied over at least two orders of magnitude in amplitude and in number of events per flying hour. In phase II, a dual-channel recording system was employed to record simultaneously data from two symmetrically located wing attachments, while in phase III, a precracked laboratory test specimen was mounted in a structure across the inner fuselage of a CC130 aircraft. G.R.

A86-12600**RELIABILITY OF WIDE-BODY AIRCRAFT [NADEZHNOST' SHIROKOFIUZELIAZHNYKH SAMOLETOV]**

G. V. NOVOZHILOV (Akademiia Nauk SSSR, Vestnik (ISSN 0002-3442), no. 8, 1985, p. 93-101. In Russian.

The use of a systems approach in assuring the reliability and flight safety of commercial wide-body aircraft is discussed with particular reference to the Il-86 and Il-96 aircraft. The role of computer-aided design is emphasized, and specific steps taken at each stage of aircraft design and testing to assure the reliability of the individual components and of the aircraft as a whole are discussed. Particular attention is given to the use of finite elements in displacements for the strength analysis of aircraft structures. V.L.

A86-12608**TURBULENCE CHARACTERISTICS OF A PLANE DIFFUSER FLOW WITH INLET VELOCITY DISTORTION**

P. A. ASWATHA NARAYANA, N. V. CHANDRASEKHARA (Indian Institute of Technology, Madras, India), and V. K. CHITHAMBARAN (Indian Institute of Science, Journal, Section A - Engineering and Technology (ISSN 0019-4964), vol. 65, April 1984, p. 57-70. refs

An experimental study of turbulent characteristics of incompressible flow in a two-dimensional diffuser with inlet velocity distortion is reported. Turbulence level in the boundary layer increases marginally towards the exit of the diffuser and decreases rapidly in the wake region. The region of maximum velocity fluctuation and the maximum Reynolds shear stress shifts away from the wall in the streamwise direction. The energy spectra of the turbulent kinetic energy in the wake region shows a characteristic behaviour indicating possible vortex shedding from the trailing edge of the airfoil. Author

N86-10550 Westland Helicopters Ltd., Yeovil (England).

TRIALS ON THE ASPERITY COUNTING MONITORING SYSTEM Final Report

R. WORDSWORTH (Imperial Coll. of Science and Technology) and P. B. MACPHERSON May 1984 32 p refs (Contract A12/1347) (RES-PAPER-670; BR93962) Avail: Issuing Activity

A monitoring system, based on asperity contacts within a loaded and lubricated pair of metal surfaces, was evaluated in a mini disk machine. Results confirm the sensitivity of the system to changes in surface topography. With additional storage capacity available in microcomputers, a tool for laboratory test running normally undertaken in a mechanical research laboratory is available. The monitor could also be applied in a gearbox test rig for studying the performance of a specific bearing or gear set.

12 ENGINEERING

Although interest in grease as a gearbox lubricant waned an effective system for routine monitoring of helicopter tail and intermediate gearboxes is feasible. Author (ESA)

N86-10554# Department of the Navy, Washington, D. C.
AIRBOC (AIR RAPID BLOOM OFFBOARD CHAFF) CHAFF DEPLOYMENT SYSTEM Patent Application
W. HUMPHRIES, J. BRYANT, R. C. EKLUND, D. C. HAYES, and P. FERKO, inventors (to Navy) 1 Apr. 1985 14 p (AD-D011746; US-PATENT-APPL-SN-718399) Avail: NTIS HC A02/MF A01 CSCL 17D

An AIRBOC (Air Rapid Bloom Offboard Chaff) chaff deployment apparatus comprising a canister with a wind flap attached externally to the canister and connected to a drogue chute that is housed inside the canister. The drogue chute is situated atop a main chute that is atop a release mechanism, which is atop a fuze and that is atop a chaff payload, all of which is housed inside the canister. When the AIRBOC is dropped from a plane, the wind flap extends, pulling out the drogue chute. The drogue chute in turn activates the release mechanism which frees the drogue chute to pull out the main chute to which the drogue chute is connected. The deployment of the main chute causes a force greater than 40 lbs to be applied to the release mechanism, resulting in the chaff payload being released from the canister and the fuze being activated, consequently detonating the released chaff payload.

GRA

N86-10564# Societe Nationale Industrielle Aerospatiale, Suresnes (France). Lab. Central.

NONDESTRUCTIVE CONTROL OF THICK STRUCTURES MADE WITHOUT DISASSEMBLING [CONTROLE NON DESTRUCTIF D'ASSEMBLAGE DE FORTES EPAISSEURS SANS DEMONTAGE DES FIXATIONS, PROCES VERBAL 43-954/F/3]

D. LECURU 21 Jan. 1985 43 p refs In FRENCH (Contract STPA-82-96-006) (PV-43-954/F/3) Avail: NTIS HC A03/MF A01

Ultrasonic and Foucault current methods to inspect aircraft structures in places where plate superposition gives a total thickness 5 to 7 mm were studied. The feasibility of the ultrasonic is demonstrated for external plates, while that of the Foucault current method is shown for the inner plates up to 20 mm thickness.

Author (ESA)

N86-10581*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

FATIGUE OF GRAPHITE/EPOXY BUFFER STRIP PANELS WITH CENTER CRACKS

C. A. BIGELOW Aug. 1985 32 p refs (NASA-TM-87595; NAS 1.15:87595) Avail: NTIS HC A03/MF A01 CSCL 20K

The effects of fatigue loading on the behavior of graphite/epoxy panels with either S-Glass or Kevlar-49 buffer strips is studied. Buffer strip panels are fatigued and tested in tension to measure their residual strength with crack-like damage. Panels are made with 45/0/-45/90 sub 2s layup with either S-Glass or Kevlar-49 buffer strip material. The buffer strips are parallel to the loading direction and made by replacing narrow strips of the 0-degree graphite plies with strips of either 0-degree S-Glass/epoxy or Kevlar-49/epoxy on a one-for-one basis. The panels are subjected to a fatigue loading spectrum MINITWIST, the shortened version of the standardized load program for the wing lower surface of a transport aircraft. Two levels of maximum strain are used in the spectrum with three durations of the fatigue spectrum. One group of panels is preloaded prior to the application of the fatigue cycling. The preload consists of statistically loading the spectrum in tension until the crack-tip damage zone reaches the adjacent buffer strips. After fatigue loading, all specimens are statistically loaded in tension to failure to determine their residual strengths. Author

N86-10594# Societe Nationale Industrielle Aerospatiale, Suresnes (France). Lab. Central.

NONDESTRUCTIVE CORROSION TEST OF ALUMINUM ALLOY STRUCTURES [CONTROLE NON DESTRUCTIF DE LA CORROSION DANS LES ASSEMBLAGES EN ALLIAGES D'ALUMINIUM, PROCES VERBAL PV 43-954/F2]

D. LECURU 21 Jan. 1985 63 p refs In FRENCH (Contract STPA-82-96006) (PV-43-954/F/2) Avail: NTIS HC A04/MF A01

In order to avoid maintenance cost penalties, aluminum aircraft structure nondestructive test methods are studied, including ultrasonics, radiography, neutronography and Foucault currents. The results show that pitting corrosion is easy to detect, but intergranular corrosion is better detected by ultrasonics or neutronography. The best solution to inspect real aircraft structures is a method based on multiparameter analysis of ultrasonic signals. Author (ESA)

N86-11228*# LTV Aerospace and Defense Co., Dallas, Tex. Vought Aero Products Div.

THE FACTORY OF THE FUTURE

J. E. BYMAN In NASA, Langley Research Center Welding, Bonding and Fastening, 1984 p 1-9 Sep. 1985 Avail: NTIS HC A21/MF A01 CSCL 13H

A brief history of aircraft production techniques is given. A flexible machining cell is then described. It is a computer controlled system capable of performing 4-axis machining part cleaning, dimensional inspection and materials handling functions in an unmanned environment. The cell was designed to: allow processing of similar and dissimilar parts in random order without disrupting production; allow serial (one-shipset-at-a-time) manufacturing; reduce work-in-process inventory; maximize machine utilization through remote set-up; maximize throughput and minimize labor.

R.J.F.

N86-11233*# National Aeronautics and Space Administration, Langley Research Center, Hampton, Va.

THE ALTERNATING SURFACE SEGMENTED LAP JOINT: A DESIGN FOR THIN HIGHLY LOADED JOINTS

V. E. WATKINS, JR. and G. C. FIRTH In its Welding, Bonding and Fastening, 1984 p 67-76 Sep. 1985 refs Avail: NTIS HC A21/MF A01 CSCL 13E

The combination of thin airfoil sections and high aerodynamic loads on many wind tunnel models presents a major problem for attachment of flap elements. Conventional methods of attaching fixed control elements such as lap and tongue-in-groove joints are not rigid enough to provide surface continuity required in high Reynolds number research. For the extreme cases, the solution has been to fabricate separate wings for each flap setting with the flap element being an integral part of the wing. Here an attractive solution to this problem, the alternating surface segmented lap joint, is discussed. This joint provides increased rigidity and lower stress levels than conventional joints. Additionally, attachment fastener loading is low and the joint can be designed to accommodate high shear levels due to bending without the use of dowel pins. Author

N86-11247*# Douglas Aircraft Co., Inc., Long Beach, Calif.
ADVANCES IN JOINING TECHNIQUES USED IN DEVELOPMENT OF SPF/DB TITANIUM SANDWICH REINFORCED WITH METAL MATRICES

J. E. FISCHLER In NASA, Langley Research Center Welding, Bonding and Fastening, 1984 p 297-322 Sep. 1985 Avail: NTIS HC A21/MF A01 CSCL 13M

Three and four-sheet expanded titanium sandwich sheets have been developed at Douglas Aircraft Company, a division of McDonnell Douglas Corporation, under contract to NASA Langley Research Center. In these contracts, spot welding and roll seam welding are used to join the core sheets. These core sheets are expanded to the face sheets and diffusion bonded to form various type cells. The advantages of various cell shapes and the design parameters for optimizing the wing and fuselage concepts are discussed versus the complexity of the spot weld pattern. In

addition, metal matrix composites of fibers in an aluminum matrix encapsulated in a titanium sheath are aluminum brazed successfully to the titanium sandwich face sheets. The strength and crack growth rate of the superplastic-formed/diffusion bonded (SPF/DB) titanium sandwich with and without the metal matrix composites are described. Author

N86-11362# New Mexico Univ., Albuquerque. Engineering Research Inst.

VALIDATION OF PROCEDURES FOR PAVEMENT DESIGN ON EXPANSIVE SOILS Final Report, May 1984 - Aug. 1985

R. G. MCKEEN Washington FAA Jul. 1985 99 p refs (Contract F29601-84-C-0080) (FAA-PM-85-15; NMERI-WA5-4(5.02)) Avail: NTIS HC A05/MF A01

This report documents site investigations and design recommendations for airport pavements on expansive soils at three sites. The methods used were developed previously in an FAA-sponsored research project. The design procedure involves soil characterization, determination of surface characteristics and evaluation of soil-pavement interaction. Investigations at three airports are reported; they are Murdo, South Dakota, Mesquite, Texas, and Love Field, Dallas, Texas. Soils data are used along with climatic information to obtain estimates of the equivalent thickness of pavement required for each site. The work at Love Field was somewhat different than the other sites since NMERI was not directly conducting the investigation. Results are reported in the form of pavement thickness required to adequately perform, in terms of surface roughness, on the soil surface characteristics predicted for each site. Recommendations are included for consideration in rehabilitation of each site since all were experiencing surface roughness at the time of the investigations. These results confirm that methods developed for evaluating airport pavements on expansive soils provide useful information for pavement design. B.W.

N86-11430# Naval Ship Research and Development Center, Bethesda, Md.

APPLICATION OF THE VORTEX-LATTICE CONCEPT TO FLOWS WITH SMOOTH-SURFACE SEPARATION Final Report

D. F. THRASHER Jul. 1985 69 p (AD-A157571; DTNSRDC-85/041) Avail: NTIS HC A04/MF A01 CSCL 20D

Numerical schemes based on the vortex-lattice concept have had considerable success in treating the fully three-dimensional separated potential flow over low aspect-ratio thin wings at high incidence and the attached potential flow over bodies of more general shape. In principle, the vortex-lattice method is not limited in application as long as convection dominates vorticity diffusion. A non-linear 3-D vortex-lattice method was developed which treats the steady separated flow over prolate bodies with open separation moving through an inviscid incompressible fluid. The strength and position of the body wake were found as part of the solution. Flows with smooth-surface separation were considered as opposed to flows with sharp-edge separation treated with the vortex-lattice concept in the past. Results for flow over an inclined ogive-cylinder demonstrated the technique. For attached flow, comparisons are presented of the results from the vortex-lattice method using optimal and average control point locations with the results of the source-distribution method and with experimental data. The same panel arrangement was used calculating both methods. The results of the present method are somewhat more sensitive to panel arrangement than are those for the source-distribution method. Also, the effect of control point location varies dramatically as the incidence of the body is changed. For separated flow, results of the vortex-lattice method were compared with experimental data and with the results of a typical 2-D analogy. The present method agrees favorably with the experimental data windward of a separation line. GRA

N86-11495*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

TURBINE ENGINE HOT SECTION TECHNOLOGY (HOST)

Oct. 1983 250 p refs Workshop held in Cleveland, Ohio, 25-26 Oct. 1983 (NASA-CP-2289; E-1816; NAS 1.55:2289) Avail: NTIS HC A11/MF A01 CSCL 21E

A two-day workshop on the research and plans for turbine engine hot section durability problems was held on October 25 and 26, 1983, at the NASA Lewis Research Center. Presentations were made during six sessions, including structural analysis, fatigue and fracture, surface protective coatings, combustion, turbine heat transfer, and instrumentation, that dealt with the thermal and fluid environment around liners, blades, and vanes, and with material coatings, constitutive behavior, stress-strain response, and life prediction methods for the three components. The principal objective of each session was to disseminate the research results to date, along with future plans, in each of the six areas. Contract and government researchers presented results of their work.

