NASA SP-7037 (289)
March 1993

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

NASA STI PROGRAM
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National Aeronautics and Space Administration
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INTRODUCTION

This issue of *Aeronautical Engineering—A Continuing Bibliography* (NASA SP-7037) lists 792 reports, journal articles, and other documents recently announced in the NASA STI Database.

Accession numbers cited in this issue include:

Scientific and Technical Aerospace Reports (STAR) (N-10000 Series)	N93-12544 — N93-15658
International Aerospace Abstracts (IAA) (A-10000 Series)	A93-13741 — A93-17520

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 publication 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.

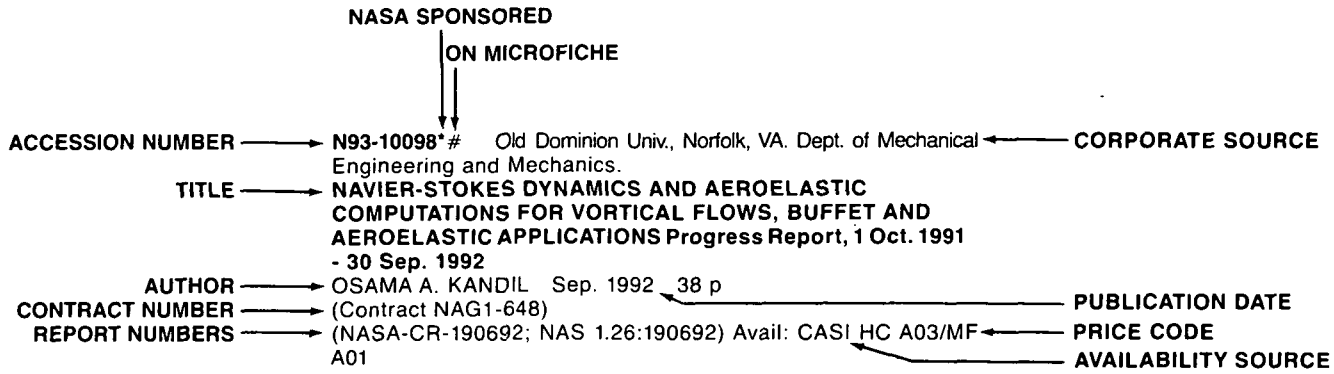
Seven indexes—subject, personal author, corporate source, foreign technology, contract number, report number, and accession number—are included.

A cumulative index for 1993 will be published in early 1994.

Information on availability of documents listed, addresses of organizations, and CASI price schedules are located at the back of this issue.

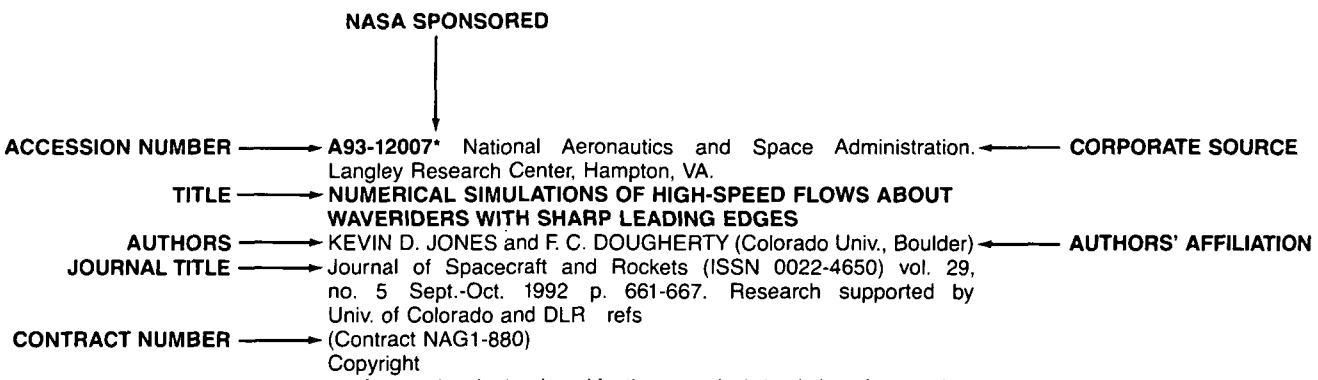
CONTENTS

TYPICAL REPORT CITATION AND ABSTRACT



The accomplishments achieved during the period include conference and proceedings publications, journal papers, and abstracts which are either published, accepted for publication or under review. Conference presentations and NASA highlight publications are also included. Two of the conference proceedings publications are attached along with a Ph.D. dissertation abstract and table of contents. In the first publication, computational simulation of three-dimensional flows around a delta wing undergoing rock and roll-divergence motions is presented. In the second publication, the unsteady Euler equations and the Euler equations of rigid body motion, both written in the moving frame of reference, are sequetially solved to simulate the limit-cycle rock motion of slender delta wings. In the dissertation abstract, unsteady flows around rigid or flexible delta wings with and without oscillating leading-edge flaps are considered. L.R.R.

TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT



A procedure is developed for the numerical simulation of stagnation-free inviscid supersonic and hypersonic flows about waveriders with sharp leading edges. The numerical approach involves the development of a specialized grid generator (named HYGRID), an algebraic solution-adaptive grid scheme, and a modified flow solving method. A comparison of the results obtained for several waverider geometries with exact solutions, other numerical solutions, and experimental results demonstrated the ability of the new procedure to produce stagnation-free Euler solutions about sharp-edged configurations and to describe the physics of the flow in these regions. I.S.

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 289)

March 1993

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AERONAUTICS (GENERAL)

A93-13957
MAINTAINABLE A330
J. M. RAMSDEN Aerospace (UK) (ISSN 0305-0831) vol. 19, no. 10 Oct. 1992 p. 12-15.
Copyright

The A330 has been designed with airline maintenance engineers 'in the loop' to advance the art of reliability. The maintenance architecture of the aircraft has been developed through an industry committee consisting of senior maintenance engineers of 14 airlines. Attention is given to the organizational meetings and the aircraft elements, the problem areas, and operational statistics that are continually reviewed and acted upon by the committee. R.E.P.

A93-14067
ANNUAL PAUL E. HEMKE LECTURE IN AEROSPACE ENGINEERING
MAX E. BLECK (Raytheon Co., Lexington, MA) AIAA Student Journal (ISSN 0001-1460) vol. 30, no. 3 Fall 1992 p. 20-27.
Copyright

Technological advances in areas including new materials, unusual aerodynamics configurations, lighting protection, avionics, and structural analysis are reviewed. It is concluded that general aviation is a fertile ground for the development of new technology in designing aircraft using new materials and configurations, expanding the boundaries of subsonic or supersonic business flight, or building the next generation of military trainers. O.G.

A93-14091
STARCH MEDIA BLASTING FOR AEROSPACE FINISHING APPLICATIONS
JOHN OESTREICH (Ogilvie Mills, Ltd., Montreal, Canada) and TODD PORTER Apr. 1992 9 p. SAE, Annual Aerospace/Airline Plating and Metal Finishing Forum and Exposition, 28th, San Diego, CA, Apr. 20-23, 1992 refs
(SAE PAPER 920948) Copyright

A wide range of starch blast media coating removal applications for the aerospace industry are reviewed with particular attention given to the coating removal technologies used in commercial and military aircraft maintenance. For commercial aircraft, these coating removal processes include processes for removing coatings from clad aluminum and from composites, removal of interior finishing coatings, and removal of structural and bonding adhesives. For military aircraft maintenance, the processes discussed include the coating removal from alumimun clad surfaces, and from composite parts. Consideration is also given to the removal of coatings and bonding adhesives as part of aircraft manufacture procedures. I.S.

A93-14092
LOCKHEED ADOPTS MEDIA BLAST DRY STRIPPING FOR THE C-130
ROBERT RAFFAELE (Lockheed Aircraft Service Co., Ontario, Canada) and ROBERT PAULI (Pauli & Griffin Co., Vacaville, CA) Apr. 1992 17 p. SAE, Annual Aerospace/Airline Plating and Metal Finishing Forum and Exposition, 28th, San Diego, CA, Apr. 20-23, 1992
(SAE PAPER 920949) Copyright

The evolution of plastic media blasting (PMB) which was implemented by the Lockheed Corporation is reviewed. Particular attention is given to a facility based on PMB that is capable of accepting a complete C-130 airframe. O.G.

A93-14112
COMMERCIAL AIRPLANE PRIMARY STRUCTURE
GARY S. BOSLEY (Boeing Co., Seattle, WA) Jan. 1992 8 p. Society of Manufacturing Engineers, Conference on Composites in Manufacturing '92, Anaheim, CA, Jan. 7, 8, 1992
(SME PAPER EM92-115) Copyright

A program for fabricating cost effective commercial aircraft primary structure is presented. Participation in a NASA program has shown that carbon/epoxy materials could save weight and serve well on commercial aircraft primary structure, but improved techniques and materials are needed to provide this structure at a cost that would be acceptable for commercial aircraft structure. R.E.P.

A93-14116
IN-SERVICE INSPECTION OF COMMERCIAL AIRCRAFT COMPOSITE STRUCTURE
LUKE PUCKETT (Boeing Commercial Airplane Group, Seattle, WA) Jan. 1992 15 p. Society of Manufacturing Engineers, Conference on Tooling for Composites '92, Anaheim, CA, Jan. 6, 7, 1992 refs
(SME PAPER EM92-124) Copyright

A review is presented of various methods for in-service inspection structures, e.g., visual examination, ultrasonic inspection, magnetic particle, and penetrant testing. Advanced inspection methods may rely more on wide-field inspection techniques including shearography or retro reflector imaging. R.E.P.

A93-14117
COUNTING THE COST OF COMPOSITES
GRAHAM WARWICK Flight International (ISSN 0015-3710) vol. 142, no. 4340 Oct. 14, 1992 p. 40-42.
Copyright

A review is presented of NASA's Advanced Composite Transport program and the manufacture of composite wing and fuselage sections utilizing the resin-transfer molding process. Attention is given to the composite content in today's commercial aircraft, and comparative weight saving versus cost in composite wings/non-composite wings. R.E.P.

A93-14151
ICAS, CONGRESS, 18TH, BEIJING, CHINA, SEPT. 20-25, 1992, PROCEEDINGS. VOLS. 1 & 2
Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. Vol. 1, 1171 p.; vol. 2, 1135 p.
(ISBN 1-56347-046-2) Copyright

The present conference on aeronautical sciences encompasses air traffic control, trajectory optimization, turbomachinery and propellers, CFD techniques, metal alloys, maintenance,

manufacturing technology, takeoff and landing, engine/airframe integration, high-temperature structures, inlets and nozzles, and aircraft design concepts. Other issues addressed are digital flight control aeroelastic analyses, passenger and crew safety, stability and control, navigation, fault-tolerant systems, hypersonic propulsion, transitional and turbulent flows, fatigue, structural dynamics, aerodynamics, combustion, noise, wind-tunnel technology, aeroelasticity and control, and structural testing methods. Specific issues addressed include over-wing propeller dynamics, automatic guidance and control for recovery of remotely piloted vehicles, flow characteristics of an S-shaped inlet at high incidence, the operating principles of hemispherical resonator gyros, and aeroservoelastic stability on aircraft. (For individual items see A93-14152 to A93-14420) C.C.S.

A93-14154
PROSPECTS FOR A SECOND GENERATION SUPERSONIC TRANSPORT
S. J. SWADLING (British Aerospace Airbus, Ltd., Bristol, United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, *Proceedings. Vol. 1* Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. LIV-LX.
Copyright

Existing supersonic transport technologies are reviewed to study the possibilities for a second-generation supersonic vehicle. The good payload and reliability characteristics of the Concorde are contrasted with the high noise levels, costs, and emissions problems associated with its operation. Second-generation supersonic transport should allow for: (1) satisfactory commercial return; (2) use of existing route patterns; and (3) and compliance with environmental requirements for noise and emissions. The requirements for developing such a second-generation aircraft include technological developments in the areas of aerodynamics, avionics, structures/materials, and powerplant. The paper concludes by emphasizing the feasibility of a successor to current supersonic transport as well as the neccessity of introducing an environmentally benign supersonic aircraft. C.C.S.

A93-14156
SPANISH-INDONESIAN COOPERATION IN THE DEVELOPMENT, PRODUCTION, CERTIFICATION AND MARKETING OF CN-235 COMMUTER AIRCRAFT
B. J. HABIBIE (Nusantara Aircraft Industries, Ltd., Bandung, Indonesia) and E. DE GUZMAN (Construcciones Aeronauticas, S.A., Madrid, Spain) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. LXX-LXXXII.
Copyright

The collaborative development and introduction of the CN-235 aircraft by a Spanish-Indonesiona consortium is examined with attention given to the motivations of each country. The program is based on the introduction of a Spanish aircraft into the international civil-transport market as well as the objective of industrial transformation in Indonesia. The commercial aircraft is based on a modified military transport aircraft, and various configurations of the proposed aircraft are illustrated. The characteristics of the engines under consideration for the aircraft are listed, and the proposed aircraft characteristics are given. The manufacturing scheme for the CN-235 structural components is broken down, and the international cooperative framework is shown to be conducive to Indonesian industrial transformation and international marketing of a Spanish aircraft. C.C.S.

A93-14183
ADVANCED TECHNOLOGIES AIRSHIPS
WINFIELD H. ARATA, JR. (Airship Development Corp., Santa Maria, CA) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 187-197.
Copyright

The abundance of new materials, processes, components and systems incorporating advanced technologies offer the airship designer many choices to improve mission capabilities, with resulting economic benefits. This paper highlights many of these available advanced technologies. In turn, a specific application for these technologies is presented. It must be mentioned that utilization of advanced technologies is a never-ending process. Thus, the airship designer is permitted to continue to incorporate improvements and upgrade air vehicles in a sequential manner.
Author

A93-14315
INVESTIGATION ON AIR REFUELING SCHEDULING
GUANXIN HONG (Beijing Univ. of Aeronautics and Astronautics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1299-1303. refs
Copyright

This paper considers air navigation, operations research, and optimization theory to define a methodology for optimizing the scheduling of air refueling. The method is developed assuming: (1) fixed takeoff states for the receiving aircraft; (2) determination of the tankers' original states by the schedule; (3) variable fuel consumption; and (4) fixed base positions for both tankers and receivers. The optimal refueling positions are evaluated by determining fuel required, possible refueling area, optimal refueling position, and by scheduling the tankers and receivers accordingly. The optimal scheduling technique is applied to an example with a tanker that has a waitline flight of 15 minutes. The results are shown to be of immediate practical application to existing air fleets. C.C.S.

A93-14659
THE APPLICATION OF HUMAN FACTORS ENGINEERING AT GENERAL ELECTRIC AIRCRAFT ENGINES
TIMOTHY J. SCANLON (GE Aircraft Engines, Cincinnati, OH) Apr. 1992 14 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992 refs
(SAE PAPER 921039) Copyright

Human factors engineering (HFE) techniques used by General Electric Aircraft Engines to analyze the engine-maintainer relationship and its impact on engine maintainability are described. This analysis performed during preliminary engine design makes it possible to specify HFE design criteria for incorporation into the system design. HFE analysis encompasses a broad spectrum of methodologies ranging from CAD systems with advanced HFE software to controlled dynamic simulations conducted with mockups, tooling, and subjects in ergonomic laboratories. It is concluded that incorporating HFE and maintainability in design is neccessary to offset rising maintenance costs, and to ensure maintainer compatability with the advanced propulsion and aicraft systems. O.G.

A93-14819 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
TILTROTOR RESEARCH AIRCRAFT COMPOSITE BLADE REPAIRS - LESSONS LEARNED
PAUL S. ESPINOSA and DAVID R. GROEPLER (NASA, Ames Research Center, Moffett Field, CA) Composites Engineering (ISSN 0961-9526) vol. 2, no. 5-7 1992 p. 477-495. Previously announced in STAR as N92-19563 refs
(Contract RTOP 505-61-51)
Copyright

The XV-15, N703NA Tiltrotor Research Aircraft located at the NASA Ames Research Center, Moffett Field, California, currently uses a set of composite rotor blades of complex shape known as the advanced technology blades (ATBs). The main structural element of the blades is a D-spar constructed of unidirectional, angled fiberglass/graphite, with the aft fairing portion of the blades constructed of a fiberglass cross-ply skin bonded to a Nomex honeycomb core. The blade tip is a removable laminate shell that fits over the outboard section of the spar structure, which contains a cavity to retain balance weights. Two types of tip shells are used for research. One is highly twisted (more than a conventional helicopter blade) and has a hollow core constructed of a thin

Nomex-honeycomb-and-fiberglass-skin sandwich; the other is untwisted with a solid Nomex honeycomb core and a fiberglass cross-ply skin. During initial flight testing of the blades, a number of problems in the composite structure were encountered. These problems included debonding between the fiberglass skin and the honeycomb core, failure of the honeycomb core, failures in fiberglass splices, cracks in fiberglass blocks, misalignment of mated composite parts, and failures of retention of metal fasteners. Substantial time was spent in identifying and repairing these problems. Discussed here are the types of problems encountered, the inspection procedures used to identify each problem, the repairs performed on the damaged or flawed areas, the level of criticality of the problems, and the monitoring of repaired areas. It is hoped that this discussion will help designers, analysts, and experimenters in the future as the use of composites becomes more prevalent. *Author*

A93-15054
ADVANCED TECHNOLOGY CONSTANT CHALLENGE AND EVOLUTIONARY PROCESS
DIETER SCHMITT (Airbus Industrie, Blagnac, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 145 1990 p. 17-24. Translation. Previously cited in issue 24, p. 3829, Accession no. A90-52699
Copyright

A93-15056
THE UNITED STATES IN THE CONQUEST OF THE HYPERSONIC [LES ETATS-UNIS A LA CONQUETE DE L'HYPERSONIQUE]
ALAIN ARNAUD (Ambassade de France aux Etats-Unis, Washington) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 145 1990 p. 41, 44, 45. In French.
Copyright
An overview is presented of the research and development efforts of the U.S.A. in its endeavor to produce the National Aerospace Plane. Attention is given to the work of the various government agencies involved in achieving this goal including DOD, DARPA, the U.S. Navy, the USAF, and NASA. The economic, industrial, and manufacturing aspects are considered in connection with the participation of the major aircraft and engine companies. R.E.P.

A93-15808
COMPOSITE WING RESULTS OF DEUTSCHE AIRBUS TECHNOLOGY PROGRAM
MICHAEL W. KOLAX (Deutsche Airbus GmbH, Hamburg, Germany) *In* International SAMPE Symposium and Exhibition, 37th, Anaheim, CA, Mar. 9-12, 1992, Proceedings Covina, CA Society for the Advancement of Material and Process Engineering 1992 p. 1146-1159. refs
Copyright
Customer complaints concerning high operating and maintenance costs associated with conventional wing structures have prompted a technology-development program aimed at composite wing manufacturing cost reduction, weight savings, and maintenance cost reduction through corrosion and fatigue prevention. Attention is being given to atmospheric pollution-related damage. An advanced wing box design for low manufacturing costs has been designed, though this is associated with certain weight penalties. An alternative design with 20-30 percent weight reduction has been evaluated. O.C.