N86-11496*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

TURBINE ENGINE HOT SECTION TECHNOLOGY (HOST) PROJECT

D. E. SOKOLOWSKI and C. R. ENSIGN *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 1-6 Oct. 1983 Avail: NTIS HC A11/MF A01 CSCL 21E

The Hot Section Technology (HOST) Project is a NASA-sponsored endeavor to improve the durability of advanced gas turbine engines for commercial and military aircraft. Through improvements in the analytical models and life prediction systems, designs for future hot section components, the combustor and turbine, will be more accurately analyzed and will incorporate features required for longer life in the more hostile operating environment of high performance engines. G.L.C.

N86-11497*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

HOST INSTRUMENTATION R AND D PROGRAM OVERVIEW

D. R. ENGLUND *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 7-9 Oct. 1983 Avail: NTIS HC A11/MF A01 CSCL 14B

The HOST Instrumentation R&D program is focused on two categories of instrumentation. One category is that required to characterize the environment imposed on the hot section components of turbine engines. This category includes instruments for measuring gas flow, gas temperature, and heat flux. The second category is that for measuring the effect of the environment on the hot section components. This category includes strain measuring instruments and an optical system for viewing the interior of an operating combustor to detect cracks, buckling, carbon buildup, etc. G.L.C.

N86-11498*# United Technologies Research Center, East Hartford, Conn.

HOT SECTION VIEWING SYSTEM

W. W. MOREY *In* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 11-16 Oct. 1983 Avail: NTIS HC A11/MF A01 CSCL 14B

The objective of the hot section viewing program is to develop a prototype optical system for viewing the interior of a gas turbine combustor during high temperature, high pressure operation in order to produce a visual record of some causes of premature hot section failures. The program began by identifying and analyzing system designs that would provide clearest images while being able to survive the hostile environment inside the combustion chamber. Different illumination methods and computer techniques for image enhancement and analysis were examined during a preliminary test phase. In the final phase of the program the prototype system was designed and fabricated and is currently being tested on a high pressure combustor rig. G.L.C.

N86-11499*# Pratt and Whitney Aircraft, East Hartford, Conn. Engineering Div.

DYNAMIC GAS TEMPERATURE MEASUREMENT SYSTEM

D. L. ELMORE, W. W. ROBINSON, and W. B. WATKINS /*n* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 17-35 Oct. 1983 refs (Contract NAS3-23154)

Avail: NTIS HC A11/MF A01 CSCL 14B

A gas temperature measurement system with compensated frequency response of 1 KHz and capability to operate in the exhaust of a gas turbine combustor was developed. Environmental guidelines for this measurement are presented, followed by a preliminary design of the selected measurement method. Transient thermal conduction effects were identified as important; a preliminary finite-element conduction model quantified the errors expected by neglecting conduction. A compensation method was developed to account for effects of conduction and convection. This method was verified in analog electrical simulations, and used to compensate dynamic temperature data from a laboratory combustor and a gas turbine engine. Detailed data compensations are presented. Analysis of error sources in the method were done to derive confidence levels for the compensated data. G.L.C.

N86-11500*# United Technologies Research Center, East Hartford, Conn.

HIGH TEMPERATURE STATIC STRAIN SENSOR DEVELOPMENT PROGRAM

C. HULSE, R. BAILEY, and H. GRANT (Pratt and Whitney Aircraft Group, East Hartford, Conn.) /*n* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 37-40 Oct. 1983 (Contract NAS3-23722)

Avail: NTIS HC A11/MF A01 CSCL 14B

Electrical resistance strain gages useful for static strain measurements on nickel or cobalt superalloy parts inside a gas turbine engine on a test stand are being developed. Measurements of this type are of great importance in meeting the goals of the HOST program because, without reliable knowledge of the stresses and strains which exist in specific components, it will be difficult to fully appreciate where improvements in design and materials can be implemented. The first part of the effort consisted of a strain gage alloy development program which will be followed by an investigation of complete strain gage systems which will use the best of the alloys developed together with other system improvements. G.L.C.

N86-11501*# United Technologies Research Center, East Hartford, Conn.

DEMONSTRATION TEST OF BURNER LINER STRAIN MEASUREMENT SYSTEMS: INTERIM RESULTS

K. A. STETSON and H. P. GRANT (Pratt and Whitney Aircraft, East Hartford, Conn.) /*n* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 41-44 Oct. 1983 (Contract NAS3-23690)

Avail: NTIS HC A11/MF A01 CSCL 20K

Work is in progress to demonstrate two techniques for static strain measurements on a jet engine burner liner. Measurements are being made with a set of resistance strain gages made from Kanthal A-1 wire and via heterodyne speckle photogrammetry. The background of the program is presented along with current results. Author

N86-11502*# Pratt and Whitney Aircraft Group, East Hartford, Conn. Engineering Div.

DEVELOPMENT OF HEAT FLUX SENSORS FOR TURBINE AIRFOILS AND COMBUSTOR LINERS

W. H. ATKINSON /*n* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 45-55 Oct. 1983 refs

Avail: NTIS HC A11/MF A01 CSCL 14B

The design of durable turbine airfoils that use a minimum amount of cooling air requires knowledge of the heat loads on the airfoils during engine operation. Measurement of these heat loads will permit the verification or modification of the analytical models used in the design process and will improve the ability to predict and

confirm the thermal performance of turbine airfoil designs. Heat flux sensors for turbine blades and vanes must be compatible with the cast nickel-base and cobalt-base materials used in their fabrication and will need to operate in a hostile environment with regard to temperature, pressure and thermal cycling. There is also a need to miniaturize the sensors to obtain measurements without perturbing the heat flows that are to be measured. G.L.C.

N86-11505*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

TURBINE HEAT TRANSFER

J. E. ROHDE /*n* its Turbine Eng. Hot Sect. Technol. (HOST) p 73-77 Oct. 1983

Avail: NTIS HC A11/MF A01 CSCL 20D

Improved turbine durability and performance and reduced development cost will all result from improved methods of predicting turbine metal temperatures. Better metal temperature prediction methods require improvements in the methods of predicting the hot gas flow over the turbine airfoils and the cooling air flow inside the airfoil and in the methods of predicting the heat transfer rates on both the hot gas side and coolant side of the airfoil. The overall HOST Turbine Heat Transfer effort is directed at improving all four of these areas of concern. G.L.C.

N86-11507*# Detroit Diesel Allison, Mich.

GAS SIDE HEAT TRANSFER

L. D. HYLTON /*n* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 87-99 Oct. 1983 refs (Contract NAS3-22761; NAS3-23695)

Avail: NTIS HC A11/MF A01 CSCL 20D

Improvements in methods for predicting heat transfer rates on the hot gas side of turbine airfoils are necessary for improved turbine durability and performance. The development and verification of improved analytical models requires a systematic, closely coupled experimental and analytical program. G.L.C.

N86-11508*# United Technologies Research Center, East Hartford, Conn.

ASSESSMENT OF A 3-D BOUNDARY LAYER CODE TO PREDICT HEAT TRANSFER AND FLOW LOSSES IN A TURBINE

V. N. VATSA /*n* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 101-106 Oct. 1983 refs (Contract NAS3-23716)

Avail: NTIS HC A11/MF A01 CSCL 20D

The prediction of the complete flow field in a turbine passage is an extremely difficult task due to the complex three dimensional pattern which contains separation and attachment lines, a saddle point and horseshoe vortex. Whereas, in principle such a problem can be solved using full Navier-Stokes equations, in reality methods based on a Navier-Stokes solution procedure encounter difficulty in accurately predicting surface quantities (e.g., heat transfer) due to grid limitations imposed by the speed and size of the existing computers. On the other hand the overall problem is strongly three dimensional and too complex to be analyzed by the current design methods based on inviscid and/or viscous strip theories. Thus there is a strong need for enhancing the current prediction techniques through inclusion of 3-D viscous effects. A potentially simple and cost effective way to achieve this is to use a prediction method based on three dimensional boundary layer (3-DBL) theory. The major objective of this program is to assess the applicability of such a 3-DBL approach for the prediction of heat loads, boundary layer growth, pressure losses and streamline skewing in critical areas of a turbine passage. A brief discussion of the physical problem addressed here along with the overall approach is presented. Author

N86-11510*# Pratt and Whitney Aircraft Group, East Hartford, Conn.

COOLANT PASSAGE HEAT TRANSFER WITH ROTATION. A PROGRESS REPORT ON THE COMPUTATIONAL ASPECTS

L. D. ACETO and G. J. STURGESS /in NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 111-116 Oct. 1983 refs

Avail: NTIS HC A11/MF A01 CSCL 20D

Turbine airfoils are subjected to increasingly higher heat loads which escalate the cooling requirements in order to satisfy life goals for the component materials. If turbine efficiency is to be maintained, however, cooling requirements should be as low as possible. To keep the quantity of cooling air bounded, a more efficient internal cooling scheme must be developed. One approach is to employ airfoils with multipass cooling passages that contain devices to augment internal heat transfer while limiting pressure drop. Design experience with multipass cooling passage airfoils has shown that a surplus of cooling air must be provided as a margin of safety. This increased cooling air leads to a performance penalty. Reliable methods for predicting the internal thermal and aerodynamic performance of multipass cooling passage airfoils would reduce or eliminate the need for the safety margin of surplus cooling air. The objective of the program is to develop and verify improved analytical methods that will form the basis for design technology which will result in efficient turbine components with improved durability without sacrificing performance. The objective will be met by: (1) establishing a comprehensive experimental data base that can form the basis of an empirical design system; (2) developing computational fluid dynamic techniques; and (3) analyzing the information in the data base with both phenomenological modeling and mathematical modeling to derive a suitable design and analysis procedure. Author

N86-11511*# Arizona State Univ., Tempe. Dept. of Mechanical and Aerospace Engineering.

JET ARRAY IMPINGEMENT HEAT TRANSFER CHARACTERISTICS

L. W. FLORSCHUETZ and D. E. METZGER /in NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 117-128 Oct. 1983 refs

Avail: NTIS HC A11/MF A01 CSCL 20D

Two dimensional arrays of circular air jets impinging on a heat transfer surface parallel to the jet orifice plate are considered. The jet flow, after impingement, is constrained to exit in a single direction along the channel formed by the jet orifice plate and the heat transfer surface. In addition to the crossflow which originates from the jets following impingement, an initial crossflow is present which approaches the array through an upstream extension of the channel. The configurations considered are intended to model the impingement cooled midchord region of gas turbine airfoils in cases where an initial crossflow is also present. A major objective is determination of the effect of initial crossflow air temperature relative to jet array air temperature on impingement surface heat fluxes. Author

N86-11514*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.

BURNER LINER THERMAL/STRUCTURAL LOAD MODELLING

R. J. MAFFEO /in NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 159-163 Oct. 1983 (Contract NAS3-23272)

Avail: NTIS HC A11/MF A01 CSCL 20K

The objective of this program is to develop a thermal data transfer computer program module for the burner liner thermal structural load modeling program. This will be accomplished by (1) reviewing existing methodologies for thermal data transfer and selecting three heat transfer codes for application in this program; (2) evaluating the selected codes to establish criteria for developing a computer program module to transfer thermal data from the heat transfer codes to selected stress analysis codes; (3) developing the automated thermal load transfer module; and (4) verifying and documenting the module. In aircraft turbine engine hot section components, cyclic thermal stresses are the most

important damage mechanism. Consequently, accurate and reliable prediction of thermal loads is essential to improving durability. To achieve this goal, a considerable effort over the past 20 years has been devoted to the acquisition of engine temperature test data, as well as the development of accurate, reliable, and efficient computer codes for the prediction of steady state and transient temperatures and for the calculation of elastic and inelastic cyclic stresses and strains in hot section components. There is a need for continued development of these codes, because the availability of more accurate analysis techniques for complex configurations has enabled engine designers to use more sophisticated designs to achieve higher cycle efficiency and reduce weight. Author

N86-11516*# General Electric Co., Cincinnati, Ohio. Aircraft Engine Business Group.

THE 3D INELASTIC ANALYSIS METHODS FOR HOT SECTION COMPONENTS

L. T. DAME and R. L. MCKNIGHT /in NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 175-177 Oct. 1983 refs

Avail: NTIS HC A11/MF A01 CSCL 20K

The objective of this research is to develop an analytical tool capable of economically evaluating the cyclic time dependent plasticity which occurs in hot section engine components in areas of strain concentration resulting from the combination of both mechanical and thermal stresses. The techniques developed must be capable of accommodating large excursions in temperatures with the associated variations in material properties including plasticity and creep. The overall objective of this proposed program is to develop advanced 3-D inelastic structural/stress analysis methods and solution strategies for more accurate and yet more cost effective analysis of combustors, turbine blades, and vanes. The approach will be to develop four different theories, one linear and three higher order with increasing complexities including embedded singularities. Author

N86-11517*# Pratt and Whitney Aircraft, East Hartford, Conn.

THE 3-D INELASTIC ANALYSIS METHODS FOR HOT SECTION COMPONENTS (BASE PROGRAM)

E. S. TODD /in NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 179-180 Oct. 1983

Avail: NTIS HC A11/MF A01 CSCL 20K

The objective of this program is to produce a series of new computer codes that permit more accurate and efficient three dimensional inelastic analysis of selected hot section components - combustor liners, turbine blades and turbine vanes. The computer codes embody a progression of mathematical models and are streamlined to take advantage of geometrical features, loading conditions, and forms of material response that distinguish each group of selected components. Author

N86-11519*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

HOST LINER CYCLIC FACILITIES

D. SCHULTZ /in its Turbine Eng. Hot Sect. Technol. (HOST) p 195-204 Oct. 1983

Avail: NTIS HC A11/MF A01 CSCL 20K

The HOST Liner Cyclic Program is utilizing two types of test apparatus, rectangular box rigs and a full annular rig. To date two quartz lamp cyclic box rigs have been tested and a third is to begin testing in late October 1983. The box rigs are used to evaluate 5x8 inch rectangular linear samples. A 21 inch diameter outer liner simulator is also being built up for testing beginning in April 1984. All rigs are atmospheric rigs. The first box rig, a three 6-kVA lamp installation, was operated under adverse conditions to determine feasibility of using quartz lamps for cyclic testing. This work was done in December 1981 and looked promising. The second box rig, again using three 6-kVA lamps, was operated to obtain instrumentation durability information and initial data input to a Finite Element Model. This limited test program was conducted in August 1983. Five test plates were run. Instrumentation consisted of strain gages, thermocouples and thermal paint. The strain gages were found to fail at 1200 F as expected though plates were

heated to 1700 F. The third box rig, containing four 6-kVA lamps, is in build up for testing to begin in late October 1983. In addition to 33 percent greater power input, this rig has provision for 400 F backside line cooling air and a viewing port suitable for IR camera viewing. The casing is also water cooled for extended durability.