A93-15810
THE PRODUCTION OF A MONOLITHIC CFRP FUSELAGE SKIN FOR THE EUROPEAN FIGHTER AIRCRAFT
J. KLENNER, F. GEIER, H. KRIEGELSTEIN, and K. REIMANN (MBB GmbH, Augsburg, Germany) *In* International SAMPE Symposium and Exhibition, 37th, Anaheim, CA, Mar. 9-12, 1992, Proceedings Covina, CA Society for the Advancement of Material and Process Engineering 1992 p. 1170-1183. refs
Copyright
This paper describes tooling and manufacturing concepts for a single-piece, integrally stiffened CFRP center fuselage skin. The main features of the structure are non-developable surface and a complex lightweight design. The component is built entirely from unidirectional carbon-fiber prepreg tape. The manufacturing processes applied result in a cost-effective, high-quality fabrication of stiffeners and skin, co-cured and net-moulded in an autoclave operation. Special emphasis is given to the laminating of the double curvature skin including extremely non-developable access door areas. Results achieved in a prototype production are presented as are the prospects for series application. Author

A93-17100
MANAGING MISTAKES
SIMON ELLIOTT Flight International (ISSN 0015-3710) vol. 142, no. 4343 Nov. 4, 1992 p. 47, 48, 50.
Copyright
An overview is presented of how airline-maintenance executives around the world minimize maintenance errors. The principal factors in controlling the impact of human elements in aircraft maintenance include basic training, refresher training, guaranteeing appropriate levels of certification of staff and engineers, and identifying areas of recurring problems. Attention is given to the adoption of total quality management concepts to improve overall efficiency and to insure that all levels of maintenance-involved personnel are thoroughly briefed. R.E.P.

N93-13025*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FUTURE REGIONAL TRANSPORT AIRCRAFT MARKET, CONSTRAINTS, AND TECHNOLOGY STIMULI
W. DON HARVEY and BRENT FOREMAN (Auburn Univ., AL.) Oct. 1992 89 p
(Contract RTOP 505-69-20-01)
(NASA-TM-107669; NAS 1.15:107669) Avail: CASI HC A05/MF A01
This report provides updated information on the current market and operating environment and identifies interlinking technical possibilities for competitive future commuter-type transport aircraft. The conclusions on the market and operating environment indicate that the regional airlines are moving toward more modern and effective fleets with greater passenger capacity and comfort, reduced noise levels, increased speed, and longer range. This direction leads to a nearly 'seamless' service and continued code-sharing agreements with the major carriers. Whereas the benefits from individual technologies may be small, the overall integration in existing and new aircraft designs can produce improvements in direct operating cost and competitiveness. Production costs are identified as being equally important as pure technical advances. *Author*

N93-13110*# National Aeronautics and Space Administration, Washington, DC.
NASA AERONAUTICS: RESEARCH AND TECHNOLOGY PROGRAM HIGHLIGHTS
1990 77 p LIMITED REPRODUCIBILITY: More than 20 percent of this document may be affected by color photographs Original contains color illustrations
(NASA-NP-159; NAS 1.83:159) Avail: CASI HC A05/MF A01; 44 functional color pages
This report contains numerous color illustrations to describe the NASA programs in aeronautics. The basic ideas involved are explained in brief paragraphs. The seven chapters deal with Subsonic aircraft, High-speed transport, High-performance military aircraft, Hypersonic/Transatmospheric vehicles, Critical disciplines, National facilities and Organizations & installations. Some individual aircraft discussed are : the SR-71 aircraft, aerospace planes, the high-speed civil transport (HSCT), the X-29 forward-swept wing research aircraft, and the X-31 aircraft. Critical disciplines discussed are numerical aerodynamic simulation, computational fluid dynamics, computational structural dynamics and new experimental testing techniques. R.L.B.

N93-13946# Air Force Inst. of Tech., Wright-Patterson AFB, OH. Foreign Aerospace Science and Technology Center.
ACTA AERONAUTICA ET ASTRONAUTICA SINICA (SELECTED ARTICLES)
7 Apr. 1992 36 p Transl. into ENGLISH from Hangong Xuebao (China), v. 12, no. 3, 1991 p 167-172 and 173-179
(AD-A255070; FASTC-ID(RS)T-0608-91) Avail: CASI HC A03/MF A01

This article introduces the use of a compensation type of non-coherent model sidelobe suppression filter (SSF) and actually develops the theoretical calculations and experimental results associated with 13 place Barker code pulse compression sidelobe suppression. Compensation type non-coherent models of SSF opt for the use of least square approximate inverse filtering techniques for designs if the subpulse width is 0.7 microsec and the peak sidelobe values do not exceed -30dB. This type of SSF Doppler tolerance is capable of reaching -40 kHz to +40 kHz. Theoretical calculations and experimental results both clearly show that compensation type non-coherent model SSF which have been designed have associated with them Doppler tolerances which, as compared to R-G-1 SSF series which possess the same type of length impact excitation effects, are a clear improvement.
GRA

N93-14102*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AN ALGEBRAIC TURBULENCE MODEL FOR THREE-DIMENSIONAL VISCOUS FLOWS
R. V. CHIMA, P. W. GIEL (Sverdrup Technology, Inc., Brook Park, OH.), and R. J. BOYLE Jan. 1993 11 p Proposed for presentation at the 31st Aerospace Sciences Meeting and Exhibit, Reno, NV, 11-14 Jan. 1993; sponsored by AIAA
(Contract RTOP 535-05-10)
(NASA-TM-105931; E-7442; NAS 1.15:105931) Copyright Avail: CASI HC A03/MF A01

An algebraic turbulence model is proposed for use with three-dimensional Navier-Stokes analyses. It incorporates features of both the Baldwin-Lomax and Cebeci-Smith models. The Baldwin-Lomax model uses the maximum of a function f(y) to determine length and velocity scales. An analysis of the Baldwin-Lomax model shows that f(y) can have a spurious maximum close to the wall, causing numerical problems and non-physical results. The proposed model uses integral relations to determine delta(*) u(sub e) and delta used in the Cebeci-Smith mode. It eliminates a constant in the Baldwin-Lomax model and determines the two remaining constants by comparison to the Cebeci-Smith formulation. Pressure gradient effects, a new wake model, and the implementation of these features in a three-dimensional Navier-Stokes code are also described. Results are shown for a flat plate boundary layer, an annular turbine cascade, and endwall heat transfer in a linear turbine cascade. The heat transfer results agree well with experimental data which shows large variations in endwall Stanton number contours with Reynolds number.
Author

N93-14549# Wright Lab., Wright-Patterson AFB, OH.
PROCEEDINGS OF THE USAF STRUCTURAL INTEGRITY PROGRAM Final Report, 2-6 Dec. 1991
THOMAS D. COOPER and JOHN W. LINCOLN Jul. 1992 787 p Conference held in San Antonio, TX, 2-6 December 1991
(Contract AF PROJ. 2418)
(AD-A255379; WL-TR-92-4045) Avail: CASI HC A99/MF A10

This report is a compilation of the papers presented at the 1991 USAF Structural Integrity Program Conference held at the Hyatt Regency, San Antonio, Texas on 2-6 December 1991.
GRA

N93-15158# Societe Francaise d'Instruments de Mesure, Massy (France).
GROUND SUPPORT EQUIPMENT (GSE) FOR AIRCRAFT CONDITION MONITORING SYSTEM (ACMS) [DIE BODENSTATION (GSE) FUER DAS FLUGZEUGUEBERWACHUNGSSYSTEM (ACMS)]
A. LEVIONNOIS *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 115-128 Jan. 1992 Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

The purpose of the GSE (Ground Support Equipment) in aircraft and engine maintenance is outlined and a general description of Aircraft Condition Monitoring (ACM) systems is given. Information on the following is also given: GSE software, fleet management, programmation of the data management unit, smart access recorder data decompression ADEPT and APM interface, user management, hardware, and sofware requirements.
ESA

N93-15181# Framasys A.G., Zurich (Switzerland).
FAILURE DIAGNOSTIC WITH MAINTEX BASED ON AIMS AT SWISSAIR [STOERUNGSDIAGNOSE MIT MAINTEX BASIEREND AUF AIMS BEI SWISSAIR]
R. OTTIGER *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 557-566 Jan. 1992 Avail: CASI HC A02/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

Aircraft Integrated Monitoring Systems (AIMS) generate airborne data on system and component failure that often need to be interpreted by human experts as symptoms to localize and resolve the real cause of a superior problem. The adequate handling of the information requires great problem handling skills and experience. As trouble shooting experts are very rare and expensive, Swissair decided to build ground based diagnostic systems, as an essential complement to AIMS. MAINTEX diagnostic systems that use the information of AIMS according to the experience and knowhow of the best experts, guarantee good returns in investment: diagnosticians are more efficient, aircrafts spend less time on the ground and maintenance is optimized.
ESA

N93-15185# MicroNet, Celle (Germany).
PERSONAL COMPUTER BASED TEST- AND EMULATION EQUIPMENT FOR MAINTENANCE AND GROUND SUPPORT [TESTGERAETE UND EMULATOREN AUF PERSONAL-COMPUTERBASIS FUER DIE WARTUNG UND DEN 'GROUND SUPPORT']
ANTON BADER *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 629-646 Jan. 1992 Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

A modular, very powerful and versatile Aircraft Integrated Monitoring System (AIMS), based on a parallel and a personal computer, is described. Details of its requirements, architecture and hardware are given. The architecture and principles of the ARINC bus and data processing interfaces are shown plus the applied technique of ARINC data acquisition and simulation with the help of a simple personal computer.
ESA

N93-15573*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
VIBRATION ISOLATION TECHNOLOGY: AN EXECUTIVE SUMMARY OF SYSTEMS DEVELOPMENT AND DEMONSTRATION
CARLOS M. GRODSINSKY, KIRK A. LOGSDON, and JOSEPH F. LUBOMSKI Jan. 1993 7 p Presented at the 31st Aerospace Sciences Meeting, Reno, NV, 11-14 Jan. 1993; sponsored by American Association of Aeronautics and Astronautics
(Contract RTOP 694-03-0C)
(NASA-TM-105937; E-7454; NAS 1.15:105937) Avail: CASI HC A02/MF A01

A program was organized to develop the enabling technologies needed for the use of Space Station Freedom as a viable microgravity experimental platform. One of these development programs was the Vibration Isolation Technology (VIT). This technology development program grew because of increased awareness that the acceleration disturbances present on the Space Transportation System (STS) orbiter can and are detrimental to many microgravity experiments proposed for STS, and in the future, Space Station Freedom (SSF). Overall technological organization

are covered of the VIT program. Emphasis is given to the results from development and demonstration of enabling technologies to achieve the acceleration requirements perceived as those most likely needed for a variety of microgravity science experiments. In so doing, a brief summary of general theoretical approaches to controlling the acceleration environment of an isolated space based payload and the design and/or performance of two prototype six degree of freedom active magnetic isolation systems is presented. Author

02

AERODYNAMICS

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

A93-13945
CONDENSATION OF NITROGEN IN HYPERSONIC FLOWS - MEASUREMENTS CONFIRM A THEORETICAL MODEL [KONDENSATION VON STICKSTOFF IN HYPERSCHALLSTROEMUNGEN - MESSUNGEN BESTAETIGEN EIN THEORETISCHES MODELL]
BENT FRITSCHE, ANDREAS DILLMANN, and CARL DANKERT (DLR, Inst. fuer Experimentelle Stroemungsmechanik, Goettingen, Germany) DLR-Nachrichten (ISSN 0937-0420) no. 68 Aug. 1992 p. 2-5. In German.
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A new nucleation theory describing nitrogen condensation in hypersonic flows is summarized and compared with conventional theories. A recently developed measurement method which confirms the theory is briefly described. The method is disturbance-free and covers the whole flow field. Condensation can be photographed directly and the measurement is considerably faster than other methods. C.D.

A93-14078
INFLUENCE OF TRAILING-EDGE GRID STRUCTURE ON NAVIER-STOKES COMPUTATION OF TURBOMACHINERY CASCADE FLOW
HEE-TAEG CHUNG and JE-HYUN BAEK (Pohang Inst. of Science and Technology, Republic of Korea) International Journal for Numerical Methods in Fluids (ISSN 0271-2091) vol. 15, no. 8 Oct. 30, 1992 p. 883-894. refs
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Three kinds of grid system based on C-type grid are examined in order to reveal their relative flow characteristics of the turbomachinery cascade, especially near the trailing edge and wake. Here, a semi-conservative interpolation technique to treat the discontinuous boundary condition along the periodic boundary is proposed and is applied on the patched-type grid structure. Computational results are presented to see the influence of trailing-edge grid structure on the Navier-Stokes solutions for the high-turning transonic turbine cascade. Author

A93-14080
NUMERICAL SOLUTION OF TRANSONIC FULL-POTENTIAL-EQUIVALENT EQUATIONS IN VON MISES CO-ORDINATES
C.-F. AN and R. M. BARRON (Windsor Univ., Canada) International Journal for Numerical Methods in Fluids (ISSN 0271-2091) vol. 15, no. 8 Oct. 30, 1992 p. 925-952. Research supported by NSERC refs
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In this paper a new approach to calculate transonic flows is developed. A set of full-potential-equivalent equations in the von Mises co-ordinate system is formulated under the irrotationality and isentropic assumptions. The emphasis is placed on supercritical flow, in which the treatment of embedded shock waves is crucial to get convergent solutions. Shock jump conditions are employed and shock point operators (SPOs) are constructed in the body-fitting streamline co-ordinate system. SPOs and a type-dependent difference scheme are applied to solve the 'main' equation for the 'main' variable, the streamline ordinate y. A number of 'secondary' equations are deduced for the corresponding 'secondary' variables. An optimal combination for the 'secondary' variable, its equation and related difference scheme is selected to be the generalized density R, its linear equation and the Crank-Nicolson scheme. Numerical results show that the present approach gives good agreement with experimental data and other computational work for NACA0012 and biconvex aerofoils in both subcritical and supercritical ranges. Author

A93-14118# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EVALUATION AND APPLICATION OF THE BALDWIN-LOMAX TURBULENCE MODEL IN TWO-DIMENSIONAL, UNSTEADY, COMPRESSIBLE BOUNDARY LAYERS WITH AND WITHOUT SEPARATION IN ENGINE INLETS
BARBARA SAKOWSKI, DOUGLAS DARLING (NASA, Lewis Research Center, Cleveland, OH), ROBERT L. ROACH (Georgia Inst. of Technology, Atlanta), and ALLAN VAN DE WALL (Case Western Reserve Univ., Cleveland, OH) Jul. 1992 10 p. AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992 Previously announced in STAR as N93-10087 refs
(Contract RTOP 505-62-20)
(AIAA PAPER 92-3676) Copyright

The Baldwin-Lomax model is used in many CFD codes because it is quick and easy to implement. In this paper, we discuss implementing the Baldwin-Lomax turbulence model for both steady and unsteady compressible flows. In addition, these flows may be either separated or attached. In order to apply this turbulence model to flows which may be subjected to these conditions, certain modifications should be made to the original Baldwin-Lomax model. We discuss these modifications and determine whether the Baldwin-Lomax model is a viable turbulence model that produces reasonably accurate results for high speed flows that can be found in engine inlets. Author

A93-14120* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
FLUID/CHEMISTRY MODELING FOR HYPERSONIC FLIGHT ANALYSIS
THOMAS A. EDWARDS (NASA, Ames Research Center, Moffett Field, CA) Computers and Mathematics with Applications (ISSN 0097-4943) vol. 24, no. 5-6 1992 p. 25-36. refs
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Design studies are underway for a variety of hypersonic flight vehicles. The National Aero-Space Plane will provide a reusable, single-stage-to-orbit capability for routine access to low earth orbit. Flight-capable satellites will dip into the atmosphere to maneuver to new orbits, while planetary probes will decelerate at their destination by atmospheric aerobraking. To supplement limited experimental capabilities in the hypersonic regime, computational fluid dynamics is being used to analyze the flow about these configurations. The governing equations include fluid dynamic as well as chemical species equations, which are being solved with new, robust numerical algorithms. Examples of CFD applications to hypersonic vehicles suggest an important role this technology will play in the development of future aerospace systems. The computational resources needed to obtain solutions are large, but solution-adaptive grids, convergence acceleration, and parallel processing may make run times manageable. Author

A93-14152
VORTEX CONTROL TECHNOLOGY
F. G. ZHUANG *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. XXXI-XLI. Research supported by NNSFC refs
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The generation of vorticity is reviewed with attention given to

the direct and indirect modification of vortex flow for producing specific interference effects. The modification techniques discussed include blowing, geometric variation, and acoustic excitation, with emphasis given to the use of unsteady excitations for inducing dynamic stall delay and steady streaming. Steady vortex-control methods include strake, vortex flaps, and mass injection. Unsteady methods examined include airfoil-control techniques such as airfoil pitch oscillation, control of vortex wake behind bluff bodies, and motion induced in a partial wall boundary. Also useful are techniques involving the excitation with flow-perturbation devices including: (1) the use of spoilerlike flaps; (2) acoustic excitation; and (3) active surface heating. C.C.S.

A93-14165
NUMERICAL ANALYSIS OF THREE-DIMENSIONAL VISCOUS FLOWS AROUND AN ADVANCED COUNTERROTATING PROPELLER
YUICHI MATSUO and SHIGERU SAITO (National Aerospace Lab., Chofu, Japan) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 55-60. refs
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Three-dimensional viscous flows around an advanced counterrotating propeller are investigated by solving unsteady Navier-Stokes equations. An efficient solution procedure has been developed and applied. The solver is originally based on an implicit finite difference method, and also uses unsteady algorithm, block structured grid system and sliding boundary technique in order to treat the relative motion between fore and aft rotors. Numerical results are presented for transonic flow of cruise flight and low-speed flow of take-off. Predicted aerodynamic loadings at take-off are compared with experimental data. Author

A93-14166
NUMERICAL INVESTIGATION OF THE UNSTEADY FLOW THROUGH A COUNTER-ROTATING FAN
K. ENGEL, M. FADEN, and S. POKORNY (DLR, Inst. fuer Antriebstechnik, Cologne, Germany) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 61-67. refs
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In this paper an interactive flow simulation system for the theoretical investigation of unsteady flow phenomena in turbomachinery components is presented. The numerical methods employed for the solution of the time dependent Euler equations, the entry and exit boundary formulations and the coupling procedure for relatively moving grids are described. The application of the system on the simulation of the start-up and acceleration process of two relatively moving cascades is illustrated by figures showing pressure contours at different time levels. Author

A93-14167
NUMERICAL COMPUTATIONS OF TURBOMACHINERY CASCADE TURBULENT FLOWS WITH SHOCKS BY USING MULTIGRID SCHEME
NAIXING CHEN, XIAOQING ZHENG, and YANJI XU (Chinese Academy of Sciences, Inst. of Engineering Thermophysics, Beijing, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 68-76. Research supported by NNSFC refs
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An analytical technique is derived for solving 2D steady transonic flows in cascades typical of turbomachinery flows. The 2D Reynolds-averaged Navier-Stokes equations are given in the finite-volume formulation, and attention is given to the turbulence term and the expression of the viscous terms. The time-marching explicit finite-volume method is applied to a multigrid scheme which solves the Navier-Stokes and Euler expressions simultaneously. The viscous terms are treated in an analogy of a staffs-springs system in which a body-fitted coordinate system with normal coordinate lines to the walls is employed. Numerical solutions are presented for two hypothetical cascade flows with similar experimental counterparts, and the data are found to agree generally. The method is of use in the analysis of both 2D and 3D cascade flows in turbomachinery for a range of conditions. C.C.S.

A93-14169 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE NEW CHALLENGE OF COMPUTATIONAL AEROSCIENCE
F. R. BAILEY (NASA, Ames Research Center, Moffett Field, CA), DOUGLAS L. DWOYER (NASA, Langley Research Center, Hampton, VA), and LESTER D. NICHOLS (NASA, Lewis Research Center, Cleveland, OH) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 83-96. refs

This paper discusses NASA's Computational Aerosciences (CAS) Project of the High Performance Computing and Communications Program (HPCCP). The project is aimed at developing advanced, multidisciplinary simulation capabilities for aerospace vehicle and propulsion system design. It is also aimed at overcoming computational performance barriers by accelerating the development of parallel computer technology. The goals and approach of the CAS Project are described and the challenges to its implementation are addressed. Specific vehicle class simulations to be demonstrated and the principal mutidisciplinary modeling approaches to be emphasized are described. The computational speed and memory requirements for representative multidisciplinary applications are estimated. Finally, the state of parallel computer technology including programming issues and the results of performance measurements are explored. Author

A93-14170
NOZZLE FLOW COMPUTATIONS USING THE EULER EQUATIONS
JOAO L. F. AZEVEDO, NIDE G. C. R. FICO, JR. (Centro Tecnico Aeroespacial, Inst. de Aeronautica e Espaco, Sao Jose dos Campos, Brazil), MARCOS A. ORTEGA, and GUILHERME C. LUNA (Centro Tecnico Aeroespacial, Inst. Tecnologico de Aeronautica, Sao Jose dos Campos, Brazil) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 97-107. Research supported by CNPq and Conselho Nacional de Desenvolvimento Cientifico e Tecnologico refs
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Inviscid, transonic, convergent-divergent nozzle flowfields are simulated using the Beam and Warming implicit approximate factorizatin alogorithm. Both two-dimensional and axisymmetric nozzle configurations are considered. Nonlinear artificial dissipation terms are explicitly added, and variable time stepping is used for steady state convergence acceleration. A procedure for using one-dimensional characteristic relations for boundary condition enforcement in the axisymmetric case was developed and implemented. Studies of several numerical boundary condition effects on solution accuracy and convergence rate were performed. The algorithm proved to be very robust, and solutions on rather realistic nozzle configurations were obtained. Present computational results show good agreement with the available data. The algorithm with the variable time stepping option proved to be computationally efficient. Author

A93-14171
NAVIER-STOKES CALCULATIONS OF THE FLOW ABOUT WING-FLAP COMBINATIONS
A. KOGAN and S. MAROM (Israel Aircraft Industries, Ltd., Tashan Engineering Center, Tel Aviv) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 108-121. refs
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The Baldwin-Lomax turbulence model incorporated into the Navier-Stokes code FIDAP is used to calculate C(L) vs. alpha curves for wing-flap combinations up to C(Lmax). Tuning the penalty

and upwinding parameters results in still better agreement with experiments. The agreement with experiments depends on the test conditions such as suction and blowing. The agreement of computed and experimental Cp for a laminar multielement at 1.5 Re is reasonable at the same C(L). The discrepancy between computed and experimental alpha increases with C(L). For 1 million Re we use a procedure to compute bubble development and Cp. Whenever possible, results are compared to experiments and the agreement is reasonable. Author

A93-14172
AERODYNAMIC CHARACTERISTICS OF TRANSPORT AIRPLANES IN LOW SPEED CONFIGURATION
R. MARTINEZ-VAL, T. MUNOZ, E. PEREZ, and J. SANTO-TOMAS (Escuela Tecnica Superior de Ingenieros Aeronauticos, Madrid, Spain) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 122-129. Research supported by Construcciones Aeronauticas, S.A. and Univ. Politecnica de Madrid refs

A method is devised for computing the variation of aerodynamic characteristics of transport aircraft due to the deployment of high-lift devices. A analytical prediction technique is described and employed to determine the aerodynamic characteristics of aircraft at low speeds based on aerodynamic data of a clean configuration. Semiempirical models for 2D configurations are adapted to aft-loaded airfoils, and lifting-surface theory is incorporated to compute lift, induced drag, and pitching moment of the wing airfoil sections. The data are smoothed for spanwise discontinuities, and the results are given for such values as parasite drag and downwash effects. The computations give the aerodynamic effects of the aircraft at low speeds and permit the analysis of the efficiencies of different leading-edge combinations as well as the study of achievable lift/drag characteristics for takeoff configurations. C.C.S.

A93-14189
OVER WING PROPELLER AERODYNAMICS
R. K. COOPER, W. J. MCCANN, and A. Q. CHAPLEO (Belfast Queen's Univ., United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 266-273. refs

The over-wing propeller configuration is studied using experimental and theoretical methods. The aim is to gain an understanding of the interaction between the propeller and wing, including the effect of trailing edge flap deflection. The numerical panel method and wind tunnel experiments showed that both lift increase and drag reduction are produced for a range of propeller positions. The maximum increment in lift coefficient occurred with the propeller at the trailing edge and the tip close to the surface. Maximum reductions in drag coefficient were obtained with the propeller in the range 0.4 to 0.6 chord, depending on wing incidence and flap angle. Author

A93-14190
A STUDY OF PROPELLER/WING INTERACTION INCLUDING THE EFFECT OF GROUND PROXIMITY
A. P. HARRIS and D. W. HURST (Southampton Univ., United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 274-285. Research supported by Department of Trade and Industry refs

Tests have been carried out on a propeller/nacelle/wing combination in the 3.5m x 2.6m low speed wind tunnel at the University of Southampton. Wing surface pressure distributions were measured both inside and outside of the propeller slipstream and also with the propeller blades removed. The wing was tested in a clean configuration and a high lift configuration with leading edge slat and single slotted trailing edge flap. In addition, the high lift configuration was tested at a ground clearance representative of full-scale aircraft in take-off or landing conditions. The propeller swirl caused an asymmetric loading on the clean wing. In the high lift configuration the leading edge slat significantly reduced this swirl effect over the wing. In ground effect an increase in lift occurred on the model. Approximately the same percentage increase was found to occur inside and outside of the propeller slipstream. Unsteady and time-averaged velocity measurements were acquired in the flowfield using a laser Doppler anemometer. A low order panel method was used which gave satisfactory results for both the clean and high lift wing configurations with the propeller blades removed. Author

A93-14191
CALCULATION OF TRANSONIC VISCOUS FLOW AROUND A DELTA WING
SEPPO LAINE, TIMO SIIKONEN, and PETRI KAURINKOSKI (Helsinki Univ. of Technology, Espoo, Finland) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 286-295. refs

Transonic viscous flow past a round leading edge cropped delta wing is determined by solving the Reynolds-averaged thin-layer Navier-Stokes equations. Three algebraic turbulence models are used and laminar flow is also calculated. In the calculations, the angle of attack varies between 10 and 40 degrees. The Mach number is 0.85 and the Reynolds number based on the root chord is 2.38 x 10 exp 6. The results are compared with experiments. Author

A93-14192
MULTIZONE NAVIER-STOKES COMPUTATIONS FOR A TRANSONIC PROJECTILE USING MACCORMACK FINITE DIFFERENCE METHOD
TZU-CHANG CHEN and CHING-CHANG CHIENG (National Tsing Hua Univ., Hsinchu, Taiwan) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 296-301. refs

MacCormack's explicit and unsplit method is employed on a multizone overlap grid system to predict the transonic, turbulent flowfield around an axisymmetric projectile at zero angle of attack. The computational results compared with wind tunnel measurements of boundary layer surveys. Two different grid systems are modeled: the projectile with the flat base as the actual projectile and the projectile with the extended boattail as a simplified model. The computational results show that the agreement with experiment can be obtained and convergence is significantly improved if the locally varying time step proposed by Kunz (1991) is employed. Author

A93-14193
ACCELERATED METHOD OF THE EULER EQUATION SOLUTION IN TRANSONIC AIRFOIL FLOW PROBLEM
S. V. LIAPUNOV (TsAGI, Zhukovski, Russia) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 302-308. refs

An efficient approximate method of the Euler equation solution is developed. The present method makes it possible to accelerate the airfoil flow calculation 10 to 20 times as compared to the direct Euler equation solution and its speed is practically the same as the speed of the potential equation solution methods. The method needs only minor modifications of the existent numerical methods for the solution of the potential equation. The comparison of the results with the direct Euler equation solution shows a satisfactory agreement both for the distributed and total aerodynamic characteristics up to the formation of strong shock waves when the potential flow model gives essentially wrong results. Author

A93-14210
INLET DESIGN USING A BLEND OF EXPERIMENTAL AND COMPUTATIONAL TECHNIQUES
J. G. MASON, B. W. FARQUHAR, A. J. BOOKER, and R. E. MOODY (Boeing Co., Seattle, WA) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 445-454. refs

The objective of this study was to use a designed experiment to optimize an aircraft gas turbine inlet for all critical operating conditions. The designed experiment achieved an optimum inlet design through the use of an orthogonal array that dictated how the shape variables were combined to arrive at a set of experimental inlets. These inlet shapes were then analyzed by a computational fluid dynamics (CFD) code and rated as to their merit. The 'criterion of goodness', also called the response, was the peak Mach number occurring on the inlet surface predicted by the CFD code. The minimization of peak Mach number in the inlet maximizes the pressure recovery at the engine fan by minimizing shock losses and diffusion rates. Following the analysis, the responses were used to develop a polynomial model of the CFD code results using least squares. This polynomial was then optimized to find the inlet shape predicted to have the best peak Mach number without developing additional inlet geometries or running the CFD code. Author

A93-14211
NUMERICAL SOLUTION OF 3-D TURBULENT FLOWS INSIDE OF NEW CONCEPT NOZZLES
XIAOQING ZHENG (Chinese Academy of Sciences, Inst. of Engineering Thermophysics, Beijing, China), MINGHENG ZHANG, CHUANXIN LAI, HUI JIN, and JUN ZEN (Gas Turbine Establishment, Jiangyou, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 455-464. refs

This paper presents a numerical method for calculating the internal flow field of circular-to-rectangular transition ducts and nonaxisymmetric nozzles. This analysis, based on the solution of N-S equations with time marching scheme, is capable of predicting the internal three dimensional turbulent flows. To improve the computational efficiency and alleviate the requirement for huge computer storage, a new finite volume approach for viscous terms in 3-D case is proposed. The B-L turbulence model is used to estimate the Reynolds stresses. The definition of the mixing length of turbulent flow in the vicinity of wall corner is suggested. The principle for choosing the eddy-viscosity is also established. An original method for generating high-performance grid inside duct is developed through analytic transformation. It is ideal to all shapes from circular to rectangular section for its excellent natures of orthogonality and controllability. Three transition ducts with different lengths connected with a convergent-divergent nozzle is investigated in present paper. Numerical results surprisingly accurately match the test data in all cases, demonstrating the accuracy and capability of present method. Author

A93-14212
PASSIVE BOUNDARY-LAYER BLEED FOR SUPERSONIC INTAKES
S. RAGHUNATHAN and S. C. ROLSTON (Belfast Queen's Univ., United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 465-475. refs

Passive boundary layer control experiments were conducted on a small supersonic sidewall intake at a Mach number of 1.36 to study the possibility of improving the intake performance by such a control. The passive bleed configuration tested had a wide suction slot in the intake duct and a narrow tangential injection slot upstream of the intake entry. The slots were interconnected by a breather passage. The results of the experiments showed that for a supersonic intake passive control can reduce the shock interaction losses, improve the overall pressure recovery, and control the pre-entry shock position. Author

A93-14213
FLOW CHARACTERISTICS OF AN S-SHAPED INLET AT HIGH INCIDENCE
Q. LIN (Xiamen Univ., China) and R. W. GUO (Nanjing Aeronautical Inst., China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 476-482. refs

This paper presents some significant experimental results of the characteristics, including unsteady property, swirl and total pressure distortion of the flow through an S-shaped inlet in a incidence range of 0 to 85 deg. The experimental results show that if a flow separation occurs at the entry area the fluctuating energy of unsteady flow will transport towards downstream along the duct. In general, the flow quality goes worse during the incidence alpha increasing. The measurement of the flow field shows that as alpha increases, the transverse velocity vectors at the exit develop gradually to appear a flow pattern of single vortex instead of the vortex pair at 0 deg incidence. The results also indicate that the strength of the swirl decides the location where the flow quality at exit is the worst. The study explains that, in considering inlet/engine compatibility at high incidence, SC60, DC60 and unsteady property are important factors. Besides, it has to be paid more attention to the swirl exerts influence on total pressure distortion and unsteady property of the flow. Author

A93-14215
THE VALUE OF A COMPUTATIONAL/EXPERIMENTAL PARTNERSHIP IN AERODYNAMIC DESIGN
R. L. BENGELINK and T. W. PURCELL (Boeing Commercial Airplane Group, Seattle, WA) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 493-499. refs

This paper reviews some of the key lessons learned from the past twenty years of Computational Fluid Dynamics (CFD) development. These lessons include the need for careful validation and verification studies, the need for application specialists in CFD and experimental testing areas, and the need for continued improvement in the teamwork between computational and experimental groups. This nature of this teamwork is discussed and several examples are presented to illustrate the broad coverage of problems that a more cooperative approach enables. A good partnership between all required disciplines is suggested to be a key condition necessary for developing tomorrow's competitive air transport designs. Author

A93-14216
COMPUTATIONAL METHODS APPLIED TO THE AERODYNAMICS OF SPACEPLANES AND LAUNCHERS
J. M. BOUSQUET, R. COLLERCANDY, L. DALA, A. DEMARGNE, and J. OSWALD (ONERA, Chatillon, France) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 500-509. refs

The numerical tools used at ONERA for the aerodynamic analysis of the Hermes spaceplane and its launcher Ariane 5 are presented. They range from panel methods suitable for subsonic to low-transonic flow conditions, to three-dimensional Euler solvers used for supersonic and hypersonic Mach number regimes, the real gas effects being accounted for in the latter case. Applications to different Hermes geometries in the launch phase on top of Ariane 5, as well as in the return flight are performed and compared to wind tunnel results. Author

A93-14217
MELINA - A MULTI-BLOCK, MULTI-GRID 3D EULER CODE WITH SUB BLOCK TECHNIQUE FOR LOCAL MESH REFINEMENT
S. RILL and K. BECKER (Deutsche Airbus GmbH, Bremen, Germany) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 510-518. refs
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A modified MELINA Euler code is described which is based on a multigrid acceleration technique to increase the convergence rate of the code. The multigrid procedure makes it possible to reduce the CPU time by up to 70 percent by clustering grid points only in regions of large gradients. This code uses a local subblock refinement technique to improve the spatial resolution of the scheme. The modified MELINA code and an interactive, algebraic grid generator facilitate application of the 3D Euler simulation to more flow problems and makes it possible to perform more iteration steps in the aerodynamic design of complex 3D geometries. O.G.

A93-14246
NUMERICAL SIMULATIONS OF HIGH SPEED INLET FLOWS
F. GRASSO and M. MARINI (Roma I, Univ., Rome, Italy) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 728-736. refs
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In this paper a multiblock finite volume technique with a second order total variation diminishing spatial discretization and an efficient implicit time integration has been used to simulate complex internal flows at high Mach numbers. The method employs a lower and upper approximate factorization of the implicit operator with symmetric successive over relaxation sweeps. In the presence of multiblocks a synchronous interface treatment has been devised for an accurate coupling of the blocks. A detailed validation by comparison of the computed results with experiments has shown the capabilities of the method to resolve complex high speed internal flows. A complete analysis of the inlet configurations of a hypersonic vehicle has been performed, evaluating the inlet performances during the phases of acceleration at low altitude and cruise at high altitude. Author

A93-14248
AN ALGEBRAIC TURBULENCE MODEL WITH MEMORY FOR THE COMPUTATION OF THREE DIMENSIONAL TURBULENT BOUNDARY LAYERS
T. D. HSING (Beijing Univ. of Aeronautics and Astronautics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 744-754. Research supported by NNSFC refs
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The paper derives additional equations based on experiments for an algebraic turbulence model to improve the prediction of the behavior of 3D turbulent boundary layers by taking the effects of the pressure gradient and the historical variation of eddy viscosity into account. Five test cases including the boundary layers developed on flat plates with obstacles standing on them, the boundary layer field simulating the flow around a back-swept wing, and the flow past a prolate spheroid with a slenderness ratio of 1/6 in a symmetrical plane were selected to validate the prediction accuracy in comparison with experimental data. The comparison shows that using the proposed algebraic turbulence model with memory yields an improvement in predicting the behavior of 3D turbulent boundary layers, especially for the distribution of turbulent stresses. P.D.

A93-14249
TURBULENCE MODELLING REQUIREMENTS FOR THE PREDICTION OF VISCOUS TRANSONIC AEROFOIL FLOWS
LESLIE J. JOHNSTON (Univ. of Manchester Inst. of Science and Technology, United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 755-765. refs
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The main features of a recently developed numerical method for predicting viscous transonic aerofoil flows are presented. The mean-flow equations governing 2D viscous transonic flows are given. The various turbulence-modeling options available for potential use with flow solvers based on the Reynolds-averaged Navier-Stokes equations are briefly reviewed. The results of an extensive evaluation of the method, covering a wide range of transonic flow conditions for the Boeing BAC I aerofoil, a typical modern supercritical section, are discussed. The results indicate that reasonably accurate quantitative predictions of integrated loads, including drag, can be obtained for freestream Mach numbers up to 0.76, at least until the appearance of extensive shock-induced separation. It is concluded that the shock wave/boundary layer interaction is underpredicted, even for fully attached flow conditions, and that this can be attributed to deficiencies in turbulence modeling at the eddy-viscosity level. P.D.

A93-14250
EXPERIMENTAL STUDY OF CROSSFLOW INSTABILITY AND LAMINAR-TURBULENT TRANSITION ON A SWEPT WING
V. M. GALKIN, O. V. BABICH, and O. K. SHAPOVALOV (TsAGI, Zhukovski, Russia) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 766-770. refs
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The laminar-turbulent boundary layer transition on a swept wing model in a subsonic wind tunnel is investigated on the basis of rotating hot-wire anemometer measurements and china-clay visualization together with a numerical study of boundary layer instability. A swept wing model with a 45-deg leading edge sweep was tested over an incidence range of -5 to 0 deg and a Reynolds number range of 2-4 x 10 exp 6. Visualization showed china-clay patterns typical for stationary waves caused by cross-flow instability; its development in the streamwise direction led to a series of turbulent wedges forming a 'shark-teeth'-like transition front. Simultaneous hot-wire measurements of cross-flow and streamwise velocity profiles showed that each turbulent wedge was the continuation of a streamwise vortex with induced near-wall cross-flow velocities directed backward with respect to the mean (span-averaged) boundary layer cross flow. P.D.