Author

N86-11520*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

LIFE PREDICTION AND CONSTITUTIVE BEHAVIOR

G. R. HALFORD *In its* Turbine Eng. Hot Sect. Technol. (HOST) p 205-207 Oct. 1983

Avail: NTIS HC A11/MF A01 CSCL 20K

One of the primary drivers that prompted the initiation of the hot section technology (HOST) program was the recognized need for improved cyclic durability of costly hot section components. All too frequently, fatigue in one form or another was directly responsible for the less than desired durability, and prospects for the future weren't going to improve unless a significant effort was mounted to increase our knowledge and understanding of the elements governing cyclic crack initiation and propagation lifetime. Certainly one of the important factors is the ability to perform accurate structural stress-strain analyses on a routine basis to determine the magnitudes of the localized stresses and strains since it is these localized conditions that govern the initiation and crack growth processes. Developing the ability to more accurately predict crack initiation lifetimes and cyclic crack growth rates for the complex loading conditions found in turbine engine hot sections is of course the ultimate goal of the life prediction research efforts. It has been found convenient to divide the research efforts into those dealing with nominally isotropic and anisotropic alloys; the latter for application to directionally solidified and single crystal turbine blades.

Author

N86-11521*# Pratt and Whitney Aircraft, East Hartford, Conn.
CREEP FATIGUE LIFE PREDICTION FOR ENGINE HOT SECTION MATERIALS (ISOTROPIC)

V. MORENO *In* NASA. Lewis Research Center Turbine Eng. Hot Sect. Technol. (HOST) p 209-210 Oct. 1983

(Contract NAS3-23288)

Avail: NTIS HC A11/MF A01 CSCL 20K

The activities performed during the first year of the NASA HOST Program, Creep Fatigue Life Prediction for Engine Hot Section Materials (Isotropic), being conducted by Pratt & Whitney Aircraft are summarized. The program is a 5 year, two part effort aimed at improving the high temperature crack initiation prediction technology for gas turbine hot section components. Significant results of the program produced thus far are discussed. Cast B1900 + Hf and wrought IN 718 were selected as the base and alternate materials, respectively. A single heat of B1900 + Hf was obtained and test specimens fabricated. The material was characterized with respect to grain size, gamma prime size, carbide distribution, and dislocation density. Monotonic tensile and creep testing has shown engineering properties within anticipated scatter for this material. Examination of the tensile tests has shown a transition from inhomogeneous planar slip within the grains at lower temperatures to more homogeneous matrix deformation. Examination of the creep tests has shown a transgranular failure mode at 1400 F and an intergranular failure mode at 1600 F and 1800 F.

Author

N86-11522*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

A STUDY OF THE CORNERING FORCES GENERATED BY AIRCRAFT TIRES ON A TILTED, FREE-SWIVELING NOSE GEAR

R. H. DAUGHERTY and S. M. STUBBS Oct. 1985 30 p refs (NASA-TP-2481; L-15954; NAS 1.60:2481) Avail: NTIS HC A03/MF A01 CSCL 20K

An experimental investigation was conducted to study the effect of various parameters on the cornering forces produced by a rolling aircraft tire installed on a tilted, free-swiveling nose gear. The parameters studied included tilt angle, trial, tire inflation pressure,

rake angle, vertical load, and whether or not a twin tire configuration corotates. These parameters were evaluated by measuring the cornering force produced by an aircraft tire installed on the nose gear of a modified vehicle as it was towed slowly. Cornering force coefficient increased with increasing tilt angle. Increasing trial or rake angle decreased the magnitude of the cornering force coefficient. Tire inflation pressure had no effect on the cornering force coefficient. Increasing vertical load decreased the cornering force coefficient. When the tires of a twin tire system rotated independently, the cornering force coefficients were the same as those for the single-tire configuration. When the twin tire system was made to corotate, however, the cornering force coefficients increased significantly.

Author

N86-11523*# National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

AEROELASTIC MODEL HELICOPTER ROTOR TESTING IN THE LANGLEY TDT

W. R. MANTAY, W. T. YEAGER, JR., M. N. HAMOUDA, R. G. CRAMER, JR., and C. W. LANGSTON Jun. 1985 19 p refs Presented at AHS Specialists' Meeting on Helicopter Test Methodology, 29 Oct. - 1 Nov. 1984, Williamsburg, Va.

(Contract DA PROJ. 1L1-62209-AH-76)

(NASA-TM-86440; NAS 1.15:86440; USAAVSCOM-TM-85-B-5)

Avail: NTIS HC A02/MF A01 CSCL 20K

Wind-tunnel testing of a properly scaled aeroelastic model helicopter rotor is considered a necessary phase in the design development of new or existing rotor systems. For this reason, extensive testing of aeroelastically scaled model rotors is done in the Transonic Dynamics Tunnel (TDT) located at the NASA Langley Research Center. A unique capability of this facility, which enables proper dynamic scaling, is the use of Freon as a test medium. A description of the TDT and a discussion of the benefits of using Freon as a test medium are presented. A description of the model test bed used, the Aeroelastic Rotor Experimental System (ARES), is also provided and examples of recent rotor tests are cited to illustrate the advantages and capabilities of aeroelastic model rotor testing in the TDT. The importance of proper dynamic scaling in identifying and solving rotorcraft aeroelastic problems, and the importance of aeroelastic testing of model rotor systems in the design of advanced rotor systems are demonstrated.

Author

N86-11524*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

STRESS ANALYSES OF B-52 PYLON HOOKS

W. L. KO and L. S. SCHUSTER Oct. 1985 33 p refs

(NASA-TM-84924; H-1221; NAS 1.15:84924) Avail: NTIS HC A03/MF A01 CSCL 20K

The NASTRAN finite element computer program was used in the two dimensional stress analysis of B-52 carrier aircraft pylon hooks: (1) old rear hook (which failed), (2) new rear hook (improved geometry), (3) new DAST rear hook (derated geometry), and (4) front hook. NASTRAN model meshes were generated by the aid of PATRAN-G computer program. Brittle limit loads for all the four hooks were established. The critical stress level calculated from NASTRAN agrees reasonably well with the values predicted from the fracture mechanics for the failed old rear hook.

Author

N86-11525*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

A COMPARISON OF MEASURED AND CALCULATED THERMAL STRESSES IN A HYBRID METAL MATRIX COMPOSITE SPAR CAP ELEMENT

J. M. JENKINS, A. H. TAYLOR (NASA, Langley Research Center), and I. F. SAKATA (Lockheed California Co., Burbank) Sep. 1985 20 p refs

(NASA-TM-86729; H-1289; NAS 1.15:86729) Avail: NTIS HC A02/MF A01 CSCL 20K

A hybrid spar of titanium with an integrally brazed composite, consisting of an aluminum matrix reinforced with boron-carbide-coated fibers, was heated in an oven and the resulting thermal stresses were measured. Uniform heating of the spar in an oven resulted in thermal stresses arising from the effects

of dissimilar materials and anisotropy of the metal matrix composite. Thermal stresses were calculated from a finite element structural model using anisotropic material properties deduced from constituent properties and rules of mixtures. Comparisons of calculated thermal stresses with measured thermal stresses on the spar are presented. It was shown that failure to account for anisotropy in the metal matrix composite elements would result in large errors in correlating measured and calculated thermal stresses. It was concluded that very strong material characterization efforts are required to predict accurate thermal stresses in anisotropic composite structures. Author

N86-11540* National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

COMPUTATIONAL STRUCTURAL MECHANICS: A NEW ACTIVITY AT THE NASA LANGLEY RESEARCH CENTER

N. F. KNIGHT, JR. and W. J. STROUD Sep. 1985 39 p refs Presented at 22nd Ann. Tech. Meeting of the Soc. of Eng. Sci., University Park, Pa., 7-9 Oct. 1985 (NASA-TM-87612; NAS 1.15:87612) Avail: NTIS HC A03/MF A01 CSCL 20K

Complex structures considered for the late 1980's and early 1990's include composite primary aircraft structure and the space station. These structures will be much more difficult to analyze than today's structures and necessitate a major upgrade in computerized structural analysis technology. A new research activity in structural analysis, the computational structural mechanics (CSM) was initiated. The objective of the CSM activity is to develop advanced structural analysis technology that will exploit modern and emerging computers such as computers with vector and/or parallel processing capabilities. The three main research activities underway in CSM include: (1) structural analysis methods development; (2) a software testbed for evaluating the methods; and (3) numerical techniques for parallel processing computers. The motivation and objectives of the CSM activity are presented and CSM activity is described. The current CSM research thrusts, and near and long term CSM research thrusts are outlined. E.A.K.

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GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

A86-11789

SMALL FORMAT MICROLIGHT SURVEYS

R. W. GRAHAM (Aerial Imaging Systems, Ltd., Amersham, England), R. E. READ, and J. KURE (International Institute for Aerial Survey and Earth Sciences, Enschede, Netherlands) ITC Journal (ISSN 0303-2434), no. 1, 1985, p. 14-20.

Conventional survey aircraft are designed to meet photogrammetric requirements of mapping. For less exacting coverage, where metric accuracy is not important, there is an urgent need for a more economical and appropriate method of obtaining primary data. This article summarizes the results of research on small format microlight surveys (SFMS)-including the types of aircraft, types of camera, various lenses and films-in an attempt to evaluate SFMS for use in urban and earth resource surveys. Author

A86-12447

THE EFFECT OF CHANGES IN AIRCRAFT NOISE EXPOSURE

G. J. RAW and I. D. GRIFFITHS (Surrey, University, Guildford, England) Journal of Sound and Vibration (ISSN 0022-460X), vol. 101, July 22, 1985, p. 273-275. Research supported by the Economic and Social Research Council.

Langdon and Griffiths (1982) have presented evidence that decreases in road traffic noise have a greater beneficial effect on annoyance caused by noise than would be predicted from a function derived from studies of steady state noise conditions. The same type of study has now been applied to aircraft noise using a regression analysis. It was found that an increase or decrease in aircraft noise results in a change in annoyance over 50 percent greater than would be predicted by using the steady state regression line. Hence, the change itself has an important effect in addition to the effect of the final noise level reached. C.D.

N86-10713# Air Command and Staff Coll., Maxwell AFB, Ala. ROTARY-WING OPERATIONS IN A MICROBURST ENVIRONMENT

E. E. MACE Apr. 1985 43 p (AD-A156695; ACSC-85-1670) Avail: NTIS HC A03/MF A01 CSCL 04B

Microburst wind shear has been directly or indirectly involved in 28 aircraft incidents or accidents since 1964. Following the last major aircraft accident attributed to microburst wind shear in 1982, a major effort was undertaken to study the hazard. The majority of the work that has been accomplished deals with the publicity of the phenomenon to the aviation community and with acceptable methods of detecting it before it occurs. This study explores the background, detection systems and special considerations of helicopter operations in relation to microburst induced wind shear. Included are subjective hazards, aircraft response and recommended pilot actions to successfully penetrate the wind shear if inadvertently encountered. The study recommends that it be used as an interim measure to supplement existing microburst wind shear information and that additional helicopter microburst testing be conducted. Author (GRA)

N86-10720# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Abt. fuer Physik der Atmosphaere.

COMPARATIVE FLIGHT MEASUREMENT OF ICING PARAMETERS FOR THE PROPELLER AIRCRAFT DO-28D2 OF THE TEST STATION 61 OF THE DFVLR AND FOR THE DFVLR AIRCRAFT FALON 20E IN STRATUS CLOUDS

K. P. SCHICKEL and K. UWIRA (Bundesamt fuer Wehrtechnik und Beschaffung, Landsberg/Lech, West Germany) Dec. 1984 52 p refs In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-941) (DFVLR-FB-85-16; ISSN-0171-1342) Avail: NTIS HC A04/MF A01; DFVLR, Cologne DM 15.50

Two aircraft of different types and instrumentation were compared during a flight operation in icing stratus clouds. The results of the measurements are comparable. It is established that differences between icing and nonicing stratus clouds can be detected in infrared satellite pictures; possible causes of these differences are given. The improvement of forecasts of icing stratus clouds is planned. Author (ESA)

N86-10721# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Abteilung Wolkenphysik.

USER MANUAL FOR THE FALCON SYSTEM

Feb. 1985 134 p refs In GERMAN; ENGLISH summary Report will also be announced as translation (ESA-TT-936) (DFVLR-MITT-85-08; ISSN-0176-7739) Avail: NTIS HC A07/MF A01; DFVLR, Cologne DM 36.50

The user manual for the meteorological research aircraft Falcon E, operated by DFVLR, is presented. The system and its technical data are described. The meteorological mission possibilities are discussed, and measuring campaigns are reviewed. Basic and special equipment is described. The onboard data acquisition

13 GEOSCIENCES

system and the operational data evaluation programs are discussed. Author (ESA)

N86-11735*# National Aeronautics and Space Administration, Marshall Space Flight Center, Huntsville, Ala.

METEOROLOGICAL AND ENVIRONMENTAL INPUTS TO AVIATION SYSTEMS

D. W. CAMP, ed. and W. FROST, ed. (Tennessee Univ. Space Inst.) Sep. 1985 144 p refs Workshop held in Tullahoma, Tenn., 26-28 Oct. 1983; sponsored by NASA, NOAA, FAA, DOD, and Office of the Federal Coordinator for Meteorology (Contract NAS8-36177) (NASA-CP-2388; NAS 1.55:2388) Avail: NTIS HC A07/MF A01 CSCL 04B

An overview of meteorological parameters effecting aircraft flight is presented.

N86-11736*# Federal Aviation Administration, Washington, D.C. Weather Coordination Program.

OVERVIEW OF METEOROLOGICAL INPUTS TO NASP

J. C. DZIUK *In* NASA. Marshall Space Flight Center Meteorol. and Environ. Inputs to Aviation Systems p 17-21 Sep. 1985 Avail: NTIS HC A07/MF A01 CSCL 04B

An overview of meteorological systems for forecasting flight conditions is presented. The types of equipment used to gather the information used to prepare pilot briefings and in flight advisories is described. Possible improvements to the systems are classified as short term or long term. G.L.C.

N86-11737*# Delta Air Lines, Inc., Atlanta, Ga.

AIRLINE METEOROLOGICAL REQUIREMENTS

C. L. CHANDLER and J. PAPPAS (Western Airlines, Los Angeles, Calif.) *In* NASA. Marshall Space Flight Center Meteorol. and Environ. Inputs to Aviation Systems p 21-23 Sep. 1985 Avail: NTIS HC A07/MF A01 CSCL 04B

A brief review of airline meteorological/flight planning is presented. The effects of variations in meteorological parameters upon flight and operational costs are reviewed. Flight path planning through the use of meteorological information is briefly discussed. G.L.C.

N86-11738*# Newton (Dennis W.), Reno, Nev.

GENERAL AVIATION'S METEOROLOGICAL REQUIREMENTS

D. NEWTON *In* NASA. Marshall Space Flight Center Meteorol. and Environ. Inputs to Aviation Systems p 23-26 Sep. 1985 Avail: NTIS HC A07/MF A01 CSCL 04B

Communication of weather theory and information about weather service products to pilots in an accurate and comprehensible manner is essential to flying safety in general. Probably no one needs weather knowledge more than the people who fly through it. The specific subject of this overview is General Aviation's Meteorological Requirements. G.L.C.

N86-11739*# Business and Commercial Aviation, White Plains, N.Y.

CORPORATE/COMMUTER AIRLINES METEOROLOGICAL REQUIREMENTS

J. W. OLCOTT *In* NASA. Marshall Space Flight Center Meteorol. and Environ. Inputs to Aviation Systems p 27-29 Sep. 1985 Avail: NTIS HC A07/MF A01 CSCL 04B

The meteorological information requirements of corporate and commuter airlines are reviewed. The skill level and needs of this class of aviator were assessed. An overview of the methodology by which meteorological data is communicated to these users is presented. G.L.C.

N86-11740*# Federal Aviation Administration, Atlantic City, N.J.

OVERVIEW OF FAA'S AIRCRAFT ICING PROGRAM

L. CZEKALSKI *In* NASA. Marshall Space Flight Center Meteorol. and Environ. Inputs to Aviation Systems p 30-34 Sep. 1985 Avail: NTIS HC A07/MF A01 CSCL 04B

An overview of the FAA's icing program is presented. The program involves certification of various types of aircraft for flight in known icing conditions, the study of icing conditions, and the

preparation of certification standards. Test and technology transfer programs are also included. G.L.C.

N86-11741*# National Aeronautics and Space Administration, Washington, D. C.

OVERVIEW OF NASA'S PROGRAMS

A. R. TOBIASON *In* NASA. Marshall Space Flight Center Meteorol. and Environ. Inputs to Aviation Systems p 34-39 Sep. 1985

Avail: NTIS HC A07/MF A01 CSCL 04B

An overview of some of NASA's aviation related programs is presented. The areas discussed include: (1) severe storms; (2) clear air turbulence; (3) icing; (4) fog; and (5) landing systems. G.L.C.

N86-11742*# Coast Guard, Elizabeth City, N.C.

ADVERSE WEATHER IMPACT ON AVIATION SAFETY, INVESTIGATION AND OVERSIGHT

M. J. SMITH *In* NASA. Marshall Space Flight Center Meteorol. and Environ. Inputs to Aviation Systems p 43-48 Sep. 1985 Avail: NTIS HC A07/MF A01 CSCL 04B

A brief review of the weather factors that effect aviation safety with respect to U.S. Coast Guard operations is presented. Precise meteorological information is an absolute necessity to the Coast Guard which must conduct life saving and rescue operations under the worst of weather conditions. Many times the weather conditions in which they operate are the cause of or a contributing factor to the predicament from which they must execute a rescue operation. G.L.C.

N86-11743*# Naval Research Lab., Washington, D. C. Experimental Cloud Physics Section.

A NEW CHARACTERIZATION OF THE ICING ENVIRONMENT BELOW 10,000 FEET AGL FROM 7,000 MILES OF MEASUREMENTS IN SUPERCOOLED CLOUDS

R. K. JECK *In* NASA. Marshall Space Flight Center Meteorol. and Environ. Inputs to Aviation Systems p 51-55 Sep. 1985 refs

Avail: NTIS HC A07/MF A01 CSCL 04B

A growing requirement over the past decade for a new assessment of aircraft icing conditions in wintertime clouds at altitudes up to about 10,000 feet is discussed. The requirement was documented in past workshops and comes primarily from the helicopter community which wants ice-protected rotorcraft to meet increasing demands for all-weather operations. Currently, only a few of the larger helicopters are equipped with certification of ice-protection devices. This is because the current FAA criteria for design and certification of ice-protection equipment results in power and payload penalties that smaller rotorcraft cannot tolerate. The FAA criteria were actually designed for large, transport-category aircraft capable of flying to 20,000 feet or more. For this reason, there have been concerns that the current criteria may be too severe for low-performance aircraft, such as helicopters, which generally operate at altitudes below 10,000 feet. G.L.C.

N86-11744*# Federal Aviation Administration, Atlantic City, N.J. **A NEW CHARACTERIZATION OF SUPERCOOLED CLOUDS BELOW 10,000 FEET AGL**

C. O. MASTERS *In* NASA. Marshall Space Flight Center Meteorol. and Environ. Inputs to Aviation Systems p 56-59 Sep. 1985 refs

Avail: NTIS HC A07/MF A01 CSCL 04B

Icing caused by supercooled clouds below 10,000 feet were characterized with a view toward a change in FAA standards for civil aircraft ice protection standards. Current techniques in cloud physics were employed. G.L.C.

N86-11745*# Spectron Development Labs., Inc., Costa Mesa, Calif.

ADVANCE PARTICLE AND DOPPLER MEASUREMENT METHODS

C. BUSCH *In* NASA. Marshall Space Flight Center Meteorol. and Environ. Inputs to Aviation Systems p 61-62 Sep. 1985
Avail: NTIS HC A07/MF A01 CSCL 04B

Particle environments, i.e., rain, ice, and snow particles are discussed. Two types of particles addressed are: (1) the natural environment in which airplanes fly and conduct test flights; and (2) simulation environments that are encountered in ground-test facilities such as wind tunnels, ranges, etc. There are characteristics of the natural environment that one wishes to measure. The liquid water content (LWC) is the one that seems to be of most importance; size distribution may be of importance in some applications. Like snow, the shape of the particle may be an important parameter to measure. As one goes on to environment in simulated tests, additional parameters may be required such as velocity distribution, the velocity lag of the particle relative to the aerodynamic flow, and the trajectory of the particle as it goes through the aerodynamic flow and impacts on the test object.

G.L.C.

N86-11746*# Flying Tigers-Retired, San Pedro, Calif.
DEVELOPMENT OF A WIND SHEAR PERFORMANCE ENVELOPE

J. H. BLISS *In* NASA. Marshall Space Flight Center Meteorol. and Environ. Inputs to Aviation Systems p 62-65 Sep. 1985
Avail: NTIS HC A07/MF A01 CSCL 04B

It is quite important that the airplane performance during a continuing headwind loss be understood. Lack of consideration of this characteristic can result in assuming almost twice the performance than that which the airplane actually has during severe wind shear at high descent rates. The example data relates to the Boeing 727-200, but the characteristics are applicable to any airplane.

G.L.C.

N86-11747*# Tennessee Univ. Space Inst., Tullahoma. Atmospheric Sciences Div.

LABORATORY MODEL OF FLIGHT THROUGH WIND SHEAR

W. FROST *In* NASA. Marshall Space Flight Center Meteorol. and Environ. Inputs to Aviation Systems p 65-67 Sep. 1985
Avail: NTIS HC A07/MF A01 CSCL 04B

The simulation of an aircraft flying through a downdraft or microburst is presented. The simulation was performed under the conditions of constant takeoff thrust. The resulting wind shear conditions were filmed and examined for possible pilot corrective action in the future.

G.L.C.

N86-11748*# Toronto Univ. (Ontario). Inst. for Aerospace Studies.

A MODEL OF A DOWNBURST, A WIND TUNNEL PROGRAM ON PLANETARY BOUNDARY LAYER, AND AIRSHIP IN TURBULENCE

B. ETKIN *In* NASA. Marshall Space Flight Center Meteorol. and Environ. Inputs to Aviation Systems p 68-73 Sep. 1985
Avail: NTIS HC A07/MF A01 CSCL 04B

An engineering model of microbursts was developed as an aid to possible future flight simulation in wind shear. Planetary boundary layer and high altitude turbulence were also modeled.

G.L.C.

N86-11758# Air Command and Staff Coll., Maxwell AFB, Ala.
RECOGNITION AND CONTROL OF LOW LEVEL WIND SHEAR
W. G. ROGERS Apr. 1985 108 p
(AD-A156500; CSCS-85-2215) Avail: NTIS HC A06/MF A01 CSCL 04B

This is a two hour lesson plan/handbook and slide presentation on low level wind shear. The project was developed for the SAC Instrument Flight Center to be used in their curriculum. The lesson plan is designed to enable SAC instructors to effectively teach other pilots how to understand, recognize, and cope with low level wind shear hazards. The lesson plan addresses the effects,

causes, detection, and control of low level wind shear.

Author (GRA)

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MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

A86-10180
FINITE WORDLENGTH DESIGN OF DIGITAL KALMAN FILTERS FOR STATE ESTIMATION

D. WILLIAMSON (New South Wales, University, Kensington, Australia) IEEE Transactions on Automatic Control (ISSN 0018-9286), vol. AC-30, Oct. 1985, p. 930-939. refs

The optimal design of a Kalman filter is considered with respect to its finite wordlength (FWL) characteristics taking into account the roundoff noise due to state quantization. The issues are particularly relevant in the design of FWL Kalman filters for continuous-time systems operating under a fast sampling rate. In this respect, the results demonstrate one compromise between the selection of the sampling rate and the selection of the state wordlength. The optimum filter structure includes state residue feedback compensation which can result in the saving of many bits of additional state wordlength.

Author

A86-10191
STOCHASTIC DYNAMIC SYSTEM SUBOPTIMAL CONTROL WITH UNCERTAIN PARAMETERS

M. H. LEE, W. J. KOLODZIEJ, and R. R. MOHLER (Oregon State University, Corvallis) IEEE Transactions on Aerospace and Electronic Systems (ISSN 0018-9251), vol. AES-21, Sept. 1985, p. 594-600. refs
(Contract N00014-81-K-0814)

The control of a linear system with random coefficients is studied here. The cost function is of a quadratic form and the random coefficients are assumed to be partially observable by the controller. By means of the stochastic Bellman equation, the optimal control of stochastic dynamic models with partially observable coefficients is derived. The optimal control is shown to be a linear function of the observable states and a nonlinear function of random parameters. The theory is applied to an optimal control design of an aircraft landing in wind gust.

Author

A86-10929#
LOGISTICS CONSIDERATIONS FOR DESIGN ENGINEERS

F. J. LAUBER (McDonnell Douglas Astronautics Co., St. Louis, MO) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 6 p. (AIAA PAPER 85-3056)

Designers of weapon systems are facing new government emphasis on providing readiness and support for new designs at an affordable and balanced life-cycle cost. Readiness and support will now receive comparable emphasis with performance, cost and schedule as a criterion for evaluating programs. To help designers adjust to this new emphasis, this paper defines logistic support, describes associated costs for operating and supporting weapon systems, and identifies the timing required to integrate support considerations into the design process. With this knowledge, designers can call for logistics assistance in the same manner that they now call for other Systems Engineering expertise to optimize the final design configuration.

Author

15 MATHEMATICAL AND COMPUTER SCIENCES

A86-10946#

INTEGRATED SYSTEMS FOR COMPONENT SPECIFIC DESIGN AND ANALYSIS

P. J. ROONEY and J. H. JACKO (Avco Corp., Avco Lycoming Stratford Div., CT) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 5 p.