A93-14251
CALCULATION OF 3-D UNSTEADY SUBSONIC FLOW WITH SEPARATION BUBBLE USING SINGULARITY METHOD
HARIJONO DJOJODIHARDJO, WIDJAJA K. SEKAR, and BONIFACIUS PRANANTA (Nusantara Aircraft Industries, Ltd., Center for Development of Method, Technology and Production, Bandung, Indonesia) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 771-781. refs
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A simple analytical method to calculate the unsteady airloads on an oscillating wing with separation bubbles on the suction side of the wing is presented. The oscillation of the wing is assumed to be harmonical. Linearized aerodynamics is assumed in the analysis. It is also assumed that the separation and reattachment points are known and fixed. Thus, the separation bubble does not move and the flow is separated during the whole cycle of oscillation. Such simplified model is considered beneficial for preliminary estimation of the unsteady aerodynamic characteristics of an oscillatory flow about wing with separation, such as those met in buffeting phenomenon. In order to aply the linearized potential flow theory, the flow is assumed to be inviscid and isentropic. Although such modeling is by no means a physical one, it is believed that it can serve as a mathematical convenience in obtaining the load acting in separated flow situation. Results of the method are presented. The validity of the method for fully

attached flow case was insured by comparison with published results, while for separated flow cases, qualitative discussions are presented. Author

A93-14252
NUMERICAL ANALYSIS OF THE 3-D TURBULENT FLOW IN AN S-SHAPED DIFFUSER
Q. LIN (Xiamen Univ., China) and R. W. GUO (Nanjing Aeronautical Inst., China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 782-789. refs
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A numerical analysis of the 3D turbulent flow in an S-shaped diffuser using the finite-difference method and improved SIM-PLE procedure is presented. The coordinate transformation was made because of the section variation along the duct in order to overcome the fundamental difficulty of the computational mesh with the boundary conditions. The computational results yield fairly satisfactory agreement with experimental data, including static pressure distribution along the walls, the main flow velocity profile at different sections of the duct, and total pressure coefficients and cross-flow velocity vectors at the outlet. The numerical approach can be extended to 3D turbulent flow in more complicated ducts. P.D.

A93-14262
AN ADAPTIVE REGION METHOD FOR COMPUTATION OF VORTEX SHEET BEHIND WING IN COMPRESSIBLE FLOW
GANG SUN and ZHIDE QIAO (Northwestern Polytechnical Univ., Xian, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 879-882. refs
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The present adaptive-region method for the computation of the vortex sheet behind a wing in compressible flow keeps the boundary computation region away from the vorticity by automatically adjusting its size, thereby ensuring accuracy while maintaining low computation time. The first derivatives of the potential on branch cuts is redefined, and second derivatives of the potential function are obtained for the improvement of calculation accuracies concerning the cross velocity on branch cuts. The computation results obtained agree with exact solutions of the Betz theory for elliptically loaded wings. O.C.

A93-14263
THE INFLUENCE OF THE FUSELAGE ON HIGH ALPHA VORTICAL FLOWS AND THE SUBSEQUENT EFFECT ON FIN BUFFETING
A. VINCENT and N. J. WOOD (Bath Univ., United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 883-890. refs
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A wind tunnel investigation has been conducted of the effect of the fuselage on the fin-buffeting characteristics of a generic combat aircraft, for both high and low wing configurations, where the wing is a 60 deg-sweep cropped delta. Laser light sheet-flow visualizations were used to establish a correlation between vortex-flowfield excitation and fin response. Peak fin buffeting occurred at 40 and 42 deg, respectively for the low and high wing cases. Unsteady pressure measurements taken at the fin surface indicate a sharp rise in the level of pressure fluctuations in the region of peak buffeting. O.C.

A93-14264
A PREDICTION OF THE STALLING FOR WINGS WITH REAR SEPARATION
JUNZHENG ZHU (Nanjing Aeronautical Inst., China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 891-894. refs
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The approximate method presented for computing the aerodynamic characteristics of high aspect ratio, low-sweep wings with rear separation at high incidences uses 3D linear lifting surface theory for inviscid flow in conjunction with 2D airfoil theory for viscous flow. The two theories are connected via iterative technique for L/D, drag, and pitching moment determinations. An integral method is used for boundary-layer calculations. The technique makes modest computational demands while furnishing fine convergence and high accuracy approximations. O.C.

A93-14265
CALCULATION OF TRANSONIC FLOW OVER BODIES OF VARYING COMPLEXITY USING SINGULAR PERTURBATION METHOD
QIANG FU (Northwestern Polytechnical Univ., Xian, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 895-897. refs
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This paper is devoted to examples of the use of Singular Perturbation Method (SPM) in transonic flow the starting point for which is the full potential equation. With the assumption of small angle of attack and slender bodies, the asymptotic expansion can be used. The rule shows that the original 3D problem is divided into two simpler component problems, the near field and the far field. The near field is described by a crossflow Laplace equation's boundary value problem, and can be solved by the panel method; the far field is described by a nonlinear transonic small disturbance equation over a body of revolution having the same longitudinal area distribution as the asymmetric body, which can be solved by the AF2 scheme (approximate factorization). The two component solutions are combinated to obtain the complete solution.
Author

A93-14275
ASSESSMENT AND CORRECTION OF TUNNEL WALL INTERFERENCE BY NAVIER-STOKES SOLUTIONS
C. E. LAN and C. A. HSING (Kansas Univ., Lawrence) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 969-978. refs
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In the present method for computationally assessing and correcting solid wall wind tunnel interference effects on models with high angles of attack at low speeds, a mesh system representing the model's domain is generated and used in conjunction with appropriate boundary conditions and a thin-layer Navier-Stokes solver. The interference flow field obtained is used to derive values for the correction of total model aerodynamic characteristics to free-air conditions. The primary interference effect at high lift arises from the wind tunnel floor surface, in a way similar to static ground effect. O.C.

A93-14277
A FLUX-DIFFERENCE FINITE VOLUME METHOD FOR STEADY EULER EQUATIONS ON ADAPTIVE UNSTRUCTURED GRIDS
KRIS RIEMSLAGH (Gent Univ., Belgium) and ERIK DICK (Liege Univ., Belgium) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 991-999. Research supported by Belgian National Programme for Large Scale Scientific Computing and Belgian National Programme on Interuniversity Poles of Attraction refs
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A flux-difference splitting-type algorithm for the time-dependent Euler equations is presently formulated on an unstructured grid composed of triangles; control volumes are constructed around each vertex of the grid by connecting the centers of surrounding triangles. The time-dependent system is integrated explicitly by means of a Runge-Kutta-type multistage time-stepping technique with local time-steps. The domain is discretized by means of a Delaunay triangular mesh generator capable of handling nonconvex

geometries. Results are presented for transonic flow over a NACA 0012 airfoil. O.C.

A93-14279
A MULTI-ZONAL LOCAL SOLUTION METHODOLOGY FOR THE ACCELERATED SOLUTION OF THE TURBULENT NAVIER-STOKES EQUATIONS
D. DRIKAKIS and S. TSANGARIS (Athens National Technical Univ., Greece) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1012-1021. refs
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A multi-zonal local solution method is developed for the solution of the compressible Navier-Stokes equations. The main feature of the method is the coupling of the Navier-Stokes equations with the Euler equations and the local adaptive mesh solution procedure. The methodology is applied to turbulent flow fields past an airfoil. A Flux Vector Splitting method with an upwind scheme up to the fourth order of accuracy is used for the discretization of the inviscid fluxes. The system of equations is solved by an unfactored implicit method using Gauss-Seidel relaxation. The multizonal local solution method gives more rapid convergence to the steady state solution retaining the accuracy of the computational code. Author

A93-14283
ANALYTIC CONTINUATION OF PADE APPROXIMATIONS TO THE UNSTEADY KERNEL FUNCTIONS TO OBTAIN A BETTER UNDERSTANDING OF THE ANALYTIC CONTINUATION OF PADE APPROXIMATIONS TO UNSTEADY PARAMETERS IN GENERAL
L. H. VAN ZYL (Council for Scientific and Industrial Research, AEROTEK, Pretoria, South Africa) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1043-1052. refs
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The Hounjet (1986) suggestion that analytic continuations of approximations of aerodynamic forces for exponentially diverging motions could yield aerodynamic forces for harmonic motions is the basis of the present approximation of aerodynamic forces by rational polynomials in the frequency parameter s. It is assumed that any unsteady parameter of interest can be represented in this way. The procedure has been applied to the unsteady subsonic kernel function in order to deepen understanding of the approximation and its analytic continuation. Numerical instabilities are noted in the Hounjet and Eussen (1991) form of the approximation. O.C.

A93-14291
THE AERODYNAMIC AND STRUCTURAL DESIGN OF A VARIABLE CAMBER WING (VCW)
J. P. FIELDING, S. H. M. MACCI, A. V. MACKINNON, and J. L. STOLLERY (Cranfield Inst. of Technology, United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1098a-1098k. refs
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The concept of a variable camber wing (VCW) is examined to define a VCW that satisfies structural and aerodynamic constraints and to assess its impact on in-flight efficiency and flexibility. Theoretical and experimental treatment is given to the high- and low-speed effects of a varying wing profile, and the practical implications of the design are discussed. Various VCW models are tested in a wind tunnel at Re = 2 x 10 exp 6, and pressure distributions are measured at twelve spanwise positions. The results demonstrate the optimum values for lift coefficient, the origin of rotation, and for avoiding leading-edge suction peaks. An optimized 2D VCW design is proposed which includes a solid trailing-edge device, a flexible upper surface, a hinged lower surface, and an extending conforming track. The 2D design is extended to a 3D configuration designed for practical implementation. The test results demonstrate that the VCW design concept satisfies the geometric and aerodynamic constraints of an airfoil. C.C.S.

A93-14297
THE CRYOGENIC APPROACH TO SIMULATING HOT JET IN TRANSONIC WIND-TUNNEL TESTING
KEISUKE ASAI (National Aerospace Lab., Tokyo, Japan) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1138-1148. refs
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A novel approach to the hot-jet simulation problems in transonic wind-tunnel testing is presented. This technique utilizes the advantages of cryogenic temperatures in wind-tunnel testing. Theoretical considerations show that in a cryogenic wind tunnel hot jet can be simulated by using a test gas at ambient or moderately elevated temperatures. It is also shown that, through use of a mixture of nitrogen and methane as a jet gas, complete simulation of the full-scale turbojet exhaust becomes possible in a cryogenic tunnel. In order to validate this concept, a series of experiments were conducted in the NAL 0.1 m Transonic Cryogenic Wind Tunnel. A blunt-based afterbody model was used to evaluate the jet temperature effect on the base pressure. A good qualitative agreement was found between the results obtained from the cryogenic approach and the previous hotjet data. By varying jet gas composition and temperature separately, the independent effects of jet temperature ratio, specific heat ratio, and molecular weight (gas constant) on the base pressure have been determined. It has been verified that the effect of gas constant on the jet entrainment is equivalent to that of jet temperature. Author

A93-14298
ON THE CONFIGURATION BUFFET OF A TRANSPORT AIRCRAFT
B. C. ZHAO (British Aerospace Airbus, Ltd., Filton, United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1149-1154. refs
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This paper presents a detailed investigation of a 'configuration buffet' phenomenon on a transport aircraft. Buffet occurred during low speed approach with the trailing-edge flaps fully deployed. Buffeting of the aircraft was characterized by discomfort in the cabin and large amplitude vibration on both the flaps and the tailplane. Investigations were initially carried out in the wind tunnel using both 2D and 3D semirigid models. It was found that changes in the wing and flap relative geometry at the flap joint where the flow separated could result in dramatic changes in the level of model buffeting. A shroud extension modification on the model was found to reduce the level of buffet significantly. Flight test evaluation of this solution showed that the level of overall aircraft buffeting was also significantly reduced. Author

A93-14301
DESIGN OF MANOEUVRABLE SIMPLE AND COMPLEX PLANFORM TRANSONIC WINGS WITH ATTAINED THRUST-, PANEL- AND EULER- METHODS
R. K. NANGIA (Nangia Associates, Bristol, United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1169-1178. refs
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An 'attained-thrust' methodology for wing leading edges (LEs) is incorporated into the linear theory and Euler techniques for analyzing flow conditions related to transonic wing designs. Near-elliptical spanwise loading is utilized for the design points of optimum camber surfaces with significant off-design capabilities. The effects of Mach number and Reynolds number on the attained thrust are derived for specific wing airfoil parameters, and the linear results are compared to those from Euler computations for transonic design points involving strong shocks. Evaluations are presented for an uncambered wing with an LE root extension (LERX) and for wing/LERX designs optimized for high speeds or high maneuverability at high altitudes. The present analysis for LE design yields information on the performance of wings with or

without LERXs and particularly the effects of camber and twist. C.C.S.

A93-14302
LATERAL AERODYNAMICS CHARACTERISTICS OF FOREBODIES AT HIGH ANGLE OF ATTACK IN SUBSONIC AND TRANSONIC FLOWS
S. KOREN (Technion - Israel Inst. of Technology, Haifa), R. ARIELI (Rafael Armament Development Authority, Haifa, Israel), and J. ROM (Technion - Israel Inst. of Technology, Haifa) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1179-1189. refs
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An investigation of the pressure distributions on three elongated forebodies of revolution with circular cross section and different bluntness ratios is presented. Measurements are conducted at Mach numbers from 0.5 to 1.0 with angles of attack up to 45 deg. Some visualization data is obtained at transonic speeds by Schlieren-shadow photographs. The local lateral force along the axis at high angles of attack is calculated to emphasize the asymmetric flow regime that is developed. Effects of the variation of the angle of attack and Mach number are discussed. Author

A93-14304
FURTHER STUDIES ON THE ASYMMETRICAL FLOW PAST YAWED CYLINDERS
SERGIO DE PONTE (Milano Politecnico, Milan, Italy) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1201-1207. refs
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The flow about a yawed cylinder is investigated in wind-tunnel tests emphasizing asymmetrical flows and their fundamental fluid dynamics. The wind-tunnel setup by Abba et al. (1988) is employed in which the cylinder is at a yaw angle of 60 deg. A five-hole pressure probe is employed for measurements of a range of flow directions, and the results are presented as representations of the wake flowfield in a coordinate system. The vortex street tends to have an alternating shape, and a range of flow patterns is noted at the vortex core. The flow morphology confirms the behavior of the plane unsteady wake as described in analyses, and significant flow characteristics including the Kelvin-Helmholtz instability can be observed. Some small-scale structure cannot be visualized, but large-scale flow behavior can be studied even in the fully turbulent regime. C.C.S.

A93-14305
SEPARATION CONTROL AND LIFT ENHANCEMENT ON AIRFOIL USING UNSTEADY EXCITATIONS
E. J. CUI, X. T. YU, G. M. FU (Beijing Inst. of Aerodynamics, China), C. XU, S. Y. ZHANG, and M. D. ZHOU (Nanjing Aeronautical Inst., China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1208-1214. Research supported by NNSFC refs
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External unsteady excitations imposed on the flow field around an airfoil can greatly change its aerodynamic properties. It may be beneficial to prevent flow separation, delay stall and enhance the lift. In this paper, the techniques used to control flow separation and the possible ways for enhancing the aerodynamic efficiency of the airfoils are investigated, by use of the wind tunnel model test and water channel flow visualization techniques. The excitation procedures considered in the experiments are: (1) pitch oscillation of the airfoil; (2) the moving surface effects produced by the rotating leading edge; and (3) the oscillating flap at leading edge of the airfoil. It is found from the experimental results obtained that the beneficial aerodynamic effects can be reached in varying degrees at high angle of attack conditions, as long as the excitation means and its frequency and amplitude are properly selected. Author

A93-14323
MODELLING FOR AILERON INDUCED UNSTEADY AERODYNAMIC EFFECTS FOR PARAMETER ESTIMATION
JATINDER SINGH and S. C. RAISINGHANI (Indian Inst. of Technology, Kanpur, India) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1355-1361. refs
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Aileron inputs give rise to a trailing vortex pattern which is a function of time. To account for the unsteady aerodynamic effects due to such a vortex pattern, a model based on a simple vortex system is proposed. Expressions for the induced sidewash and downwash angles are derived and recast into a form which can be conveniently used in the equations of motion for parameter estimation. Maximum-likelihood method in frequency-domain is utilized to analyze the frequency response curves of an example airplane. Parameter estimation is carried out with and without the inclusion of unsteady aerodynamic modeling in the estimation model. For the latter case, an explanation is provided for the significant differences observed in the aileron control derivatives when unsteady aerodynamic modeling was omitted fully or partially. Author

A93-14329
ON THE MEASUREMENTS OF THE SKIN FRICTION IN 3-D FLOWS - APPLICATION TO A COMPLETE 3-D SHEAR LAYER FLOW
G. IUSO (Torino, Politecnico, Turin, Italy), M. S. OGGIANO (CNR, Centro di Studio sulla Dinamica dei Fluidi, Turin, Italy), and S. DE PONTE (Milano, Politecnico, Milan, Italy) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1417-1425. Research supported by CNR and MURST refs
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Two different techniques based on different working principles, and suitable for measuring wall shear stress in 3D boundary layer have been investigated. Triangular block pressure probe and hot-wire wall probe have been accurately calibrated in a channel flow and an application is given for a complex 3D shear flow generated in the same calibration channel, mounting a cylinder from wall to wall in the center of the test section. Oil flow visualization and power spectrum are also performed. Author

A93-14330
WING ROCK OF LIFTING SYSTEMS
IU. A. PRUDNIKOV, E. A. KARAVAEV, and O. V. ROKHMISTROV (Siberian Aeronautical Research Inst., Novosibirsk, Russia) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1426-1429. refs
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The physical characteristics of the wing rock occurring in lifting systems comprised of thin slender delta wings with a sharp leading edge were investigated in tests conducted in subsonic and transonic wind tunnels. Results were used to examine the dependence of the wing-rock onset and its suppression on the particular types of vortical flows and to determine the trajectories of the vortex cores during oscillation. Results were also obtained on the effect of air compressibility on the parameters of wing rock. It was found that, at high subsonic and transonic speeds, the oscillation amplitudes decrease. I.S.