(AIAA PAPER 85-3097)

The use of integrated design and analysis tools can significantly increase the ability to address multiple alternatives and to identify optimal solutions for component design. Key elements in developing integrated systems are a single part definition, a comprehensive database, the user interface, and component specific software modules. This paper describes one approach to the design and implementation of integrated systems for gas turbine components through the development of a system for Disc Design. Author

A86-10948#

CONSIDERATIONS FOR THE IMPLEMENTATION OF INTELLIGENT WORKSTATION NETWORKS

H. JACOBSON and A. GORDON (Boeing Aerospace Co., Seattle, WA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 6 p. (AIAA PAPER 85-4001)

Intelligent workstations linked together in Local Area Networks (LANs) are ushering in a new era in engineering/scientific computing. Powerful interactive graphics software and high resolution output presentation capabilities can now be provided economically at the engineer's desk. Paperless electronic data flows between functions and departments are technically feasible. This paper describes the Boeing Aerospace Company's experiences with the initial deployment of intelligent workstations in LANs. The issues discussed include in-house customer relations, software vendors, user experiences, potential pitfalls, and future plans. Author

A86-11053#

PAN AIR CONSULTATIONS USING EXPERT SYSTEM TECHNIQUES

R. S. CONNER (Boeing Military Airplane Co., Seattle, WA), D. J. PURDON (Boeing Computer Services Co., Seattle, WA), and F. K. WAMSLEY (Asymetrix Corp., Bellevue, WA) AIAA, Applied Aerodynamics Conference, 3rd, Colorado Springs, CO, Oct. 14-16, 1985. 7 p. refs

(AIAA PAPER 85-4094)

Expert system techniques are proposed to aid aircraft design engineers who run the PAN AIR program within the constraints of a project environment. Expert systems are programs which mimic human problem solving by performing symbolic computations. Performing all the tasks associated with running PAN AIR would require knowledge of proper geometric modeling, program input options and output analysis methods. A prototype of a program input option expert system was built. It demonstrates a very user friendly interface to the code by querying the user about the problem in general terms and translating the responses into a PAN AIR input deck. Author

A86-11123

MATCHED PROCESSORS FOR QUANTIZED CONTROL - A PRACTICAL PARALLEL-PROCESSING APPROACH

E. H. FERIA (College of Staten Island, NY) International Journal of Control (ISSN 0020-7179), vol. 42, Sept. 1985, p. 695-713. refs

Deterministic 'quantized control' problems are investigated from a novel and often computationally feasible 'matched processors' (MPs) perspective. It is noted that a bank of independent MPs, each matched to an admissible decision sequence, can evaluate, given the state and remaining duration, the dynamic performance cost-to-go values corresponding to a suitably selected 'small' subset of all admissible decision sequences. By choosing the best admissible decision sequence in this subset and using its first decision at each stage a computationally feasible and generally suboptimum MP control scheme is produced. This scheme is found

to be ideally suited for very-large-scale integration. In particular, for processes that are linear in the state and performance criteria that are quadratic in the state, the cost-to-go reduces to a simple quadratic function of the given state which in turn results in an MP control scheme structure similar to offered VLSI-based digital computers. It is demonstrated that the proposed scheme performs quite well in two experimental examples. Author

A86-11401*

COMPUTERS IN AEROSPACE CONFERENCE, 5TH, LONG BEACH, CA, OCTOBER 21-23, 1985, TECHNICAL PAPERS

Conference sponsored by AIAA, Association for Computing Machinery, NASA, and IEEE. New York, AIAA, 1985, 519 p. For individual items see A86-11402 to A86-11470.

Among the topics discussed are: access control models for a distributed CAIS-conforming system; a knowledge-based advisory system for casualty procedures; and automated interactive simulation modeling system. Consideration is also given to: reusable software concepts and software development methodologies; the electronic device aspects of neutral network memories; an expert system for automated satellite anomaly resolution; and the use of automatic programming techniques for fault-tolerant computing systems. Among additional topics discussed are: systems approaches to software fault tolerance; a Space Shuttle navigation validation system; and a vision-based road following system for an autonomous land vehicle. I.H.

A86-11411#

THE AUTOMATED INTERACTIVE SIMULATION MODELING SYSTEM

N. A. KUO (USAF, Bedford, MA) IN: Computers in Aerospace Conference, 5th, Long Beach, CA, October 21-23, 1985, Technical Papers. New York, AIAA, 1985, p. 84-91.

(AIAA PAPER 85-5055)

A new general purpose simulation modeling tool, AISIM (Automated Interactive Simulation Modeling System), has been developed by Air Force System Command's Electronic Systems Division under the direction of Air Force Program Element 64740F, Computer Resource Management Technology. AISIM is designed to provide quick answers to system performance questions during the conceptual phase of a system's acquisition. AISIM has undergone many tests and is currently in the initial operating capability phase of software development. Initial test results indicate potential for wide application to the study of communication nets, computer system architectures, and data processing functions during the conceptual stages of system development. This paper introduces the reader to AISIM - its model building capabilities and its five user interfaces. Author

A86-11441#

MULTITASK SCHEDULING FOR TIME-CRITICAL APPLICATIONS

J. F. READY (Hunter and Ready, Inc., Palo Alto, CA) IN: Computers in Aerospace Conference, 5th, Long Beach, CA, October 21-23, 1985, Technical Papers. New York, AIAA, 1985, p. 294-304.

(AIAA PAPER 85-6008)

A hierarchy of control loops is employed as an example to demonstrate the most efficient software methodology for testing synchronous, hybrid, and asynchronous (C3I and EW) time-critical avionics applications. It is noted that, as the cyclic control loops increase in complexity, the software must become aware of multiple functions and the priorities of such functions, which leads to a consideration of a multitasking methodology as a practical solution. Illustrations including code examples in Ada are presented which provide a step-by-step guide through the subject of multitask scheduling for time-critical applications. B.J.

A86-11442#

SOFTCOST - A USER-FRIENDLY SOFTWARE COST ESTIMATION TOOL

D. J. REIFER and M. H. HILL (Reifer Consultants, Inc., Torrance, CA) IN: Computers in Aerospace Conference, 5th, Long Beach, CA, October 21-23, 1985, Technical Papers. New York, AIAA, 1985, p. 305-313. refs
(AIAA PAPER 85-6009)

The SoftCost estimating tool, its features, and initial user experiences with it in operational environments are described. SoftCost is a software system that integrates a powerful screen editor, a hybrid parametric software estimation model, and a flexible report generator with Gantt/PERT charting capabilities into an user-friendly environment where software project costs can be estimated quickly and accurately under a wide variety of situations. The tool builds on both the strengths and weaknesses of other similar packages available in the public domain. These features and SoftCost's approach to interfacing with the management user are explained in depth as the paper relates how the tool's goals of user-friendliness, fidelity, and flexibility were achieved in the tool's design. Initial experiences with the tool on both military and commercial projects are described. Author

A86-11446#

BOEING STRESS ANALYSIS WORKSTATION DEVELOPMENT

D. C. JACK and F. GAMA-LOBO (Boeing Co., Seattle, WA) IN: Computers in Aerospace Conference, 5th, Long Beach, CA, October 21-23, 1985, Technical Papers. New York, AIAA, 1985, p. 349-354.

(AIAA PAPER 85-6014)

With the increased design productivity resulting from a CAD/CAM environment, it is evident that traditional hand methods of strength checking airframe structures are rapidly becoming inadequate. This paper describes the development of a pilot stress analysis workstation program which, using a MASSCOMP MC500 workstation, takes full advantage of today's microcomputer capability to address this situation. The stress workstation fully synthesizes the digital product definition, the mainframe internal loads analysis, and classical ultimate, fatigue and damage tolerance strength-checks into a user-friendly, integrated system. The system uses modern data base management and graphic display techniques to provide the analyst with a real-time comprehensive analysis with an innovative informative display of results which parallels the current stress analysis. Requirements, program design and structure, and engineering acceptance are discussed in detail. Author

A86-11450#

PREDICATE/TRANSITION NETWORK ANALYSIS OF REDUNDANT CHANNEL SYNCHRONIZATION

L. A. BARTON, D. B. MULCARE, L. E. DOWNING (Lockheed-Georgia Co., Marietta), and R. J. LEBLANC (Georgia Institute of Technology, Atlanta) IN: Computers in Aerospace Conference, 5th, Long Beach, CA, October 21-23, 1985, Technical Papers. New York, AIAA, 1985, p. 374-379.

(AIAA PAPER 85-6020)

The predicate/transition network analysis technique provides a powerful tool for modeling and analyzing concurrent systems with discrete states. In a recent project, a predicate/transition network was used to model the cross-channel synchronization design for a quadruplex digital flight control system (DFCS). An analysis program was developed and applied in exercising the network to confirm its proper operation, i.e., its correct sequencing of state transitions. This tool was then extended by the use of Ada tasking to a time-based simulation that permits the inclusion of nonideal timing effects that tend to be present in practical systems. Although it possesses more general utility, the predicate/transition network analysis program has provided the capacity to rigorously verify DFCS designs on an analytical basis, rather than by trial and error methods such as breadboarding. Its development has also afforded considerable design and programming experience with the Ada programming language, especially with regard to

applications of tasking, which have been found to be particularly well suited to time-based simulations. Author

A86-11452*# Charles River Associates, Inc., Cambridge, Mass. PERFORMANCE ANALYSIS OF A FAULT INFERRING NONLINEAR DETECTION SYSTEM ALGORITHM WITH INTEGRATED AVIONICS FLIGHT DATA

A. K. CAGLAYAN, P. M. GODIWALA (Charles River Analytics, Inc., Cambridge, MA), and F. R. MORREL (NASA, Langley Research Center, Hampton, VA) IN: Computers in Aerospace Conference, 5th, Long Beach, CA, October 21-23, 1985, Technical Papers. New York, AIAA, 1985, p. 391-398. refs
(AIAA PAPER 85-6022)

This paper presents the performance analysis results of a fault inferring nonlinear detection system (FINDS) using integrated avionics sensor flight data for the NASA ATOPS B-737 aircraft in a Microwave Landing System (MLS) environment. First, an overview of the FINDS algorithm structure is given. Then, aircraft state estimate time histories and statistics for the flight data sensors are discussed. This is followed by an explanation of modifications made to the detection and decision functions in FINDS to improve false alarm and failure detection performance. Next, the failure detection and false alarm performance of the FINDS algorithm are analyzed by injecting bias failures into fourteen sensor outputs over six repetitive runs of the five minutes of flight data. Results indicate that the detection speed, failure level estimation, and false alarm performance show a marked improvement over the previously reported simulation runs. In agreement with earlier results, detection speed is faster for filter measurement sensors such as MLS than for filter input sensors such as flight control accelerometers. Finally, the progress in modifications of the FINDS algorithm design to accommodate flight computer constraints is discussed. Author

A86-11455#

ALGEBRAIC POLYNOMIAL APPROXIMATION IN THE LSQ SENSE OF A FAMILY OF CURVES

C. P. NEHRA (Allied/Bendix Aerospace Sector, Bendix Flight Systems Div., Teterboro, NJ) IN: Computers in Aerospace Conference, 5th, Long Beach, CA, October 21-23, 1985, Technical Papers. New York, AIAA, 1985, p. 416-421.

(AIAA PAPER 85-6026)

An algorithm to derive an algebraic polynomial approximation in the LSQ sense for a family of curves generated by an n-dimensional function of form $G(x,y,z,\dots)$ is developed with reference to the design of embedded processor real-time systems. The algorithm has been used to approximate a family of curves representing: (1) the maximum range of an aircraft, which is a function of true air speed, altitude, and outside air temperature; and (2) damped sinusoids with the independent variables time, damping factor, and frequency. B.J.

A86-11464#

ARCHITECTURAL CONCEPTS FOR INTEGRATED REALTIME MULTIPROCESSORS

G. W. GRUBE, W. W. SCALES, and D. P. WILLIAMS (AT&T Bell Laboratories, Whippany, NJ) IN: Computers in Aerospace Conference, 5th, Long Beach, CA, October 21-23, 1985, Technical Papers. New York, AIAA, 1985, p. 474-477. refs
(AIAA PAPER 85-5053)

Methodology and architectural concepts at the system level for real-time microprocessor systems are examined with particular reference to multiprocessors for aerospace platforms. Data-flow multiprocessor architectures are illustrated by two examples, the Enhanced Modular Signal Processor and the AT&T Bell Laboratories' Data Flow Architecture. It is pointed out that the system architecture is strongly influenced by such nonfunctional requirements as reliability, fault tolerance, programmability, and modularity. V.L.

15 MATHEMATICAL AND COMPUTER SCIENCES

A86-11535

FUNDAMENTAL ASPECTS OF THE THEORY OF CONTINUOUS MARKOVIAN CONTROLLABLE SYSTEMS AND THE APPLICATION OF THIS THEORY [OSNOVYE ASPEKTY TEORII NEPRERYVNYKH MARKOVSKIKH UPRAVLIAEMYKH SISTEM I EE PRILozHENIE]

V. K. BRUTIAN Yerevan, Izdatel'stvo Aiastan, 1984, 296 p. In Russian. refs

This monograph examines the theory of continuous stochastic automatic systems in the case of incomplete and imprecise information and significant parameter variations. Mathematical methods for the analysis and synthesis of Markovian controllable systems are developed in the framework of dynamic programming. The primary applications discussed pertain to the field of aviation; various problems of motion control for flight vehicles are examined, including the synthesis of an optimal autopilot and the angular stabilization of a flight vehicle. B.J.

A86-11597

STRUCTURAL IDENTIFICATION OF LINEAR TIME-INVARIANT DYNAMIC SYSTEMS UNDER RANDOM INPUTS [STRUKTURNAYA IDENTIFIKATSIIA LINEINYKH STATSIONARNYKH DINAMICHESKIKH SISTEM PRI SLUCHAINYKH VOZDEISTVIIAKH]

V. N. AZARSKOV, L. N. BLOKHIN, and A. A. TUNIK (Kievskii Institut Inzhenerov Grazhdanskoi Aviatsii, Kiev, Ukrainian SSR) Elektronnoe Modelirovanie (ISSN 0204-3572), vol. 7, Sept.-Oct. 1985, p. 39-42. In Russian.

An algorithm is developed which uses experimental data to obtain optimal estimates of the dynamic characteristics of a complex system and the random inputs acting on this system under regular operating conditions. This algorithm can be used for the identification of the dynamic characteristics of a passenger aircraft during automatic landing descent. B.J.

N86-10831# Air Command and Staff Coll., Maxwell AFB, Ala.

LET'S GET SERIOUS ABOUT SOFTWARE

J. R. HEGLAND Apr. 1985 47 p
(AD-A156819; ACSC-85-1130) Avail: NTIS HC A03/MF A01
CSCL 09B

This guide translates applicable Air Force and TAC data processing requirements into language and examples fighter crews can relate to and understand. It provides information on methods of programming, documenting, and submitting software to TAC. It is designed to help get fighter squadron software into TAC-wide distribution and prevent wasted efforts. Author (GRA)

N86-10900# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.