A93-14332
FLOW STRUCTURES AROUND A CONSTANT-RATE PITCHING AIRFOIL AND MECHANISM OF DYNAMIC STALL
M. SUN, J. L. WANG, and Q. X. LIAN (Beijing Univ. of Aeronautics and Astronautics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1442-1449. Research supported by Fok Ying Tung Education

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The vortical flow structure of a constant-rate pitching airfoil is studied numerically and by flow visualization method. The N-S equation in the vorticity-stream function form is solved, using ADI method for the vorticity equation and a direct method for the stream-function equation. Hydrogen bubble technique is used for flow visualization. The time development of the separated flow structure on the upper surface of the airfoil and the structure of the vortex sheet shed from the lower surface boundary layer at the trailing edge are revealed, and the effects of pitch rate and pitch axis location are studied. Based on the vortical flow structures and calculated aerodynamic forces on the airfoil, and using vorticity dynamics theory, the mechanism of dynamic stall is studied and insights are provided. Author

A93-14333
LEADING EDGE VORTICES IN A CHORDWISE PERIODIC FLOW

M. AMITAY, J. ER-EL, and A. SEGINER (Technion - Israel Inst. of Technology, Haifa) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1450-1459. refs
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The flow over a slender delta wing in a periodically changing free-stream, is investigated theoretically and experimentally. The theoretical model assumes the wings to be slender and infinitesimally thin with straight spanwise cross-sections. The amplitudes and frequencies of the periodic motion are assumed to be very small so that the flow is governed by the steady two-dimensional Laplace equation. Time dependence is introduced through the boundary condition. The theoretical model was validated by the visualization of the flow over a delta wing in a periodic translational motion in a water tunnel. The vortical flow field over the wing was visualized by the hydrogen-bubbles techniques. The spatial trajectories of the leading edge vortices as a function of several parameters, were found from the flow visualization results. Good agreement between the theoretical and the experimental results was found, as long as the small-perturbations assumption was justified. The results alos show that the effects of a periodic flow are comparable with those of a periodically translating wing, under these assumptions and Galilei transformation. Author

A93-14344
A METHOD FOR OPTIMIZING THE MERIDIONAL PASSAGE OF THE ROTOR IN CENTRIFUGAL COMPRESSORS

JIANG RAO and JING P. LI (Chinese Academy of Sciences, Energetics Research and Development Center, Beijing, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1539-1542. refs
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Based on the S1, S2 stream filament theory, a method is developed to generate an optimized meridional passage of the rotor in centrifugal compressors. Two optimization principles are adapted. First, the gradient of static pressure in stream line direction, which is mainly responsible for the boundary layer separation at the hub and shroud, should be minimized. Second, the gradient of static pressure from hub to shroud, which is generally considered the major reason of triggering the secondary flow in the passage, should be reduced as well. According to these two principles, a reasonable criterion is set up. In order to develop a computer code to generate the optimized meridional passage automatically, two practical schemes are used. The comparison of the static pressure distributions at hub and shroud between the initial and optimized passages indicates that the methods achieved the anticipated result. Author

A93-14345
EXPERIMENTAL INVESTIGATIONS OF THE SEPARATION BEHAVIOR IN 3D SHOCK WAVE/TURBULENT BOUNDARY-LAYER INTERACTIONS

HUA-SHU DOU and XUE-YING DENG (Beijing Univ. of Aeronautics and Astronautics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1543-1553. refs
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An experimental study has been carried out in detail for 3D shock wave/turbulent boundary-layer interactions generated by swept compression corners. The surface pressure distributions in the interaction flow field were measured at Mach numbers 2.04 and 2.50 and were compared with the oil streak patterns. Then, the separation behavior versus various parameters in 3D shock wave/turbulent boundary-layer interaction at swept compression corners was investigated and the separation mechanism of 3D interactions was analyzed. It is discovered that the separation behavior and its physical mechanism in 3D interactions are much different from 2D interactions and vary with various parameters. The separation behaviors generated by 2D ramp and by sharp fin could be connected through a serious of swept compression corner models with different sweepback angles. Author

A93-14348
INTERACTIVE HYPERSONIC WAVERIDER DESIGN AND OPTIMIZATION

K. B. CENTER, K. D. JONES, F. C. DOUGHERTY, A. R. SEEBASS, and H. SOBIECZKY (Colorado Univ., Boulder) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1571-1580. refs
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Discussed is development, operation, and validation of two design codes that generate waveriders based on non-axisymmetric flowfields. In the first method, an approximation is applied to generate an undersurface flowfield based on the local curvature of an arbitrary user-defined exit-plane shock shape. The code is controlled by a graphical work-station interface so that interactive modifications to the flow conditions and geometric parameters can be computed and redisplayed in real-time. The second method marches inward from a shock surface to determine the resulting waverider lower surface. The ultimate application of these codes is to serve as an expert system for the development of waveriders that are strongly competitive candidates for integration into a wide range of potential high-speed aerodynamic applications. Author

A93-14354
GENERATION OF FLOW DISTURBANCES IN TRANSONIC WIND TUNNELS

B. L. MEDVED (National Research Council of Canada, Inst. for Aerospace Research, Ottawa) and A. VITIC (Aerospace Inst., Belgrade, Yugoslavia) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1623-1629. refs
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Unsteady flows in two transonic wind tunnels are identified and related to potential sources of the flow disturbances. The low-frequency disturbances are measured with attention given to three sources: the pressure regulating valve, the test-section diffuser, and the perforated test-section walls. A 2D choke system is employed to prevent flow disturbances from the diffuser from reaching the test section. Low-frequency flow disturbances are shown to arise in both perforated and solid test-section walls, and diffuser geometry is found to have a pronounced effect on similar test sections. The results indicate the potential generation of flow disturbances by typical wind-tunnel test-section geometries. C.C.S.

A93-14355
AN EXPERIMENTAL STUDY FOR INTERACTION FLOW BETWEEN SHOCK WAVE AND TURBULENT BOUNDARY LAYER
SUXUN LI, YUEDING SHI, and HANLONG CAI (Beijing Inst. of Aerodynamics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1630-1636. Research supported by NNSFC refs

Wind-tunnel testing is conducted to investigate flows generated by the interaction of shock waves and boundary layers at hypersonic velocities. A hypersonic blowdown wind tunnel is used with shock generators for 3D waves that induce turbulent boundary layer separation and reattachment on a flat plate. Pressure and heat-flux samples are taken during tests with a free-stream Mach number of 5, stagnation temperatures and pressures of 430 K and 3.5 MPa, and Re = 5.7 x 10 exp 7/M. Schlieren photography and oil-flow imaging are used to supplement the measured data, and the shocked waves are found to be more complex than their 2D counterparts. Incident shock strength of the impact point dictates the range of separated flow, and the heat-flux distributions in the interactive region are found to be similar to the distributions of static pressure. C.C.S.

A93-14356
EXPERIMENTAL AND THEORETICAL STUDIES OF HELICOPTER ROTOR-FUSELAGE INTERACTION
N. BETTSCHART, A. DESOPPER, R. HANOTEL, and R. LARGUIER (ONERA, Chatillon, France) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1637-1646. Research supported by Ministry of Defence of France and EEC refs

Subsonic wind-tunnel tests and rotor-fuselage analyses are compared to study the unsteady velocity field about a helicopter in forward flight. Unsteady measurements taken with a laser Doppler velocimeter are taken in three dimensions, and calculated values are determined for two helicopter configurations. The computational method is based on an iterative coupling technique utilizing the panel method for source and doublet singularities of the fuselage, and the rotor component is modeled by means of a lifting-line theory approach. Laser Doppler velocimetry yields results that describe the complex flow configurations about the moving surfaces, and comparisons with analyses suggest that fuselage effects must be included in the calculations of the inboard rotor disk and rotor wake. If these effects are not included, discrepancies are noted in the analytical results as noted in a comparison with previous results. C.C.S.

A93-14359
NUMERICAL SOLUTION OF RADIATIVE FLOWFIELD ON THE NOSE REGION OF BLUNT BODIES
JIAN-WEI SHEN and ZHANG-HUA QU (Changsha Inst. of Technology, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1663-1671. Research supported by NNSFC refs

The radiative viscous flow over hypersonic blunt bodies is calculated numerically. Chemical nonequilibrium and equilibrium are considered with viscous shock-layer equations. Both line and continuum radiation models are employed. A 1D planar medium assumption is used to deal with radiative transport so that the spatial marching technique is available in the numerical calculation. The numerical results show that the convective-heating transfer rate prevails as the reentry velocity lower than 7.6 km/sec at high altitude, and the radiative heating transfer rate increases with the increase of freestream velocity and density. Author

A93-14366
A DIGITAL SIMULATION AND ITS EXPERIMENTAL INVESTIGATION FOR THE RESPONSE OF GAS-TURBINE ENGINES TO INTAKE FLOW DISTORTION
YAN LIU and FUQUN CHEN (Northwestern Polytechnical Univ., Xian, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1723-1727. refs

A digital analysis methodology is introduced that can be used to assess the effects of intake flow distortion on the operation of simulated gas-turbine engines. The modeling of the multiple-segment parallel compressor is described which incorporates a dynamic stall-delay effect, and an expression is developed for calculating distortion-induced flow redistribution in the inlet. A test engine is fitted with an inlet pipe to measure flow rate, and intake-flow distortion is varied by means of different screen meshes attached to the pipe. Attention is given to experimental attempts to force the engine into surge, and predicted data are compared to the test data for the surge point related to inlet distortion. The results compare favorably, indicating that the dynamic stall delay effect and the inlet flow-redistribution can be employed to predict the point at which stall occurs. C.C.S.

A93-14380
EXPERIMENTAL INVESTIGATION OF AEROTHERMAL PROBLEMS ASSOCIATED WITH HYPERSONIC FLIGHT OF HST
K. HOZUMI, S. NOMURA (National Aerospace Lab., Chofu, Japan), Y. AIHARA, E. MORISHITA, and T. OKUNUKI (Tokyo Univ., Japan) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1863-1875. refs

Tests were performed to investigate the feasibility of a sharp leading edge HST configuration, heat transfer measurement tests for the cruising type HST model and the flat plate model. The heat transfer distribution of the cruising HST model at Mach 5.05 demonstrated that the nose and the leading edge heat transfer is most severe as expected. The heat conduction equation was used to obtain an accurate heat transfer instead of the semiinfinite 1D heat conduction model. R.E.P.

A93-14381
SIMULATION OF A HYPERSONIC FLOW OVER VEHICLES AT LOW REYNOLDS NUMBERS
V. N. GUSEV (TsAGI, Zhukovski, Russia) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1876-1882. refs

Some relationships between similarity criteria utilized and reasoning for their specific application in various combinations when simulating hypersonic gas flows from continuum to free-molecular ones are established on the basis of an analytical examination. The possibilities of utilizing current numerical analysis in the problems of the simulation and determination of thermal and aerodynamic characteristics of hypersonic vehicles in full scale conditions are presented. The test and computed results are analyzed and compared with flight test data. R.E.P.

A93-14382
DETECTION OF GOERTLER VORTICES IN HYPERSONIC FLOW
L. DE LUCA, G. CARDONE, and G. M. CARLOMAGNO (Naples Univ., Italy) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1883-1891. Research supported by Centro Italiano Ricerche Aerospaziali and Dassault Aviation refs

The Goertler instability of hypersonic boundary layer flow and

its influence on the wall heat transfer are experimentally analyzed. Measurements, made in a wind tunnel by means of a computerized IR imaging system, refer to the flow over 2D concave walls as well as 2D and 3D wedge models in viscous interaction regime. Wall temperature maps (that are to be interpreted as surface flow visualizations) and heat transfer spanwise fluctuations are presented. Measured vortices wavelengths are correlated to non-dimensional parameters and compared with numerical predictions of literature. Author

A93-14391
SUPERSONIC WING/BODY INTERFERENCE
S. C. BLANK (Cranfield Inst. of Technology, United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1949-1959. refs
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An experimental investigation of glancing shock wave/turbulent boundary layer interaction produced by hemicylindrically blunted swept (45 deg) and unswept fins was conducted at a Mach number of 2.45 and a Reynolds number of 4.1 x 10,000. In an attempt to weaken the interaction strength fillets were used which created significant alterations to the flow field structure. The study involved mean static pressures measured on the side wall, surface oil flow pictures taken over the side wall and the fin, and schlieren pictures taken in two planes normal to each other. Author

A93-14392
EULER SOLUTIONS SIMULATING STRONG SHOCK WAVES AND VORTEX PHENOMENA OVER 3D WINGS
MENG FAN and TIEYOU MA (Beijing Univ. of Aeronautics and Astronautics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1960-1966. refs
Copyright

Based on Beam and Warming's Implicit Approximate Factorization Algorithm this paper solves conservative Euler equations on arbitrary curvilineal coordinates. The algorithm with diagonal form and local time step is used to obtain a faster convergence rate. The ONERA M6 Wing's C-H grid is generated by using an algebraic method. Results in strong shock case are obtained. By comparing the computed results with experimental data, the feasibility of the algorithm has been tested and verified. This paper still used C-H grid to simulate the leading edge and wing tip vortex flow phenomena over delta wing at subsonic Mach numbers. A hybrid method in diagonal form has been tested for accelerating convergence rate, which saves about 11 percent CPU time for each step. Author

A93-14405
EXPERIMENTAL STUDY ON THE MECHANISM OF FAVOURABLE INTERFERENCES OF BODY STRAKES
XUEJIAN XIA, XIAOFENG LIU, and YANAN FENG (Beijing Univ. of Aeronautics and Astronautics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 2054-2062. refs
Copyright

The phenomena of favorable interferences among the body-strake vortex, the wing leading-edge vortex, and the body vortex, which delay wing vortex bursting, were investigated using results of wind-tunnel flowfield measurements and water-channel flow visualizations. The vortex flowfields were measured for a model with and without body strakes using a seven-hole probe. It is shown that the body strakes are capable of increasing the wing vortex intensity. The analysis of flowfields measured in different sections made it possible to quantitatively examine the mechanism of favorable interferences among vortices. I.S.

A93-14406
EXPERIMENTAL STUDIES OF VORTEX FLAPS AND VORTEX PLATES
K. RINOIE and J. L. STOLLERY (Cranfield Inst. of Technology, United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 2063-2071. refs
Copyright

Low-speed wind tunnel tests have been made on a number of vortex flap and vortex plate configurations, in order to assess the benefits of these devices. The force and surface pressure measurements were made on a 1.15 m span 60-deg delta wing model. Results indicate that the vortex flap deflection angle, which causes the flow to come almost smoothly onto the flap surface without any large separation, shows a much higher lift/drag ratio than the flap deflection angle which forms a leading-edge separation vortex over the flap surface. The performance of a vortex plate protruding from the leading-edge of the datum delta wing is comparable to that of the vortex flap. However, when the vortex plate is used with the vortex flap deflected, it showed no benefit in these tests. Author

A93-14407
VORTEX BREAKDOWN STUDY ON A 65-DEG DELTA WING TESTED IN STATIC AND DYNAMIC CONDITIONS
G. GUGLIERI (CNR, Turin, Italy), M. ONORATO, and F. B. QUAGLIOTTI (Turin Polytechnic Inst., Italy) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 2072-2081. refs
Copyright

A delta wing was extensively tested in the Turin Polytechnic Institute/Technical University Low Speed Wind Tunnel, both under static and under dynamic conditions. The model was a sharp-leading-edge flat-plate delta wing with a 65-deg sweep angle, which could be transformed into a double delta by adding an 80-deg tip. Force measurements are presented for both the static and the oscillatory conditions at different angles of attack and reduced oscillation frequencies and are correlated to flow visualizations. The effect of reduced frequency on the roll and pitch damping parameters is discussed. I.S.

A93-14408
A VORTEX CONTROL TECHNIQUE FOR THE ATTENUATION OF FIN BUFFET
DAVID E. BEAN, DOUGLAS I. GREENWELL, and NORMAN J. WOOD (Bath Univ., United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 2082-2091. Research supported by Defence Research Agency refs
Copyright

The application of tangential leading edge blowing to reduce levels of single fin buffeting has been studied. The test were performed at the University of Bath 2.1 m x 1.5 m Wind Tunnel, using two cropped 60-deg delta wings. To measure the buffet excitation, a rigid fin instrumented with miniature differential pressure transducers was used. A flexible fin of similar planform and size was used to measure the buffeting response. Steady state static pressure data and laser light sheet flow visualization were employed to aid interpretation of the vortical flow over the wings, and, hence, identify the causes of the buffeting. The profiles of the buffet excitation and response were found to match each other very closely. It was observed that symmetric leading edge blowing modified the leading edge vortices by reducing the 'effective angle of attack' of the vortex. Blowing at a constant rate shifted the buffet excitation and response to higher angles of attack. It has been shown that the use of an optimum blowing profile could completely suppress the buffeting response without impairing the wing lift characteristics. Author

A93-14409* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A LOW-SPEED WIND TUNNEL STUDY OF VORTEX INTERACTION CONTROL TECHNIQUES ON A CHINE-FOREBODY/DELTA-WING CONFIGURATION
DHANVADA M. RAO and M. K. BHAT (Vigyan, Inc., Hampton, VA) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 2092-2103. Previously announced in STAR as N92-25510 refs
(Contract NAS1-18856)
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A low speed wind tunnel evaluation was conducted of passive and active techniques proposed as a means to impede the interaction of forebody chine and delta wing vortices, when such interaction leads to undesirable aerodynamic characteristics particularly in the post stall regime. The passive method was based on physically disconnecting the chine/wing junction; the active technique employed deflection of inboard leading edge flaps. In either case, the intent was to forcibly shed the chine vortices before they encountered the downwash of wing vortices. Flow visualizations, wing pressures, and six component force/moment measurements confirmed the benefits of forced vortex de-coupling at post stall angles of attack and in sideslip, viz., alleviation of post stall zero beta asymmetry, lateral instability and twin tail buffet, with insignificant loss of maximum lift. Author

A93-14479
DIGITAL SIMULATION OF TRANSONIC FLOW FIELDS IN A PLANAR NOZZLE
IAOQING ZHENG (Northwestern Polytechnical Univ., Xian, China) and JUN ZEN (Gas Turbine Establishment, Jiangyou, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 7, no. 4 Oct. 1992 p. 312-314. In Chinese. refs

This paper presents a method for the simulation of transonic flowfields in a planar nozzle. For this purpose, the Jameson-type Runge-Kutta finite volume method is applied to solving Euler equation with the aid of local time stepping and impicit residuals averaging techniques. In such a manner, the convergence rate is sped up in planar nozzle flow solution, so that the steady state can be obtained in less than a hundred iterations. An adaptive dissipation term is added to the equations to eliminate the fluctuation of the flow parameters and the vibrations in front of and behind the shock. The results of the calculations are in good agreement with the test data, and the results of calculations agree with other numerical methods. Author

A93-14480
CALCULATION OF PRESSURE RATIO AT NOZZLE EXIT WITH SHOCK
JUN ZEN and JINGYUN ZHAO (Gas Turbine Establishment, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 7, no. 4 Oct. 1992 p. 315, 316. In Chinese. refs

A mathematical model of a axisymmetric convergent-divergent nozzle is set up by multivariant linear regression analysis method. The relationships of pressure ratio at nozzle exit with shock to four geometric parameters (i.e., the area ratio, the half-convergent angle, the half-divergent angle, and the radius ratio of throat curvature to throat) are considered. The pressure ratio depends only on the area ratio. Other parameters have little effect on it. The results provide the basis for testing and transonic calculation of the axisymmetric convergent-divergent nozzle. Author

A93-14515* National Aeronautics and Space Administration, Washington, DC.
EXPERIMENTAL INVESTIGATION OF AN AXISYMMETRIC HYPERSONIC SCRAMJET INLET FOR LASER PROPULSION
R. A. JONES, L. N. MYRABO, H. T. NAGAMATSU (Rensselaer Polytechnic Inst., Troy, NY), and M. A. S. MINUCCI (Centro Tecnico Aeroespacial, Sao Jose dos Campos, Brazil) Journal of Propulsion and Power (ISSN 0748-4658) vol. 8, no. 6 Nov.-Dec. 1992 p. 1232-1238. Previously cited in issue 07, p. 968, Accession no. A91-21332 Research supported by NASA and Universities Space Research Association refs
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A93-14520* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
STUDY ON VORTEX FLOW CONTROL OF INLET DISTORTION
BERNHARD H. ANDERSON (NASA, Lewis Research Center, Cleveland, OH), PAO S. HUANG, WILLIAM A. PASCHAL, and ENRICO CAVATORTA (Dee Howard Co., San Antonio, TX) Journal of Propulsion and Power (ISSN 0748-4658) vol. 8, no. 6 Nov.-Dec. 1992 p. 1266-1272. Previously cited in issue 08, p. 1167, Accession no. A92-23767 refs
Copyright

A93-14537* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NAVIER-STOKES COMPUTATION OF WING/ROTOR INTERACTION FOR A TILT ROTOR IN HOVER
IAN FEJTEK and LEONARD ROBERTS (Stanford Univ., CA) AIAA Journal (ISSN 0001-1452) vol. 30, no. 11 Nov. 1992 p. 2595-2603. Previously cited in issue 07, p. 975, Accession no. A91-21593 refs
(Contract NCC2-55)
Copyright

A93-14541* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
GENERALIZED MULTIPOINT INVERSE AIRFOIL DESIGN
MICHAEL S. SELIG and MARK D. MAUGHMER (Pennsylvania State Univ., University Park) AIAA Journal (ISSN 0001-1452) vol. 30, no. 11 Nov. 1992 p. 2618-2625. Previously cited in issue 23, p. 4006, Accession no. A91-53815 refs
(Contract NGT-50341)
Copyright

A93-14546* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
IMPLICIT NAVIER-STOKES SOLVER FOR THREE-DIMENSIONAL COMPRESSIBLE FLOWS
SEOKKWAN YOON and DOCHAN KWAK (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452) vol. 30, no. 11 Nov. 1992 p. 2653-2659. Previously cited in issue 17, p. 2848, Accession no. A91-40729 refs
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A93-14548
HYBRID GRID APPROACH TO STUDY DYNAMIC STALL
TAEKYU REU and SUSAN X. YING (Florida State Univ., Tallahassee) AIAA Journal (ISSN 0001-1452) vol. 30, no. 11 Nov. 1992 p. 2670-2676. Previously cited in issue 07, p. 974, Accession no. A91-21550 refs
(Contract DE-FC05-85ER-25000)
Copyright

A93-14550
ANALYTICAL SOLUTIONS FOR HYPERSONIC FLOW PAST SLENDER POWER-LAW BODIES AT SMALL ANGLE OF ATTACK
A. MERLEN and D. ANDRIAMANALINA (ONERA, Lille, France) AIAA Journal (ISSN 0001-1452) vol. 30, no. 11 Nov. 1992 p. 2683-2693. Research supported by DRET refs
Copyright

Hypersonic flows around axisymmetrical power-law slender bodies are calculated for high, but finite, Mach numbers and for low angles of attack. This is done by a small perturbation expansion of self-similar solutions using the equivalence principle. The solutions depend only on the exponent n of the power law defining the body and on the specific heat ratio of the gas, which is assumed to be perfect and inviscid. These solutions, the shock equation, the pressure coefficient on the body, and the aerodynamic coefficients are obtained in universal analytical form and depend on numerical coefficients determined once and for all for each pair (eta, gamma). The effects of the angle of attack for nonconical

noses is an innovation presented here: we observe that the effect of gamma on the shift of the shock and on the normal force and pitching coefficients depends, both on its sense and its intensity, on the shape of the nose cone. Finally, the stream functions are found to generalize the Hayes' and Probsteins' entropy correction principle to these three-dimensional flows. The results tabulated in this paper are intended to be used as test cases for inviscid numerical simulation and comparisons with specific experiments. Author

A93-14552
CORRELATION OF MEAN VELOCITY MEASUREMENTS DOWNSTREAM OF A SWEPT BACKWARD-FACING STEP
DANIEL J. WEBER (U.S. Army, Chemical Research, Development and Engineering Center, Aberdeen Proving Ground, MD) and JAMES E. DANBERG (U.S. Army, Ballistic Research Lab., Aberdeen Proving Ground, MD) AIAA Journal (ISSN 0001-1452) vol. 30, no. 11 Nov. 1992 p. 2701-2706. Previously cited in issue 23, p. 4000, Accession no. A91-53755 refs

A93-14554* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMPARISON OF ALGEBRAIC TURBULENCE MODELS FOR AFTERBODY FLOWS WITH JET EXHAUST
WILLIAM B. COMPTON, III (NASA, Langley Research Center, Hampton, VA), KHALED S. ABDOL-HAMID (Analytical Services and Materials, Inc., Hampton, VA), and WILLIAM K. ABEYOUNIS (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452) vol. 30, no. 11 Nov. 1992 p. 2716-2722. refs
Copyright

Three-dimensional Navier-Stokes simulations have been done for transonic and low supersonic flow past a nonaxisymmetric nozzle typical of those advocated for advanced fighter airplanes. The jet exhaust is included in the calculations. The investigation compares the performance of the unmodified Baldwin-Lomax turbulence model with its performance when enhanced by the Degani-Schiff and the Goldberg modifications. Solutions are presented for Mach numbers of 0.80, 0.94, and 1.20 at 0-deg angle of attack and a Reynolds number of 20 x 10 to the 6th. The numerical results, which are compared to the wind-tunnel data, show that the three turbulence models predict considerably different shock locations, separated-flow regions, and flowfields. Author

A93-14555
GENERALIZED VORTEX LATTICE METHOD FOR OSCILLATING LIFTING SURFACES IN SUBSONIC FLOW
PAULO A. O. SOVIERO (Inst. Tecnologico de Aeronautica, Sao Jose dos Campos, Brazil) and MARCOS V. BORTOLUS (Minas Gerais, Univ. Federal, Brazil) AIAA Journal (ISSN 0001-1452) vol. 30, no. 11 Nov. 1992 p. 2723-2729. refs
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A numerical method for calculating the unsteady pressure distribution on harmonically oscillating lifting surfaces in subsonic flow is presented. The Helmholtz equation for the complex velocity potential is written in integral form and solved by discrete panels superposition, which can be recognized as a generalization of the well-known vortex lattice method. Numerical calculations are carried out for a rectangular wing and are compared with well-established literature data. The influence of chordwise and spanwise discretization, as well as wake length, on the convergence rate, is also numerically studied. Good results have been obtained using the present method even for high values of reduced frequency and Mach number. Author

A93-14556
METHOD OF SIMULATING UNSTEADY TURBOMACHINERY FLOWS WITH MULTIPLE PERTURBATIONS
LI HE (Cambridge Univ., United Kingdom) AIAA Journal (ISSN 0001-1452) vol. 30, no. 11 Nov. 1992 p. 2730-2735. Research supported by Rolls-Royce, PLC refs
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Currently time-marching methods for unsteady turbomachinery flow calculations suffer from the inability to deal with multiple perturbations in a single-passage solution. A new periodic boundary condition method has been proposed, in which one can perform a single-passage solution with multiple perturbations. At the periodic boundaries, all of the perturbations are identified by their own phase-shifted periodicities and approximated by Fourier series. A combined parameter is chosen for the Fourier transform so that the Fourier coefficients can be efficiently updated. Corrections on both the variables at a current time level and on the Fourier coefficients are carried out repeatedly until a periodic state is reached. Numerical examples for oscillating cascade flows subject to inlet/outlet perturbations have demonstrated the validity of the present method and its ability to deal with situations of practical interest. Author

A93-14557
DETERMINATION OF VORTEX BURST LOCATION ON DELTA WINGS FROM SURFACE PRESSURE MEASUREMENTS
DOUGLAS I. GREENWELL and NORMAN J. WOOD (Bath Univ., United Kingdom) AIAA Journal (ISSN 0001-1452) vol. 30, no. 11 Nov. 1992 p. 2736-2739. refs
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A shape parameter for the vortex-induced upper surface pressure distribution on a delta wing has been derived from a simple two-dimensional potential flow model. For this model the half-width of the suction peak is a function solely of the vortex height above the wing surface. Published experimental data are used to show that this result holds for real delta wing flows at low angles of attack, thus allowing a good estimate of vortex trajectory and strength to be made from surface pressure measurements alone. At higher angles of attack, where the vortex burst region is over the wing, the simple model breaks down; however, the variation in half-width with both chordwise location and angle of attack appears to correlate well with the condition of the adjacent vortex. In particular, the burst point corresponds to an abrupt, well-defined change in half-width. This observation offers an alternative to flow visualization techniques for experimental determination of burst location. Author

A93-14564
CORIOLIS EFFECTS ON GOERTLER VORTICES IN THE BOUNDARY-LAYER FLOW ON CONCAVE WALL
AHMED AOUIDEF (ONERA, Chatillon, France), JOSE E. WESFREID (Ecole Superieure de Physique et de Chimie Industrielles, Paris, France), and INNOCENT MUTABAZI (Havre Univ., Le Havre, France) AIAA Journal (ISSN 0001-1452) vol. 30, no. 11 Nov. 1992 p. 2779-2782. refs
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A study is conducted on the stability of the boundary layer on a cave wall subject to uniform rotation around the axis of a curved plate, as encountered in turbomachine blading, centrifugal pumps, and centrifugal chemical reactors. It is shown that, when the rotating boundary layer on the concave wall with rotation axis parallel to the shear vorticity becomes unstable to longitudinal vortices, the rotation or the shear vorticity in the opposite direction stabilizes the flow and delays the appearance of Taylor-Goertler vortices. Attention is given to the asymptotic behavior of the marginal stability curve for large wave numbers. O.C.

A93-14628* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HYBRID LAMINAR FLOW CONTROL APPLIED TO ADVANCED TURBOFAN ENGINE NACELLES
F. S. COLLIER, JR., P. C. ARCARA, JR. (NASA, Langley Research Center, Hampton, VA), and Y. S. WIE (High Technology Corp., Hampton, VA) Apr. 1992 11 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992 refs
(SAE PAPER 920962) Copyright

The potential application of hybrid laminar flow control (HLFC) to the external surface of an advanced, high bypass ratio turbofan engine nacelle with a wetted area that approaches 15 percent of the wing total wetted area of future commercial transports is

presented. A pressure distribution compatible with HLFC is specified and the corresponding nacelle geometry is computed employing a predictor/corrector design technique. Performance evaluations on an advanced twin-engine transport configuration are discussed to determine potential benefits in terms of reduced fuel consumption. R.E.P.

A93-14782* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EXPERIMENTAL STUDY OF ROTOR WAKE/BODY INTERACTIONS IN HOVER
A. BAGAI and J. G. LEISHMAN (Maryland Univ., College Park) American Helicopter Society, Journal (ISSN 0002-8711) vol. 37, no. 4 Oct. 1992 p. 48-57. Research supported by Minta Martin Aeronautical Research Fund refs
(Contract DAAL03-88-C-0002; NAG2-607)
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Experiments were conducted to document the tip vortex geometries and interactional effects betwen a hovering rotor and a body representing a simplified helicopter fuselage. The wide-field shadowgraph technique was used to visualize the rotor tip vortices and to obtain quantitative information on the trajectories, with and without the presence of the body. It was found that the effects of the body caused significant changes to both the radial contraction and axial displacements of the tip vortices compared to the isolated case. Direct impingement of the tip vortices on the body surface was also observed, and found to cause large local wake deformations. The rotor performance was significantly affected by the body, producing a higher figure of merit relative to the isolated case. Author

A93-15034
STUDY OF A MACH 2 SUPERSONIC TRANSPORT AIRCRAFT [ETUDE D'UN AVION DE TRANSPORT SUPERSONIQUE CROISANT A MACH 2]
DUDLEY COLLARD (Aerospatiale, Div. Avions, Toulouse, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 141 1990 p. 42-51. In French.
Copyright

A review is presented of a study conducted to determine if a future SST is technically possible, commercially viable, and can meet the environmental rules when it is introduced into service. The design refinements for the contemplated SST are continually checked against the actual operating statistics of the Mach 2 Concorde. Attention is given to details of aerodynamics, powerplant installation, structural design, and material choices. R.E.P.

A93-15109
SUBSONIC SEPARATED FLOW PAST SLENDER DELTA WINGS [DOZVUKOVOE SRYVNOE OBTEKANIE TONKIKH KRYL'EV TREUGOL'NOI FORMY V PLANE]
V. I. VORONIN and A. I. SHVETS Moskovskii Universitet, Vestnik, Seriia 1 - Matematika, Mekhanika (ISSN 0579-9368) no. 4 July-Aug. 1992 p. 72-82. In Russian. refs
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A method is proposed for calculating the aerodynamic characteristics of slender delta wings of arbitrary aspect ratio in the path of subsonic flow of an incompressible nonviscous gas with flow separation at the leading edge. Results of calculations of the aerodynamic characteristics of slender delta wings of moderate and small aspect ratios are presented and compared with experimental data. V.L.

A93-15146
CALCULATION OF FLOW OF A RAREFIED GAS PAST A SPHERE FOR AN ARBITRARY KNUDSEN NUMBER [RASCHET OBTEKANIIA SFERY RAZREZHENNYM GAZOM PRI PROIZVOL'NOM CHISLE KNUDSENA]
S. K. MATVEEV and N. ZH. DZHAICHIBEKOV Sankt-Peterburgskii Universitet, Vestnik, Seriia 1 - Matematika, Mekhanika, Astronomiia (ISSN 0024-0850) no. 2 April 1992 p. 77-81. In Russian. refs
Copyright

Flow of a rarefied gas at large and moderate Knudsen numbers is modeled by the combined motion of two gases, with the distribution function in each gas assumed to be close to the Maxwellian value, with its own temperature and mean velocity. One of the gases consists of molecules of the incoming flow, while the other gas consists of surface-reflected molecules. This model is applied to the problem of flow past a sphere at large Mach numbers. The calculated density fields for Kn = 35 are in reasonably good agreement with the exact solution for free-molecular flow; the calculated sphere drag coefficients for Kn = 0.025-8.5 are in satisfactory agreement with experimental data. V.L.

A93-15178
OBLIQUE WAVE EVOLUTION IN A PLANE SUBSONIC BOUNDARY LAYER [O RAZVITII NAKLONNYKH VOLN V PLOSKOM DOZVUKOVOM POGRANICHNOM SLOE]
IU. I. BUBLIKOV and V. M. FOMICHEV PMTF - Prikladnaia Mekhanika i Tekhnicheskaia Fizika (ISSN 0044-4626) no. 3 May-June 1992 p. 45-50. In Russian. refs
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The stability of a plane subsonic laminar boundary layer of an incompressible fluid on an isothermal surface with respect to small-amplitude perturbations is investigated analytically using a mathematical model based on Navier-Stokes equations. It is shown that the notion that oblique waves play a less important role in the laminar-turbulent transition than direct waves is erroneous even in the case of a plane incompressible isothermal boundary layer in the plane-parallel approximation. Oblique waves may have lower Reynolds numbers of stability loss and higher increments and thus play an essential role in the transition to turbulence. V.L.

A93-15189
MODELING OF INTERFACES IN PROBLEMS OF FLOW OF A PONDERABLE FLUID PAST A WING PROFILE [MODELIROVANIE GRANITS RAZDELA V ZADACHAKH OBTEKANIIA PROFILIA KRYLA VESOMOI ZHIDKOST'IU]
M. V. LOTFULLIN and S. I. FILIPPOV PMTF - Prikladnaia Mekhanika i Tekhnicheskaia Fizika (ISSN 0044-4626) no. 4 July-Aug. 1992 p. 84-89. In Russian. refs
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The method of singularity distribution is used to solve the problem of flow of a two-layer ponderable fluid with a free surface past an airfoil in the case where the airfoil is located in the bottom layer of the fluid. The problem is relevant to the 'dead water' phenomenon associated with the formation of waves at the interface between fluids of different densities. By using the approach proposed here, the problem is reduced to that of solving a system of integral Fredholm equations of the second kind. V.L.

A93-15209
CALCULATION OF RADIANT ENERGY TRANSFER IN HYPERSONIC FLOW PAST BLUNT BODIES USING THE P1 AND P2 APPROXIMATIONS OF THE SPHERICAL HARMONIC METHOD [RASCHET PERENOSA LUCHISTOI ENERGII PRI GIPERZVUKOVOM OBTEKANII ZATUPLENNYKH TEL S ISPOL'ZOVANIEM P1- I P2-PRIBLIZHENII METODA SFERICHESKIKH GARMONIK]
V. M. BORISOV and A. A. IVANKOV Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki (ISSN 0044-4669) vol. 32, no. 6 June 1992 p. 952-966. In Russian. refs
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For solving multidimensional problems in radiation gas dynamics, a new approach has been developed whereby radiation transfer is calculated by the spherical harmonic method. Within the framework of this method, two successive approximations, P1 and P2, are used to account for the entire radiating-absorbing gas volume. The advantage of the approach is that a unified algorithm is used for solving both the gasdynamic and thermal parts of the common system of equations. Flow of air and a helium-hydrogen mixture past axisymmetric bodies of various shapes is considered as an example. V.L.

A93-15215
A FAST METHOD FOR CALCULATING THREE-DIMENSIONAL TRANSONIC POTENTIAL FLOWS IN TURBOMACHINE BLADE ROWS [BYSTRYI METOD RASCHETA PROSTRANSTVENNYKH TRANSZVUKOVYKH POTENTSIAL'NYKH TECHENII V VENTSAKH TURBOMASHIN]
P. M. BYVAL'TSEV and M. IA. IVANOV Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki (ISSN 0044-4669) vol. 32, no. 7 July 1992 p. 1093-1113. In Russian. refs
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An efficient method is presented for calculating three-dimensional steady-state subsonic, transonic, and supersonic potential flows in isolated turbomachine blade rows. The method is based on the numerical integration of a three-dimensional equation for the full velocity potential by means of a modified implicit relaxation method characterized by a high convergence rate. Calculation results are presented for three-dimensional flows in turbine blade rows and in a fan rotor. V.L.

A93-15216
A METHOD FOR CALCULATING SUPERSONIC THREE-DIMENSIONAL FLOWS IN PYRAMIDAL NOZZLES [OB ODNOM METODE RASCHETA SVERKHZVUKOVYKH PROSTRANSTVENNYKH TECHENII V PIRAMIDAL'NYKH SOPLAKH]
M. P. LEVIN and L. V. SIDOROV Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki (ISSN 0044-4669) vol. 32, no. 7 July 1992 p. 1138-1142. In Russian. refs
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In using the inverse method of characteristics for solving problems in supersonic aerodynamics, the initial data must be reinterpolated at each computation layer. The transition to an expanded characteristic form of gasdynamic equations makes it possible to avoid reinterpolation. Here, an implementation of such an approach is examined for the case of three independent variables on pyramidal templates. Calculation examples are presented to illustrate the accuracy and possibilities of this approach. V.L.