GENERATION OF FLIGHT PATHS USING HIERARCHICAL PLANNING M.S. Thesis

K. B. KLINE 1985 265 p
(AD-A156905; AFIT/CI/NR-85-37T) Avail: NTIS HC A12/MF
A01 CSCL 12B

This thesis examines the use of an artificial intelligence technique, hierarchical planning, to solve the problem of generating an aircraft route and finding a path through various hostile environments. A route or path is evaluated by the number and type of threats the aircraft encounters on the route and the route length. An algorithm using hierarchical planning is presented and tested against several hostile environments. Specifically, the algorithms will divide the problem space or grid into smaller spaces or boxes. These boxes are then assigned values based upon the input hostile environment. Block paths are then constructed and evaluated based on the values in the boxes. An exhaustive search is performed on the two best block paths to find a flight path for the aircraft. Test results are compared to previous results obtained using heuristic search and indicate an improvement in solution quality. Although specific plans are incorporated into the algorithm to obtain test results, many other plans within the realm of hierarchical planning certainly exist and could be used to solve this problem. GRA

N86-11857# Air Command and Staff Coll., Maxwell AFB, Ala.
A COMPUTER ENGINEERING CURRICULUM FOR THE AIR FORCE ACADEMY: AN IMPLEMENTATION PLAN

L. L. BURGE, JR. Apr. 1985 113 p
(AD-A156464; ACSC-85-0335) Avail: NTIS HC A06/MF A01
CSCL 05I

The recent advances in computer technology which impact present and future Air Force systems led the Air Force Academy to include computers and information systems engineering courses in the curriculum. This analysis addresses the issue of a major in computer engineering at the Academy. The Air Force computer engineer (AFSCs 2625, 2736 and 2885) specializes in designing, developing, installing, and testing embedded computer systems in aircraft, missiles, flight simulators, and command, control, and communications systems. An embedded computer system is all computer equipment, programs, data, documentation, personnel, and supplies integral to a defense system from the design, acquisition, or operations and support point of view. This report addresses the Air Force need for computer engineers, the need for the computer engineering major at the Academy, the appropriate department to administer the major, the structure of the degree, and the implementation of the discipline at the Academy. Author (GRA)

N86-11898# Lockheed-California Co., Burbank.

KRASH85 USER'S GUIDE: INPUT/OUTPUT FORMAT Final Report, Jan. - Sep. 1984

M. A. GAMON, G. WITTLIN, and W. L. LABARGE Jul. 1985
240 p refs
(Contract DTFA03-84-C-00004)

(FAA-CT-85-10; LR-30777) Avail: NTIS HC A11/MF A01

The input and output formats appropriate for the computer program KRASH 85 are presented. Features that are incorporated into KRASH85 include: (1) an improved plastic hinge moment algorithm; (2) gear-oleo metering pin coding; (3) load-interaction curves; (4) an expanded initial conditions subroutine (combined with NASTRAN); (5) a comprehensive energy balance; (6) center of gravity (c.g.) displacement, velocity, acceleration and force time histories; (7) revised vertical beam orientation coding; (8) provision to save data for post-process i.e., acceleration, mass location and forces; (9) provisions to input preprocessed data; (10) a corrected uncoupled KR curve unloading/reloading algorithm; (11) provisions to define a tire spring (remains normal to the ground plane); (12) provisions to number the masses to an arbitrary sequence; and (13) an option to compute section shear and moment distributions. Author

16

PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

A86-10177

THE GENERATION OF NOISE IN IMPINGING VORTEX MOTION PAST A STEP

A. T. CONLISK and D. VELEY (Ohio State University, Columbus) Physics of Fluids (ISSN 0031-9171), vol. 28, Oct. 1985, p. 3004-3012. Research supported by the Ohio State University. refs

The noise field generated by the motion of one, two, or several rectilinear vortices in an inviscid, irrotational mean flow past a step is considered for low Mach number. The streakline patterns of an impinging vortex are compared with flow visualization studies, and qualitative agreement between the present analytical results and the experiments is achieved. Both acoustic pressure and intensity are strong functions of the vortex motion near the step which, because of the complexity of the geometry, must be

computed numerically. Results for the acoustic pressure and intensity are presented for a variety of incident vortex arrays.

Author

**A86-12025#
HELICOPTER NOISE**

R. LEGENDRE (ONERA, Chatillon-sous-Bagneux, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 6, 1984, p. 59-61.

The state of the art in predicting and modeling helicopter noise, its sources, components, magnitudes and dynamic characteristics, is assessed. Noise is not emitted by steady flow, and can be decomposed into noise and pseudo-noise. Account must be taken of pseudo-noise in considerations of passenger comfort. The evolution of vortices in the turbulent boundary layer, the turbulent wake and at the blade tips produces noise. The difficulty in predicting noise arises from the complex behavior of vortices, atmospheric processes which affect the noise during flight and interactions among noise effects of separate blades and the fuselage noise. Various experiments are suggested for deriving quantitative laws to improve noise prediction efforts. M.S.K.

N86-10909 ESDU International Ltd., London (England).

SUMMARY OF WORK ON JET NOISE PREDICTION

R. F. LAMBERT Apr. 1985 38 p refs
(ESDU-BR-62636; ESDU-AN-36B) Avail: ESDU

Design data for aircraft noise, which include the estimation of subsonic far-field jet mixing noise are presented. It is proposed to extend the existing far field jet mixing noise to supersonic jet velocity conditions. The theories which form the basis for jet exhaust noise prediction are summarized. Measured and predicted overall and spectrum noise levels are compared. The existing data item, the theoretical basis for extending the item into the supersonic jet velocity region, and comparison with jet noise predictions are assessed. E.A.K.

N86-10920# Sandia National Labs., Albuquerque, N. Mex.

UNDERSTANDING AND IMPROVING ACOUSTIC TO SEISMIC COUPLING AS IT PERTAINS TO SANDIA'S HELICOPTER DETECTOR

G. ELLIOTT and R. J. FOGLER 18 Mar. 1985 22 p
(Contract DE-AC04-76DP-00789)
(DE85-009440; SAND-85-0841C) Avail: NTIS HC A02/MF A01

The basic physics of the acoustic-to-seismic coupling phenomenon involved in the operation of a helicopter detector under development are reported. A series of tests were conducted near Albuquerque, New Mexico, investigating the coupling phenomenon using an impulsive noise source and two different helicopters. Results of the tests including the evaluation of a new microphone windscreen design are presented. DOE

N86-11169# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (West Germany). Inst. for Experimental Fluid Mechanics.

AEROACOUSTIC WIND TUNNEL MEASUREMENTS ON PROPELLER NOISE

F. R. GROSCHE and H. STIEWITT /n AGARD Aerodyn. and Acoustics of Propellers 9 p Feb. 1985 refs
Avail: NTIS HC A20/MF A01

Model tests were conducted in a low speed wind tunnel to determine the sound radiation of 5 propellers with different blade designs including variations of thickness ratios, blade profiles, blade planforms and blade tip configurations. The diameter of the propellers was 0.9 m, the propeller speed was kept constant. The tip Mach number was $M_{sub} 1 = 0.66$ and the helical tip Mach number varied between 0.66 and 0.69. The main objectives were to investigate the effects of blade geometry on near field and far field noise and to locate the dominant sound sources in the propeller plane, radiating to the observer, by means of a highly directional microphone system. The results include: (1) comparisons of noise spectra of different propeller configurations; (2) near field sound pressures as function of axial distance from the propeller

plane; and (3) directivity of sound radiation from the moving blades.

Author

N86-11171# Pratt and Whitney Aircraft of Canada Ltd., Longueuil (Quebec).

AN INVESTIGATION OF IN-FLIGHT NEAR-FIELD PROPELLER NOISE GENERATION AND TRANSMISSION

H. BONNEAU, D. F. WILFORD, and L. K. WOOD /n AGARD Aerodyn. and Acoustics of Propellers 12 p Feb. 1985 refs
Avail: NTIS HC A20/MF A01

In flight near field propeller noise measurements, made on a General Aviation turboprop aircraft, are reported for a range of propeller operating conditions, and are shown to be well defined and reproducible. Measurements have been made at 8 exterior microphones, 2 located on a wing mounted boom, and 6 embedded in, and flush with the aircraft fuselage. Interior noise levels are also presented. Measured propeller harmonic levels are compared to first principle calculations of near field noise, using a modified version of the Farassat computer program, in which the blade surface pressure is described using the known aerodynamic properties of the blade (NACA 16) airfoil sections. The first few; i.e., the dominant harmonic levels of propeller noise are shown to be well predicted, while higher harmonic levels are underpredicted. The transmission loss between exterior and interior noise levels is shown to be relatively constant for varying propeller operating conditions and at two different locations along the length of the fuselage. Interior noise levels are also shown for the aircraft in gliding flight at various forward velocities, with both engines at idle and propellers feathered. A method of interpolating these measurements is discussed, which allows the interior noise due only to the forward velocity of the aircraft, to be determined. The transmission loss for this component is also discussed. Finally, interior noise levels are presented for a series of ground static tests with engine mounts of various different stiffnesses. B.W.

N86-11172# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Entwurfsaerodynamik.

FULL-SCALE FLIGHT AND MODEL-SCALE WIND TUNNEL TESTS ON THE NEARFIELD NOISE CHARACTERISTICS OF AIRCRAFT PROPELLERS

H. HELLER, M. KALLERGIS, and B. GEHLHAR /n AGARD Aerodyn. and Acoustics of Propellers 17 p Feb. 1985 refs
Avail: NTIS HC A20/MF A01

Flight noise tests employing a single engine Cessna T 207 aircraft with an array of wing mounted microphones were conducted to investigate nearfield acoustic characteristics of a 3 blade variable pitch propeller under different operational conditions, varying helical blade tip Mach number, propeller advance ratio, and blade loading. A special technique to minimize the engine exhaust influence on the propeller signature had been developed for this purpose. Supplementary, yet much more extensive tenth scale tests were performed in the DFVLR One Meter Acoustic Tunnel again in the acoustic nearfield of propellers with 2 to 6 blades over a substantial range or operational, partially interdependent, parameters, such as helical blade tip Mach number, blade pitch angle setting, blade incidence angle, rotational plane attitude, and ambient temperature. These data could also be compared to some third scale results for geometrically identical propellers. Especially the model tests allowed an exact quantification of the effect of the various parameters on the ensuing harmonic and subharmonic propeller noise spectra. Author

N86-11173# Aeritalia S.p.A., Pomigliano D'Arco (Italy).

CABIN NOISE REDUCTION FOR A NEW DEVELOPMENT TURBOPROP COMMUTER AIRCRAFT

A. CARBONE, A. PAONESSA, L. LECCE (Ist. Progetto Velivoli, Naples), and F. MARULO (Ist. Progetto Velivoli, Naples) /n AGARD Aerodyn. and Acoustics of Propellers 14 p Feb. 1985 refs
Avail: NTIS HC A20/MF A01

The program followed to attain an interior noise level similar to turboprop aircraft in a new design turboprop commuter is described. The need for an early consideration, in the definition

phase of the aircraft, of the acoustic requirement for configuration development is stressed, along with some peculiar characteristics of this program. After a brief presentation of features of the aircraft related to interior noise control, the analytical and experimental models developed in the course of program are discussed. Some of the results of the studies are presented, clarifying the impact that they have had on the configuration of the aircraft. The output of three structural analysis theoretical procedures is compared to experiments. Two of these procedures, the panel stringer periodic model, and a simplified FEM analysis, are found adequate to represent experimental findings. The cylindrical shell - frame model is found not representative of test results. Sidewall treatment performance is discussed, with reference to theoretical and experimental results. The noise reductions measured in a furnished fuselage are compared to data obtained without interior treatment. Future developments and recommendations for additional work are discussed. Author

N86-11174# Lockheed-California Co., Burbank.
PROPELLER AIRCRAFT CABIN VIBRATION AND NOISE-EXCITATION, SOURCES, AND PATHS

R. E. DONHAM, F. J. BALENA, E. Z. BOCHARY, and O. K. LIEHR *In* AGARD Aerodyn. and Acoustics of Propellers 14 p Feb. 1985 refs

Avail: NTIS HC A20/MF A01

The potential sources and paths by which the propeller produces structural responses resulting in vibration and noise in the cabin of a transport aircraft are discussed. New low cost, convenient experimental and analytical techniques are described for evaluating the excitations; propeller airborne pressures on the fuselage shells, slip stream induced forces on the wing and tail, and oscillatory forces on the propeller. The techniques described make use of ground determined structural signatures to relate forces with vibrations or noise, and of propeller signatures from flight which define the vibroacoustic contributions of individual propellers. Author

N86-11175# Hamilton Standard, Windsor Locks, Conn.
THE STATE OF THE ART IN PROPFAN TURBOPROP NOISE

F. B. METZGER *In* AGARD Aerodyn. and Acoustics of Propellers 20 p Feb. 1985 refs

Avail: NTIS HC A20/MF A01

The evolution of propeller noise research is summarized from 1919 to the present. The early experimental and analytical work to understand and predict propeller noise is discussed. Emphasis is placed on understanding source noise. However, the major advances in cabin comfort assessment and design of airplane fuselage and cabin trim to improve passenger comfort are briefly described. Emphasis is on the recent noise research work on the propfan, a many bladed relatively small diameter unshrouded motor with swept blades that will allow future transports to cruise efficiently at speeds equal to modern turbofan transports. The most recent propfan concept, a counter rotation version with even greater efficiency potential than the propfan with a single blade row is also discussed. Author

N86-11176# Lockheed-Georgia Co., Marietta.
APPLICATION OF ACTIVE NOISE CONTROL TO MODEL PROPELLER NOISE

M. SALIKUDDIN, H. K. TANNA, R. H. BURRIN, and W. E. CARTER *In* AGARD Aerodyn. and Acoustics of Propellers 15 p Feb. 1985 refs

Avail: NTIS HC A20/MF A01

The applicability of active noise control to reduce cabin noise of turboprop aircraft is demonstrated by conducting several laboratory experiments. The principle of active noise control is to reduce the noise radiated from a primary source by superimposing a signal from a secondary source, which is made identical in amplitude but opposite in phase to the primary sound signal. A computer controlled algorithm was developed to implement this concept in a free field environment, in which, the noise from the primary source (eventually the propeller) and the noise measured at several locations on a representative surface (eventually the

fuselage) were used to create the input for the secondary source. Experiments using a number of sinusoidal signals were conducted. An average noise reduction of 8 to 14 dB was achieved on the surface in the frequency range of 200 to 1000 Hz. Next the concept was applied to the propeller problem where the sound signal contains many discrete tones at harmonics of the blade passage frequency. For this purpose, a prerecorded time history of a 1/10th scale model propeller was used to drive the primary source. An average noise reduction of about 15 dB was observed at the first two blade passage frequencies, and 12 dB and 5 dB reductions were observed at the 3rd and 4th blade passage frequencies, respectively. Finally, the active noise control concept was applied to a 1/10th scale propeller, installed in an anechoic chamber with flight simulation facility. A substantial amount of noise reduction was achieved on the model fuselage surface. Author

N86-12011*# Texas A&M Univ., College Station. Dept. of Aerospace Engineering.