A93-15217
A CONFORMAL-INTEGRAL METHOD FOR SOLVING THE DIRECT PROBLEM IN TURBOMACHINE CASCADE AERODYNAMICS [KONFORMNO-INTEGRAL'NYI METOD RESHENIIA PRIAMOI ZADACHI AERODINAMIKI RESHETOK PROFILEI TURBOMASHIN]
F. F. NEVZOROV Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki (ISSN 0044-4669) vol. 32, no. 7 July 1992 p. 1145-1148. In Russian. refs
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An efficient approach to the solution of the direct aerodynamic problem for turbine cascades is proposed which combines the method of conformal mapping with the method of integral equations. It is shown that the approach proposed here makes it possible to significantly increase the solution accuracy and to expand the range of cascade types that can be calculated on a computer. V.L.

A93-15254
INSTABILITY OF LOCAL SEPARATED FLOWS WITH RESPECT TO SMALL-AMPLITUDE PERTURBATIONS [NEUSTOICHIVOST' LOKAL'NYKH OTRYVNYKH TECHENII K VOZMUSHCHENIIAM MALYKH AMPLITUD]
A. V. BOIKO and A. V. DOVGAL' (RAN, Inst. Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, Russia) Sibirskii Fiziko-Tekhnicheskii Zhurnal (ISSN 0869-1339) no. 3 May-June 1992 p. 19-24. In Russian. refs
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The paper is concerned with flow instability in local separation regions of a laminar boundary layer (separation bubbles) formed in flow of an incompressible gas. A simplified scheme is proposed which allows for the fact that flow instability seems to be independent of the mean velocity profile. The validity of the simplified scheme is supported by experimental measurements of the frequencies and increments of growing oscillations, characteristic of separation region, indicating the nonviscous nature of flow instability in separation bubbles. V.L.

A93-15256
ACOUSTIC CONTROL OF FLOW SEPARATION ON A STRAIGHT AND A YAWED WING [UPRAVLENIE OTRYVOM POTOKA NA PRIAMOM I SKOL'ZIASHCHEM KRYLE PRI POMOSHCHI ZVUKOVOGO VOZDEISTVIIA]
B. IU. ZANIN, V. V. KOZLOV, and V. N. LUSHIN (RAN, Inst. Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, Russia) Sibirskii Fiziko-Tekhnicheskii Zhurnal (ISSN 0869-1339) no. 3 May-June 1992 p. 32-36. In Russian. refs
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The effect of the irreversible reattachment of global separation under the effect of sound on a straight infinite-span wing model has been reported in an earlier study (Zanin et al., 1990). Here, results of a further study of this effect, including the case of three-dimensional flow over a yawed wing, are reported. The results of the study indicate that acoustic control of flow separation is applicable to a wide range of flows past wings, including swept wings. V.L.

A93-15341
AN AF3 ALGORITHM FOR THE CALCULATION OF TRANSONIC NONCONSERVATIVE FULL POTENTIAL FLOWS OVER WINGS OR WING/BODY COMBINATIONS
HONG-QUAN CHEN and MING-KE HUANG (Nanjing Aeronautical Inst., China) Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 5, no. 3 Aug. 1992 p. 150-158. Translation. Previously cited in issue 22, p. 3813, Accession no. A91-52189 refs
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A93-15443
TURBULENT STRUCTURE IN A VORTEX WAKE SHED FROM AN INCLINED CIRCULAR CYLINDER
TSUTOMU HAYASHI, FUMIO YOSHINO, RYOJI WAKA, SEIICHI TANABE, and TETSUYA KAWAMURA Japan Society of Mechanical Engineers, Transactions B (ISSN 0387-5016) vol. 58, no. 546 Feb. 1992 p. 297-304. In Japanese. refs

This paper proposes a method by which to infer the turbulent structure in a vortex wake shed from a finite-length inclined circular cylinder in a uniform flow using the power spectrum and cross correlation. It is inferred from the results of cross correlation that the shedding vortex from the inclined circular cylinder forms a step like vortex line or a sawtooth-shaped vortex line. It was observed through the power spectrum that the end condition of the inclined circular cylinder gives a sensitive influence to the spanwise distribution of the turbulent structure in a vortex wake. It is also found that the inferred turbulent structure agrees with an aspect inferred from the results of a numerical calculation.
Author

A93-15446
A FLAT PLATE WING STANDING ON A WALL COVERED WITH A THICK BOUNDARY LAYER. II - WING CHARACTERISTICS UNDER THE EFFECTS OF SIDE WALL BOUNDARY LAYER AND WING TIP VORTEX
YOSHINORI KITA, HIROAKI KOUMOTO, KOJI HIROSE, and KYOJI YAMAMOTO Japan Society of Mechanical Engineers, Transactions B (ISSN 0387-5016) vol. 58, no. 546 Feb. 1992 p. 430-436. In Japanese. refs

The flow on a flat-plate wing with low aspect ratio suffers the effect of side wall boundary layer and also of wing tip vortex. In this study, the flow on the suction surface of the wing is observed by the oil film visualization, and the pressure distribution on the wing surface along the chord is measured in many spanwise positions. The results obtained are as follows: the side wall boundary layer induces secondary flow which suppresses the separation of the flow near the root of the wing, and the wing tip vortex suppresses flow separation near the tip of the wing. On a small aspect ratio wing, the separation of the flow is suppressed

more strongly by the effects of both the side wall boundary layer and the wing tip vortex. Author

A93-15449
VISUALIZATION AND ANALYSIS OF SUPERSONIC FLOW IN ROTATING TURBINE STAGE. I - INFLUENCE OF SHOCK WAVE BETWEEN STATIONARY AND MOVING BLADES
MASASHI AKIBA, AKIHITO TODA, and KAORU UNO Japan Society of Mechanical Engineers, Transactions B (ISSN 0387-5016) vol. 58, no. 546 Feb. 1992 p. 602-606. In Japanese. refs

This paper presents visualization and analysis of the unsteady interaction and reflection of shock waves between stationary and moving blades in a rotating turbine. The stroboscope-type Schlieren method in which a reflection mirror is installed at the stationary blade flow path is utilized. The experimental turbine was running at 2000 rpm with a pressure ratio over 2.5. The periodical interaction and reflection of shock waves caused by the effects of rotating blades were observed clearly by photograph. The locations and deviations are verified from the calculations of the shock waves. Author

A93-15488
THE FREQUENCY OF INCIPIENT VORTEX-SHEDDING FROM A CIRCULAR CYLINDER IN A LAMINAR BOUNDARY LAYER (THE EFFECT OF THE GAP RATIO ON THE VORTEX SHEDDING FREQUENCY)
KAZUO MURAOKA and SHINICHI TASHIRO Japan Society of Mechanical Engineers, Transactions B (ISSN 0387-5016) vol. 58 Jan. 1992 p. 85-89. In Japanese. refs

The effect of the Reynolds number, the boundary layer thickness, and the gap ratio on the beginning of the periodic vortex-shedding from a circular cylinder in a laminar boundary layer was experimentally investigated. The Reynolds number, which was defined in terms of the cylinder diameter, and the free stream velocity, ranged from 40 to 1000. The range of the boundary layer thickness was from 0.08 to 0.38. The gap ratio defined by the circular cylinder and the clearance between the circular cylinder and the wall was varied from 0.38 to 3.0. As a result, the frequency of the vortex-shedding from the circular cylinder in the laminar boundary layer can be determined by the gap ratio, but it does not depend on the Reynolds number and the boundary layer thickness. Author

A93-15494
NUMERICAL ANALYSIS OF TWO-DIMENSIONAL TURBULENT FLOWS THROUGH AN OSCILLATING CASCADE
YOSHIO SHIKANO and KIYOSHI NAMURA Japan Society of Mechanical Engineers, Transactions B (ISSN 0387-5016) vol. 58 Jan. 1992 p. 139-144. In Japanese. refs

A numerical technique for the computation of two-dimensional unsteady turbulent flows through an oscillating cascade is presented. To consider the interblade phase angle, a time phase shifted boundary condition is introduced on the periodic boundaries. A finite volume method is used to obtain the spatially discretized governing equations, while the second-order accurate Adams-Bashforth method is employed for the time integration. In the present analysis, a two-equation model of turbulence is introduced to estimate the turbulence effect. In order to assure the effectiveness of the present method, computations are carried out for the flow through cascades of flat plate blades (inviscid flow analysis), lens-type blades and compressor blades. The present method gives unsteady periodic flow fields including the aerodynamic forces and moments acting on the blade clearly, and the negative damping force is obtained from the computational result of flat plate cascade flow. Author

A93-15495
MODAL ANALYSIS OF UNSTEADY AERODYNAMIC RESPONSE OF SUBSONIC ANNULAR CASCADE WITH STEADY LOADING UNDER ELASTIC VIBRATION
KAZUHIKO TOSHIMITSU and MASANOBU NANBA Japan Society of Mechanical Engineers, Transactions B (ISSN 0387-5016) vol. 58 Jan. 1992 p. 145-152. In Japanese. refs

Aerodynamic analysis based on the double linearization theory has been combined with a structural analysis by a finite element method to study the unsteady aerodynamic response of a rotating subsonic annular cascade composed of twisted blades undergoing three-dimensional elastic vibrations with chordwise displacements and flexible deformations. Numerical results are presented to demonstrate the unsteady pressure difference distributions on blade surfaces, aerodynamic works, three-dimensional effects and flutter boundaries for two kinds of cascade blades. In particular, it is found that the second elastic vibration mode can be most unstable for a turbine-type cascade with small camber operating at a subsonic Mach number. Author

A93-15627
UNSTEADY TRANSONIC AERODYNAMIC LOADINGS ON THE AIRFOIL CAUSED BY HEAVING, PITCHING OSCILLATIONS AND CONTROL SURFACE
ZHENG-HONG GAO (Northwestern Polytechnical Univ., Xian, China) Applied Mathematics and Mechanics (English Edition) (ISSN 0253-4827) vol. 13, no. 9 Sept. 1992 p. 805-813. refs
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The unsteady transonic aerodynamic loadings impinging on an airfoil due to heaving and pitching oscillations are derived based on calculations with unsteady Euler equations. The finite-difference and finite-volume methods are employed in combination with a central difference scheme to solve the Euler equations, and dissipative terms are introduced by means of a flux-splitting method based on time-dependent body-fitted coordinates. The implicit finite-volume formulations for the unsteady Euler equations are established, yielding tridiagonal block-matrix structures. The block matrices are transformed into separated tridiagonal algebraic expressions, and the analytical results are compared to some experimental data. Reasonable agreement is noted for values such as transonic flutter boundaries, active flutter suppression, and transonic time-response analysis. The Euler equations should be coupled with boundary-layer equations or Navier-Stokes equations to characterize viscous-inviscid interactions. C.C.S.

A93-16400
THE CONCORDE WING - A USEFUL MODEL
ROBERT G. LEGENDRE La Recherche Aerospatiale (English Edition) (ISSN 0379-380X) no. 2 1992 p. 81-84. refs
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A development history and retrospective evaluation is presented for the flow field calculation method initially devised by Roy (1952) and Legendre (1952) for the sharply swept and slender delta wings incorporated by the designers of Concorde. By keeping the supersonic speed of the calculation at a minimum, it was found possible to use the Jones approximation to simplify calculations. The Kutta-Joukowski condition was maintained at the trailing edge to preclude any discontinuity at the sound barrier. O.C.

A93-16473
STRONG COUPLING BETWEEN INVISCID FLUID AND BOUNDARY LAYER FOR AIRFOILS WITH A SHARP EDGE. II - 2D UNSTEADY CASE FOR ISOLATED AIRFOIL AND STRAIGHT BLADE CASCADE
C. SOIZE (ONERA, Chatillon, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X) no. 3 1992 p. 23-53. Research supported by DRET refs
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This article deals with 2D unsteady aeroelasticity in cascades of blades with sharp leading edges at positive incidence, not completely stalled, in a compressible flow. The upper surface boundary layer, which separates at the leading edge and reattaches on the airfoil, has a significant effect on the prediction of the steady and the unsteady aerodynamic forces. We present the mathematical and physical models of the boundary layer, and the proposed method for solutions with strongly coupled inviscid fluid and boundary layer. The inviscid fluid predictor, based on the

small transonic perturbation isentropic Euler equations, uses an unstructured finite element mesh of the computation domain. We give some numerical results with wind tunnel comparisons for an isolated airfoil and for a blade cascade. Several steady and unsteady cases are studied. A quasi-steady simplified approach is also proposed to determine the unsteady aerodynamic forces in cascades. Author

A93-16664
UNSTEADY TRANSONIC FLOW PAST A QUARTER-PLANE
N. PEAKE (Cambridge Univ., United Kingdom) Journal of Fluid Mechanics (ISSN 0022-1120) vol. 244 Nov. 1992 p. 377-404. Research supported by Emmanuel College refs
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A model problem of the unsteady interaction between a convected harmonic velocity gust and a quarter-plane is solved for the case of mean flow Mach number in the transonic range. Analysis of the detailed lift distribution near the leading edge and corner reveals the complicated nature of the lift singularity at the corner. The strength of the singularity is found to depend crucially on the path along which the corner was approached. Acoustically weighted lift is described by a closed-form expression that can be easily incorporated into existing noise prediction scheme to correct the rear-row blade response calculations for the presence of the blade tips. The analysis has yielded physical insight into the structure of the scattered field and the nature of unsteady corner interactions, and has provided approximate formulae and scaling laws which should be of practical interest. O.G.

A93-16666
A STUDY OF SINGULARITY FORMATION IN VORTEX-SHEET MOTION BY A SPECTRALLY ACCURATE VORTEX METHOD
M. J. SHELLEY (Chicago Univ., IL) Journal of Fluid Mechanics (ISSN 0022-1120) vol. 244 Nov. 1992 p. 493-526. Research supported by DARPA and NSF refs
(Contract N00014-86-K-0759; N00014-82-C-0451)
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A new, spectrally accurate approximation to the Birkhoff-Rott integral is used to compute the motion of periodic vortex sheets. It is found that to capture the correct asymptotic behavior of the spectrum, the calculations must be performed in very high precision, and second-order terms must be included in the Ansatz to the spectrum. The form of the singularity is found to depend upon the initial amplitude of the disturbance. Results suggest that either Moore's analysis gives the complete form of the singularity only in the zero amplitude limit, or that the initial data is not yet sufficiently small for the behavior to be properly described by the asymptotic analysis. O.G.

A93-16707
FLOW PAST A FINITE-SPAN WING IN THE PRESENCE OF EXTERNAL ACOUSTIC LOADING [OBTEKANIE KRYLA KONECHNOGO RAZMAKHA PRI VNESHNEM ZVUKOVOM VOZDEISTVII]
V. N. LUSHIN (Gosudarstvennyi Sibirskii NII Aviatsii, Novosibirsk, Russia) Sibirskii Fiziko-Tekhnicheskii Zhurnal (ISSN 0869-1339) no. 4 July-Aug. 1992 p. 64-68. In Russian. refs
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Flow past a finite-span wing in the presence of acoustic loading was investigated experimentally in a wind tunnel using a rectangular wing model with an aspect ratio of 5 and a span of 2.5 m. The tests were carried out for sideslip angles of 0, 15, and 30 deg and flow velocities ranging from 0 to 30 m/s. It is shown that acoustic loading has a substantial effect on the overall aerodynamic characteristics of the wing model and that the acoustic method can be used to control three-dimensional separation vortices generated on finite-span wings. V.L.

A93-16708
EFFECT OF THE BODY SHAPE ON HEAD SHOCK ATTENUATION AT A LARGE DISTANCE FROM THE AXIS [VLIIANIE FORMY TELA NA ZATUKHANIE GOLOVNOI UDARNOI VOLNY VDALI OT OSI]
M. S. REZNIKOV and A. I. RUDAKOV (RAN, Vychislitel'nyi Tsentr, Krasnoyarsk, Russia) Sibirskii Fiziko-Tekhnicheskii Zhurnal (ISSN 0869-1339) no. 4 July-Aug. 1992 p. 69-72. In Russian. refs
Copyright
Results of the numerical modeling of flow at a large distance from axisymmetric blunt bodies in the path of supersonic flow of a nonviscous non-heat-conducting gas are reported. In particular, attention is given to the effect of the body shape on the attenuation characteristics of shock wave perturbations and flow in the wake of the shock wave. Flow calculations are presented for a family of semiinfinite bodies with a parabolic spherically blunted nose for free-stream Mach 1.5, 2, 3, 4, 6, and 8. V.L.