A NUMERICAL METHOD OF CALCULATING PROPELLER NOISE INCLUDING ACOUSTIC NONLINEAR EFFECTS Abstract Only

K. D. KORKAN *In* NASA. Lewis Research Center Numerical Tech. in Acoustics p 9-10 Oct. 1985 refs

(Contract NAG3-354)

Avail: NTIS HC A03/MF A01 CSCL 20A

Using the transonic flow fields(s) generated by the NASPROP-E computer code for an eight blade SR3-series propeller, a theoretical method is investigated to calculate the total noise values and frequency content in the acoustic near and far field without using the Ffowcs Williams - Hawkings equation. The flow field is numerically generated using an implicit three dimensional Euler equation solver in weak conservation law form. Numerical damping is required by the differencing method for stability in three dimensions, and the influence of the damping on the calculated acoustic values is investigated. The acoustic near field is solved by integrating with respect to time the pressure oscillations induced at a stationary observer location. The acoustic far field is calculated from the near field primitive variables as generated by NASPROP-E computer code using a method involving a perturbation velocity potential as suggested by Hawkings in the calculation of the acoustic pressure time-history at a specified far field observed location. The methodologies described are valid for calculating total noise levels and are applicable to any propeller geometry for which a flow field solution is available. Author

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SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

A86-10274
THE BRAZILIAN AIRCRAFT INDUSTRY AND THE USE OF LAW AS A TOOL FOR DEVELOPMENT

B. M. CARL (Southern Methodist University, Dallas, TX) *Journal of Air Law and Commerce* (ISSN 0021-8642), vol. 50, no. 3-4, 1985, p: 513-586. Research supported by the Dana Foundation. refs

The innovative legal structure of Brazil's aircraft industry is discussed. The capitalizing of that industry through the mixed economy corporation and special techniques for marketing private shares are described, and the effect of these capital formation techniques are addressed. The production of Brazilian aircraft and the technology involved are discussed. The development of markets for the aircraft is addressed, including export incentives, and the relevance of these incentives for GATT rules and United States law is considered. C.D.

A86-10937#

TEACHING AND LEARNING CONCEPTUAL DESIGN IN THE CAD ERA GENERATING PROBLEMS AND INTEGRATING SOLUTIONS

E. TORENBEK (DELFT, Technische Hogeschool, Netherlands) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 7 p. refs (AIAA PAPER 85-3081)

Although universities are generally lagging behind the industry in adaptation of CAD techniques in preliminary aircraft design, they realize that changes in teaching methods are necessary. The paper describes a program undertaken at the Delft University of Technology to generate a pilot system for interactive computer-assisted conceptual aircraft design. A description is presented of the approach in designing the various major components of this system: geometry development, overall optimization and executive system, design analysis modules and technology data collection. Author

A86-10959#

GENERAL AVIATION COST EFFECTIVENESS

R. E. ETHERINGTON (Gates Learjet Corp., Wichita, KS) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Colorado Springs, CO, Oct. 14-16, 1985. 6 p. (AIAA PAPER 85-4029)

The General Aviation Industry has not recovered from the last economic recession in the robust manner of the industry's recovery in the 1970 time frame. Indeed, the recovery in the 1970's was so strong that the middle seventies slow down was hardly noticed. The General Aviation Industry has not recovered from the major recession of the early eighties as have the other major industries. This paper examines cost effectiveness of the General Aviation Aircraft and postulates a loss of cost effectiveness as one possible reason for the lack of recovery. A cursory look at the cost effectiveness of the aircraft in the early 70's versus the early 80's reveals a dramatic reduction in productivity represented by the index of cost per pound-mile of payload range. This reduction is well in excess of the inflation rate. This paper examines in some limited detail the causes of this loss in cost effectiveness. Author

A86-10972

COST AND SCHEDULE IMPLICATIONS OF MULTINATIONAL COPRODUCTION

M. D. RICH, W. L. STANLEY, and J. L. BIRKLER (Rand Corp., Santa Monica, CA) SAE, Aerospace Vehicle Requirements Conference, Washington, DC, May 20-23, 1985. 7 p. (SAE PAPER 851150)

The feasibility of multinational collaboration in connection with the acquisition of tactical weapon systems is being considered by both the United States and its European allies. Reasons for an interest in such a collaboration are related to the ever-rising cost of developing and producing weapon systems, a desire to standardize weapon systems used by North Atlantic Treaty Organization nations, a desire on the part of European members to improve their defense industrial capabilities, requirements for an equitable balance of defense hardware trade, and the growing number of European firms with suitable technical capacities. Taking into account, as an example, the F-16 fighter aircraft program, an analysis is conducted to assess the impact of coproduction on acquisition costs and schedules. It is found that European prices are competitive with U.S. prices for only about one-third of the part sets considered in a sample. Some guidelines are provided for lessening the inherent difficulties of collaboration. G.R.

N86-11089#

National Aerospace Lab., Amsterdam (Netherlands).

AEROSPAC²: RESEARCH AT NLR

1984 39 p Original contains color illustrations
Avail: NTIS HC A03/MF A01

The NLR fluid dynamics, flight, structures and materials, space, and engineering and technical services divisions activities are presented. Research covers wind tunnel tests, computational

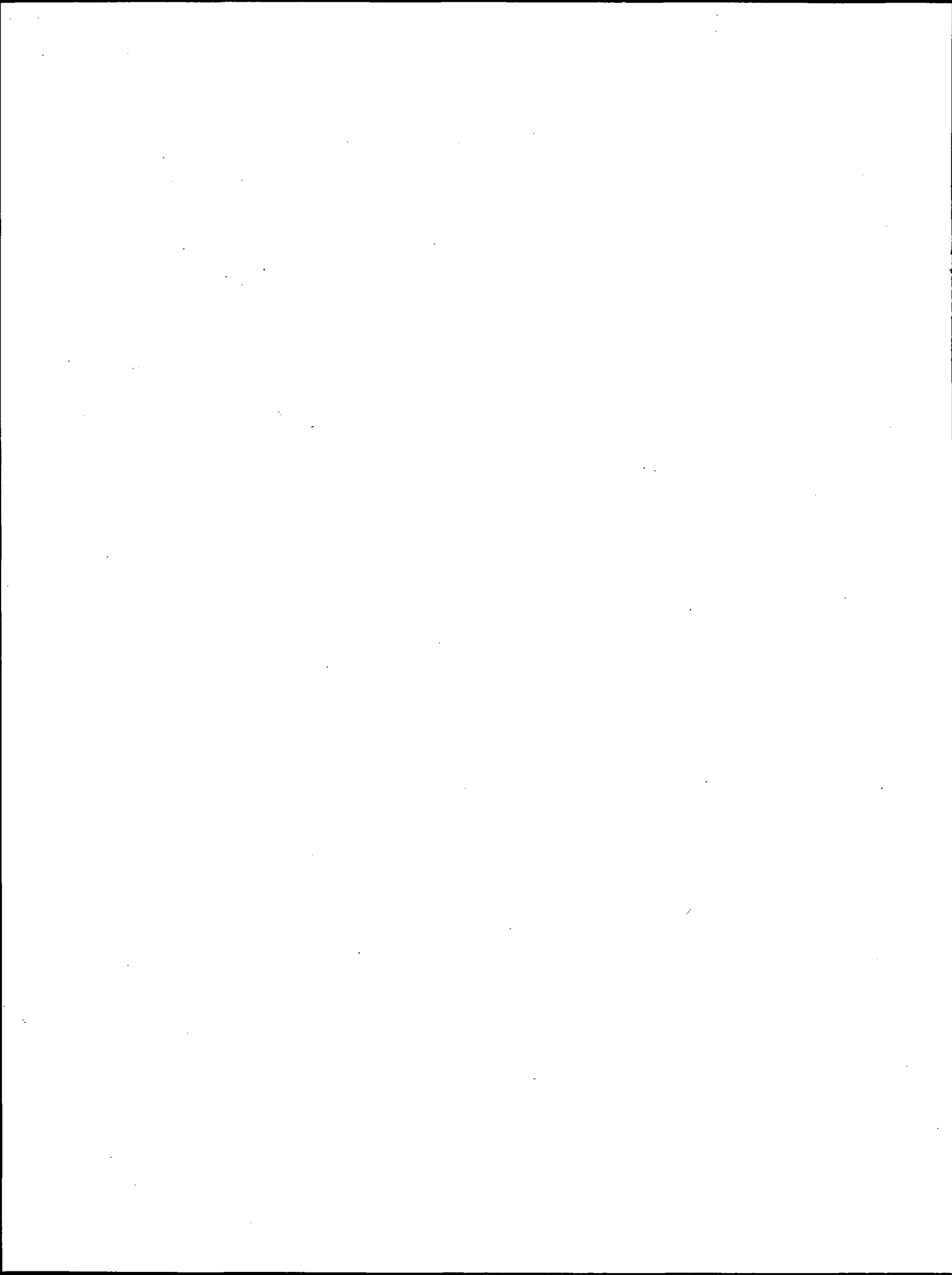
aerodynamics, unsteady aerodynamics, aeroacoustics, propulsion systems, flight tests, aircraft performance assessment, human factors engineering, aircraft structures, aircraft loads, fatigue and corrosion, engine tests, satellite attitude control and ground operations, microgravity effects, robotics, and signal processing. Author (ESA)

N86-12158*# National Academy of Sciences - National Research Council, Washington, D. C.

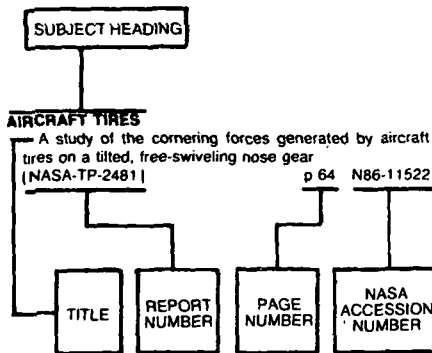
NASA-UNIVERSITIES RELATIONSHIPS IN AERO/SPACE ENGINEERING: A REVIEW OF NASA'S PROGRAM

1985 33 p refs
(NASA-CR-176307; NAS 1.26:176307) Avail: NTIS HC A03/MF A01 CSDL 051

NASA is concerned about the health of aerospace engineering departments at U.S. universities. The number of advanced degrees in aerospace engineering has declined. There is concern that universities' facilities, research equipment, and instrumentation may be aging or outmoded and therefore affect the quality of research and education. NASA requested that the National Research Council's Aeronautics and Space Engineering Board (ASEB) review NASA's support of universities and make recommendations to improve the program's effectiveness. G.L.C.



Typical Subject Index Listing



The subject heading is a key to the subject content of the document. The title is used to provide a description of the subject matter. When the title is insufficiently descriptive of the document content, the title extension is added, separated from the title by three hyphens. The (NASA or AIAA) accession number and the page number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document. Under any one subject heading, the accession numbers are arranged in sequence with the AIAA accession numbers appearing first.

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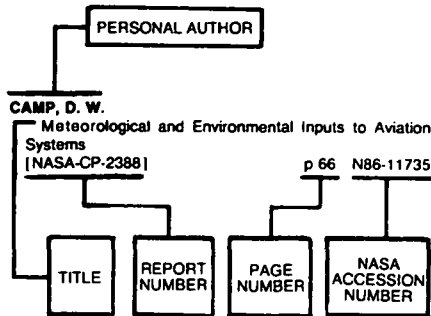
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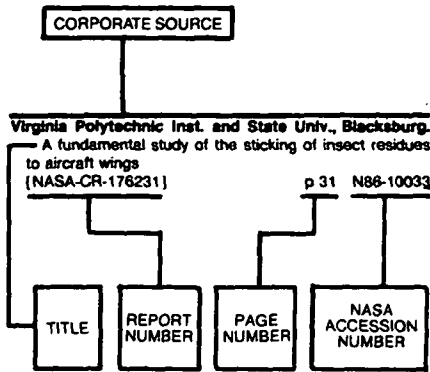
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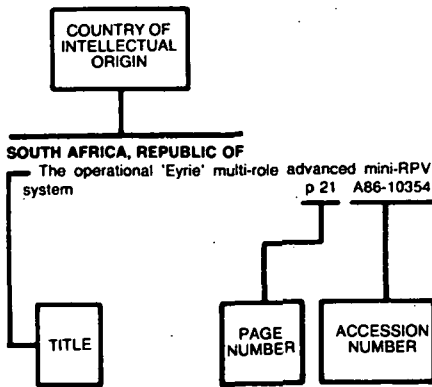
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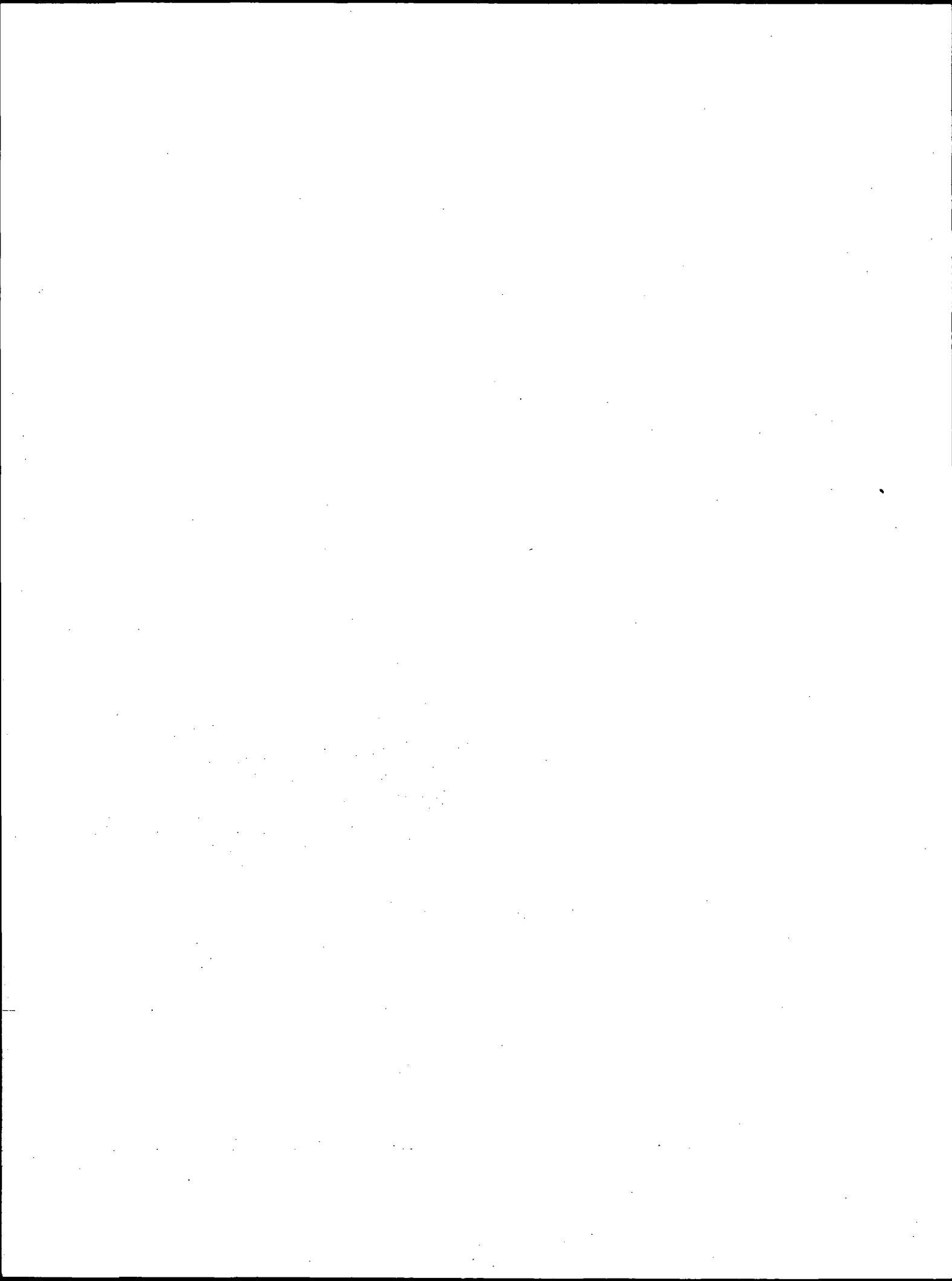
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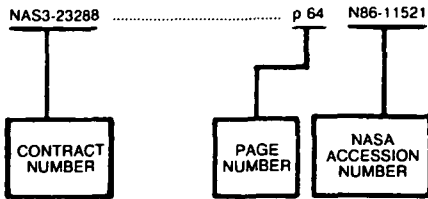
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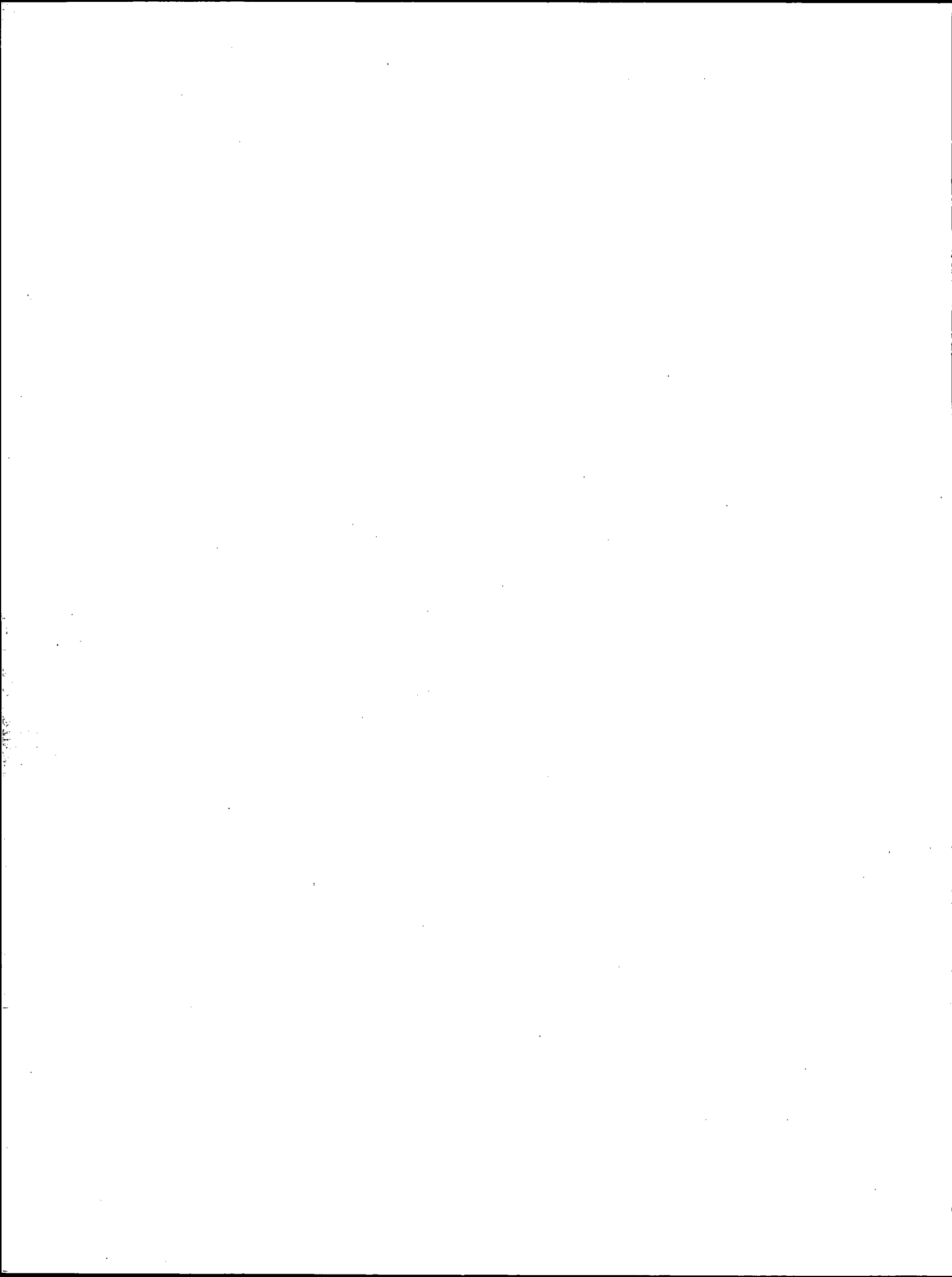


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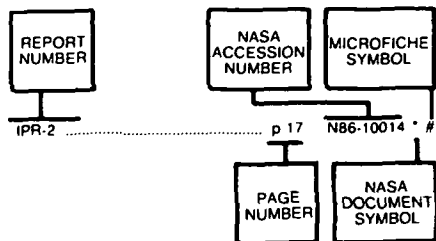
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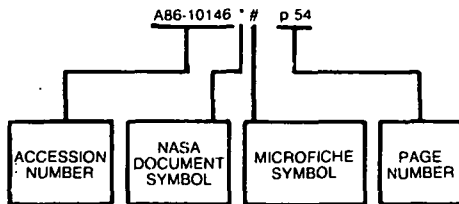
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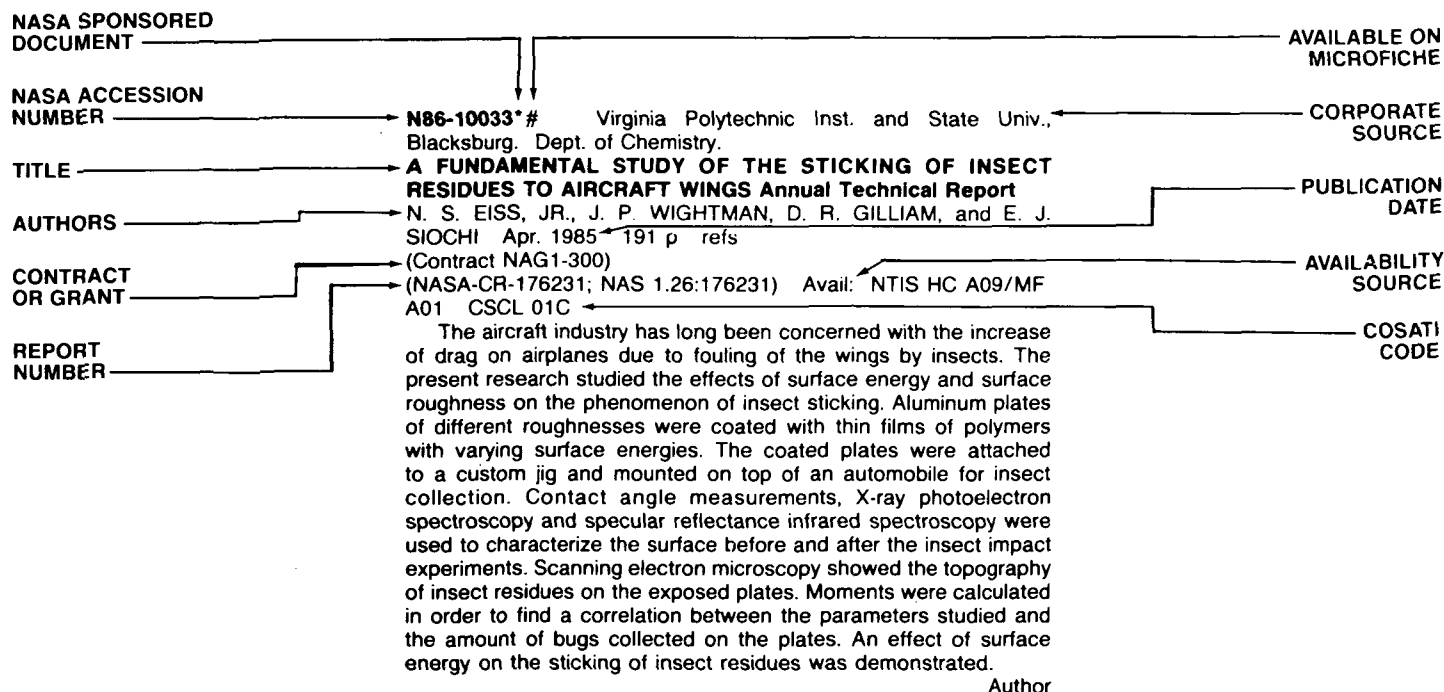
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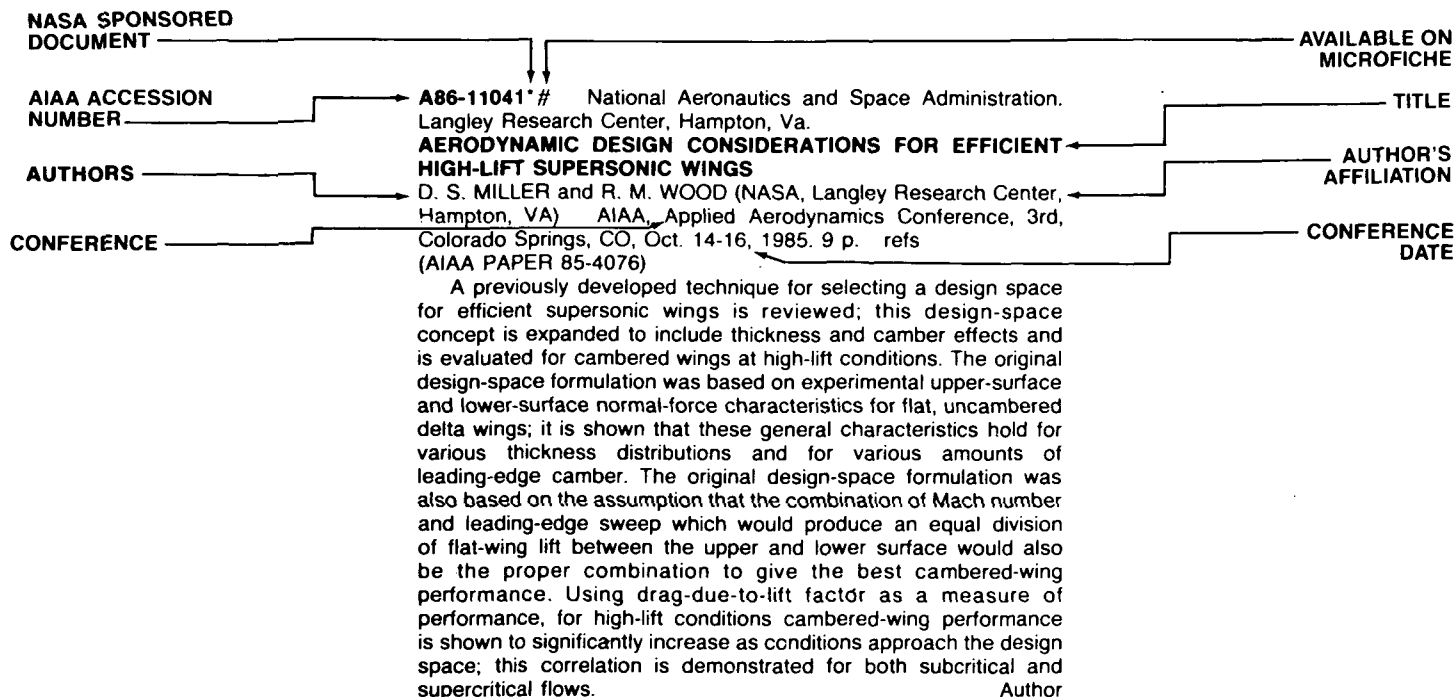
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