A93-16932
EFFECT OF WING PLANFORMS ON INDUCED DRAG REDUCTION
AKIRA SUGIMOTO and JUNZO SATO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663) vol. 40, no. 466 1992 p. 603-609. In Japanese. refs
Effect of wing planforms on the induced drag is studied by using boundary element method. It is shown that the sweeping back of the wing tip of elliptical wings can reduce the induced drag. This reduction results from the increase of spanwise velocity component around the tip leading edge through the local increase of sweepback angles. The wake nonplanarity is shown to have little influence on the evaluation of induced drags. The minimum induced drag planforms are computed by using the nonlinear programming technique combined with some constraints on the wing tip maximum lift. Author

A93-16933
STUDY ON UNSYMMETRICAL SUPERSONIC NOZZLE FLOWS
SHIGERU MATSUO, YASUSHI WATANABE, and FUMIO HIGASHINO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663) vol. 40, no. 466 1992 p. 610-616. In Japanese. refs
The shape of scramjet-engine utilized for a space vehicle may be unsymmetrical in general. Supersonic flows generated in such asymmetric nozzle are very unstable due to pseudoshock waves. To analyze the effects of the nozzle contour on the flow, three kinds of nozzle configuration were examined experimentally. The interaction of supersonic expansion flows in the nozzle with the boundary layer developed on a nozzle wall was investigated by applying a Mach-Zehnder interferometer. This used an argon-ion laser with an electromagnetic shutter (AOM and EOM) as the light source. The frequency of the pseudoshocks was not affected by the flow velocity at the nozzle entrance but was affected by the nozzle configuration. It is possible to measure the density distribution in supersonic unsteady flow fields quantitatively by using the present optical system. Author

A93-17252
RECENT SUPERSONIC TRANSITION STUDIES WITH EMPHASIS ON THE SWEPT CYLINDER CASE
D. ARNAL, F. VIGNAU, and F. LABURTHE (ONERA, Toulouse, France) *In* Boundary layer transition and control; Proceedings of the Conference, Univ. of Cambridge, United Kingdom, Apr. 8-12, 1991 London Royal Aeronautical Society 1991 p. 3.1-3.14. refs
Copyright
This paper gives a survey of theoretical and experimental results related to the problem of boundary layer transition at supersonic speeds. The first part deals with linear stability computations in 2D mean flows. The effects of freestream Mach number, wall temperature, and streamwise pressure gradient are considered. Three-dimensional problems are studied in the second part of the paper. Experiments have been conducted on swept cylinders at a freestream Mach number equal to 10. No 'natural' transition was detected, but wall visualizations showed the appearance of streaks generated by crossflow instability. These phenomena are analyzed by using the linear stability theory. Boundary layer tripping experiments were also performed, with roughness elements placed

on and off the attachment line. It is confirmed that the attachment line is the location where the boundary layer is the most sensitive to the roughness effects. Author

A93-17253 National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A HIGH-FREQUENCY, SECONDARY INSTABILITY OF CROSSFLOW VORTICES THAT LEADS TO TRANSITION
YASUAKI KOHAMA (Tohoku Univ., Sendai, Japan), WILLIAM S. SARIC, and JON A. HOOS (Arizona State Univ., Tempe) *In* Boundary layer transition and control; Proceedings of the Conference, Univ. of Cambridge, United Kingdom, Apr. 8-12, 1991 London Royal Aeronautical Society 1991 p. 4.1-4.13. refs
(Contract NAG1-937; NCC2-659)
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Three-dimensional boundary-layer transition experiments are currently being conducted on a 45 deg swept wing in the Arizona State University Unsteady Wind Tunnel. Crossflow-dominated transition is produced via a model with contoured end liners to simulate infinite swept-wing flow. Fixed-wavelength, stationary and travelling crossflow vortices are observed. The frequencies of the most amplified travelling waves are in agreement with linear-stability theory; however travelling waves at frequencies an order of magnitude higher than predicted are also observed near transition. Near the transition location, the distorted boundary layer is due to the stationary crossflow vortex and is subject to a Rayleigh-type instability in the stream direction. As a result, a high-frequency secondary instability is detected in the transition region and spatial relations of the process are well documented by coupled use of flow visualization and hot-wire measurements. Author

A93-17256
APPLICATION OF LAMINAR FLOW TO AERO ENGINE NACELLES
A. J. MULLENDER (Rolls-Royce, PLC, Derby, United Kingdom), A. L. BERGIN, and D. I. A. POLL (Manchester Victoria Univ., United Kingdom) *In* Boundary layer transition and control; Proceedings of the Conference, Univ. of Cambridge, United Kingdom, Apr. 8-12, 1991 London Royal Aeronautical Society 1991 p. 10.1-10.7. Previously announced in STAR as N93-11020 Research supported by Royal Aerospace Establishment refs
Copyright

In the search for methods of reducing aircraft drag, the engine nacelle is considered as a candidate for laminar flow control. Preliminary results from wind tunnel tests on a two-dimensional model of Laminar Flow Control (LFC) by suction nacelles are presented. An approach to transition prediction using stability theory is outlined. The experimental results demonstrated the achievement of laminar flow by suction to a length Reynolds number of 4,600,000, in a two-dimensional model with a pressure distribution similar to that found on a conventional aero engine nacelle. The theoretical results obtained to date are inconsistent with the experimental results. The theoretically predicted separation bubble is located above the first suction compartment of the laminar flow central model and would be removed with the application of suction. Author

A93-17262
UNSTABLE BRANCHES OF A HYPERSONIC, CHEMICALLY REACTING BOUNDARY LAYER
GREGORY K. STUCKERT and HELEN L. REED (Arizona State Univ., Tempe) *In* Boundary layer transition and control; Proceedings of the Conference, Univ. of Cambridge, United Kingdom, Apr. 8-12, 1991 London Royal Aeronautical Society 1991 p. 19.1-19.13. Research supported by NSF refs
(Contract F49620-88-C-0076)
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The linear stability of viscous flow over a 10 degree cone is studied subject to different assumptions about the state of the gas flow. Ideal air, chemical equilibrium air, and chemical nonequilibrium air boundary layers are all investigated in detail to ascertain the effects of chemical reactions on the stability of the flow. Multiple viscous solutions are found which can to some extent be explained by the inviscid ideal gas linear stability theory. Author

A93-17264
ON THE CROSS-FLOW INSTABILITY NEAR A ROTATING DISK
P. R. SPALART (Boeing Commercial Airplane Group, Seattle, WA) *In* Boundary layer transition and control; Proceedings of the Conference, Univ. of Cambridge, United Kingdom, Apr. 8-12, 1991 London Royal Aeronautical Society 1991 p. 22.1-22.13. refs
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Linear disturbances with various degrees of spatial regularity and time-dependence, including an analogy to natural roughness, are considered in the present numerical simulations of linear disturbances in the flow near a rotating disk. The simulations cover the entire disk, and the results obtained are in good agreement with most experiments. It is judged on these bases that those theories which include curvature terms are accurate, and the Orr-Sommerfeld equations that exclude them are not. Vortices are found to generally follow logarithmic spirals. O.C.

A93-17265
NUMERICAL SIMULATION OF A THREE-DIMENSIONAL WAVE PACKET IN A GROWING FLAT PLATE BOUNDARY LAYER
U. KONZELMANN (Stuttgart Univ., Germany) and H. FASEL (Arizona Univ., Tucson) *In* Boundary layer transition and control; Proceedings of the Conference, Univ. of Cambridge, United Kingdom, Apr. 8-12, 1991 London Royal Aeronautical Society 1991 p. 24.1-24.11. refs
(Contract DFG-FA-117/2-1; DFG-FA-117/2-3)
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The physical parameters were chosen to closely model the experimental conditions of Gaster and Grant (1975). A very good qualitative and quantitative agreement of numerical simulation and experiment at the measuring positions of Gaster and Grant outside the boundary layer validates the numerical method. Inside the boundary layer, in the later stage of the evolution of the wave packet, structures appear, which are related to large velocity defects. These structures are similar to the subharmonic breakdown in controlled transition. The application of secondary stability analysis with the parameters of the simulated wave packet shows that, even for the small initial amplitudes of the wave packet, subharmonic effects play an important role in the wave packet transition process. Author

A93-17277
EXPERIMENTAL INVESTIGATION OF LAMINAR TO TURBULENT BOUNDARY LAYER TRANSITION WITH SEPARATION BUBBLES AT LOW REYNOLDS NUMBER
ALEX C. N. TAN and DOUGLASS J. AULD (Sydney Univ., Australia) *In* Boundary layer transition and control; Proceedings of the Conference, Univ. of Cambridge, United Kingdom, Apr. 8-12, 1991 London Royal Aeronautical Society 1991 p. 46.1-46.5. refs
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Experimental boundary layer investigations were conducted in a 3 ft x 4 ft low speed wind tunnel. A NACA 64-215 2D aerofoil section was surveyed over a range of Reynolds number from 100,000 to 400,000 and at angles of attack from -5 to 10 deg. Hot-wire anemometry was used to obtain mean velocity profiles. The standard boundary layer thickness and shape parameters were calculated from these mean profiles. Details of the measurement of the boundary layers, locations of laminar separation, transition, and reattachment are presented in this paper. Author

N93-12716# Tokyo Univ. (Japan). Inst. of Space and Astronautical Science.
EFFECT OF THE FLOW NON-UNIFORMITY ON THE MIXING LAYER AT THE INTERFACE OF PARALLEL SUPERSONIC FLOWS
TAKASHI ABE (Tokyo Univ., Sagamihara, Japan), KATSUSHI

FUNABIKI, HIRONOBU ARIGA (Musashi Inst. of Tech., Tokyo, Japan), and KATSUMI HIRAOKA (Tokai Univ., Tokyo, Japan) Jun. 1992 20 p
(ISSN 0285-6808)
(ISAS-RN-646) Avail: CASI HC A03/MF A01

The effect of flow non-uniformity on the supersonic mixing layer was investigated. The mixing layer is formed at the interface between the parallel supersonic flows of air and helium. The mixing layer was directly investigated by measuring the concentration ratio of helium. As for the flow non-uniformity, the stream-wise pressure gradient and the shock wave penetrating the mixing layer were considered. The effect of the stream-wise pressure gradient enhances the mixing rate by around 2 times in comparison with the one of the mixing layer without the effect. The shock impingement further enhances the mixing rate in comparison with the one of the mixing layer with the stream-wise pressure gradient but without the shock impingement. The enhancement of the mixing layer growth rate caused by the flow non-uniformities is attributed to the vorticity enhancement at the mixing layer, for which the baroclinic torque is a strong candidate. Author

N93-12721*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NAVIER-STOKES SIMULATIONS OF UNSTEADY TRANSONIC FLOW PHENOMENA
C. A. ATWOOD Aug. 1992 131 p
(Contract NCC2-540; NCC2-677; RTOP 505-59-00)
(NASA-TM-103962; A-92159; NAS 1.15:103962) Avail: CASI HC A07/MF A02

Numerical simulations of two classes of unsteady flows are obtained via the Navier-Stokes equations: a blast-wave/target interaction problem class and a transonic cavity flow problem class. The method developed for the viscous blast-wave/target interaction problem assumes a laminar, perfect gas implemented in a structured finite-volume framework. The approximately factored implicit scheme uses Newton subiterations to obtain the spatially and temporally second-order accurate time history of the blast-waves with stationary targets. The inviscid flux is evaluated using either of two upwind techniques, while the full viscous terms are computed by central differencing. Comparisons of unsteady numerical, analytical, and experimental results are made in two- and three-dimensions for Couette flows, a starting shock-tunnel, and a shock-tube blockage study. The results show accurate wave speed resolution and nonoscillatory discontinuity capturing of the predominantly inviscid flows. Viscous effects were increasingly significant at large post-interaction times. While the blast-wave/target interaction problem benefits from high-resolution methods applied to the Euler terms, the transonic cavity flow problem requires the use of an efficient scheme implemented in a geometrically flexible overset mesh environment. Hence, the Reynolds averaged Navier-Stokes equations implemented in a diagonal form are applied to the cavity flow class of problems. Comparisons between numerical and experimental results are made in two-dimensions for free shear layers and both rectangular and quieted cavities, and in three-dimensions for Stratospheric Observatory For Infrared Astronomy (SOFIA) geometries. The acoustic behavior of the rectangular and three-dimensional cavity flows compare well with experiment in terms of frequency, magnitude, and quieting trends. However, there is a more rapid decrease in computed acoustic energy with frequency than observed experimentally owing to numerical dissipation. In addition, optical phase distortion due to the time-varying density field is modelled using geometrical constructs. The computed optical distortion trends compare with the experimentally inferred result, but underpredicts the fluctuating phase difference magnitude.
Author

N93-13010 Florida Atlantic Univ., Boca Raton.
DYNAMIC STALL EFFECTS ON HINGELESS ROTOR STABILITY WITH EXPERIMENTAL CORRELATION Ph.D. Thesis
DINESH BARWEY 1992 283 p
Avail: Univ. Microfilms Order No. DA9213129

The effects of dynamic stall, lift, drag and pitching moment on the aeroelastic stability of hingeless rotors are predicted. The emphasis is on correlating the predictions with the measured lag-damping levels of a three-bladed model rotor operated in an untrimmed mode. The correlation covers a wide range of test conditions for several values of rotor speed, collective pitch angle, shaft-tilt angle and advance ratio. The database includes cases that vary from near zero-thrust conditions in hover to highly stalled forward-flight conditions with dimensionless speed or advance ratios as high as 0.55 and shaft angles as high as 20 degrees. The aerodynamic representation is based on the ONERA dynamic stall models comprising virtually independent unified lift, drag and pitching-moment models. The nonlinear equations of blade motion and stall dynamics are perturbed about a periodic forced response, and the damping is evaluated by Floquet analysis. The extensive correlation study, based on a rigid-blade flap-lag analysis, demonstrates the viability of Floquet analysis in predicting lagmode damping under dynamically stalled forward-flight conditions. It also demonstrates the limitations of the linear and quasisteady stall aerodynamic theories. In comparison to these theories, the theory with dynamic stall lift and quasisteady stall drag qualitatively improves the correlation and is viable over the entire range of the database. Addition of dynamic stall drag provides further quantitative improvement. Also presented is a comparative study of two dynamic stall drag models: circulation-like drag variables incorporating unsteady air-velocity variations and conventional drag-coefficient variables. While the formulation with drag coefficients exhibits computational sensitivity to convergence with respect to blade discretization for some isolated cases, the formulation with circulation-like drag variables removes this sensitivity and is computationally robust. The investigation concludes with an elastic blade analysis that includes blade flexibility in lag bending, flap bending and torsion as well as root-flexure elasticity. This analysis shows increasing sensitivity to structural refinements in blade and root-flexure modeling, and this sensitivity increases with increasing pitch setting. Correlation and parametric studies show that the root-flexure elasticity introduces significant bending-torsion couplings that have considerable impact on the stability of a rotor for which the root-flexure is soft, and the blade is stiffer in comparison with the root. This research is expected to serve as a reference comparison with other correlations based on different approaches of modeling dynamic stall and the elasticity of hingeless rotor blades and root-flexure.
Dissert. Abstr.

N93-13128 Michigan Univ., Ann Arbor.
A NUMERICAL STUDY OF HYPERSONIC FLOW WITH STRONG SURFACE BLOWING Ph.D. Thesis
NELSON DAVID CARTER 1992 153 p
Avail: Univ. Microfilms Order No. DA9226861

A possible means of controlling hypervelocity vehicles within the atmosphere is the use of boundary-layer blowing (blowing a gas from the vehicle surface) to introduce desired modifications in the pressure distribution along the surface, and thus provide the required control forces for the vehicle. This study considers the effects of massive blowing on the simple geometries of a flat plate and a wedge in a hypersonic flow. A computer code has been developed which can calculate the resulting flow field for a variety of different blowing distributions. A higher-order Godunov-type finite-volume approach is used to discretize the Euler and Navier-Stokes equations. Interface values of the state variable are reconstructed using a monotone interpolation technique based on Van Leer's kappa scheme. The inviscid fluxes are computed using Roe's upwind-biased flux-difference splitting technique. The viscous fluxes are calculated using central differencing. The time-differencing algorithms used are a line-implicit Gauss-Seidel iteration scheme and an explicit multi-stage scheme with optimized short-wave damping. Ideal and non-ideal gas flows are considered. For non-ideal gas flows, curve fit equations of state are used. The injection of gases other than air is also considered. The resulting numerical solutions compare well with analytical solutions which are known for certain blowing distributions and free-stream conditions. Favorable comparisons between the numerical solutions

and experimental results are also found for several cases. The computer code is also used to investigate the time evolution of the flow for both slot and continuous gas injection.
Dissert. Abstr.

N93-13141 Purdue Univ., West Lafayette, IN.
APPLICATION OF A SOLUTION ADAPTIVE GRID TO FLOW OVER AN EMBEDDED CAVITY Ph.D. Thesis
ANTHONY LINN THORNTON 1992 124 p
Avail: Univ. Microfilms Order No. DA9229199

The effect of a surface discontinuity (e.g. gaps, notches, cavities, etc.) on the local flowfield over flight vehicles has been an area of interest to researchers in fluid mechanics for many years. The most relevant problems relating to cavity flow include determining the effect the surface defect has on the local pressure and drag. A multivariable adaptive grid technique was developed to resolve the essential viscous and inviscid flow features in a compressible flow problem. The adaptive methodology, although one-dimensional in nature, assists in equally distributing the solution error throughout the flowfield. The adaptive scheme was applied to the steady 'open' cavity configuration in which the dividing streamline spans the length of the cavity. The analysis involves the numerical solution of the 2-D, compressible Navier-Stokes equations using the method of Beam and Warming. The goal of this investigation was to develop an understanding, both qualitative and quantitative, of the dominant flow features in the neighborhood of small gaps and notches embedded in a laminar supersonic boundary layer. The results of this research provide a clearer understanding of the effects of Reynolds number on the wall shear stress and pressure distribution within an open cavity in laminar, supersonic flow. Dissert. Abstr.

N93-13205# National Aerospace Lab., Amsterdam (Netherlands).
AERODYNAMIC ANALYSIS OF SLIPSTREAM/WING/NACELLE INTERFERENCE FOR PRELIMINARY DESIGN OF AIRCRAFT CONFIGURATIONS
C. M. VANBEEK, W. J. PIERS, and B. OSKAM *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 20 p Sep. 1992 Sponsored by Netherlands Agency for Aerospace Programs
Copyright Avail: CASI HC A03/MF A04

A panel method based model for the computation of the time-averaged influence of a propeller slipstream on the aerodynamic characteristics of an aircraft configuration is described. The slipstream model is based on the simplifications that the single-rotating propeller is replaced by an actuator disk and that all the vorticity of the slipstream is represented on a cylindrical sheet of fixed geometry which envelops the slipstream in combination with a discrete vortex at the axis of the slipstream. Appropriate jump conditions across the actuator disk and boundary conditions on the cylindrical sheet, solved simultaneously with the boundary conditions on the aircraft configuration, yield the mutual influence of the propeller and the slipstream on the aerodynamic characteristics of the aircraft configuration. This slipstream model is incorporated in a three-dimensional panel method. Computed lift increments due to the slipstream are presented for a realistic wing/nacelle/fuselage-configuration and compared with wind-tunnel data for several thrust coefficients and angles of attack of the aircraft. Author

N93-13221# Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany).
COMPARATIVE PERFORMANCE TESTS OF A PITOT-INLET IN SEVERAL EUROPEAN WIND-TUNNELS AT SUBSONIC AND SUPERSONIC SPEEDS
P.-A. MACKRODT, E. L. GOLDSMITH (Aircraft Research Association Ltd., Bedford, England), I. MCGREGOR (Royal Aircraft Establishment, Bedford, England), J. LEYNAERT (Office National d'Etudes et de Recherches Aerospatiales, Paris, France), F. GARCON (Office National d'Etudes et de Recherches Aerospatiales, Modane, France), and J. BRILL (Messerschmitt-Boelkow-Blohm G.m.b.H., Munich, Germany) *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 14 p Sep. 1992
Copyright Avail: CASI HC A03/MF A04

A common design of inlet model (RAE Model 742L Cowl 2), but built to slightly different scales (convenient to the specific wind tunnel), was investigated in the RAE 8 ft x 8 ft tunnel, the ONERA S2MA-tunnel (1.75 m x 1.77 m), and the transonic 1 m x 1 m wind tunnel (TWG) of DLR. The measurements were carried out at subsonic and supersonic Mach numbers, at several Reynolds numbers and angles of attack. The paper presents--aside of a short description of the wind tunnels and the models--details of the instrumentation and the formulae used to calculate the steady-state and the instantaneous distortion parameters. A brief description of the data acquisition and reduction systems is also given. Results of the three tests are presented in the usual format, and from the comparison of the results the differences are analyzed and the main origins of the discrepancies discussed and explained. Finally some recommendations are given for reducing those discrepancies in further tests. Author

N93-13223# Nangia Associates, Bristol (England).
APPLICATION OF SUBSONIC FIRST-ORDER PANEL METHODS FOR PREDICTION OF INLET AND NOZZLE AERODYNAMIC INTERACTIONS WITH AIRFRAME
R. K. NANGIA and M. E. PALMER *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 16 p Sep. 1992
Copyright Avail: CASI HC A03/MF A04

Modern aircraft require intake and nozzle flows to be closely integrated with the airframe, and various layouts are possible. In some cases, the intake/nozzle is integral with the fuselage providing a relatively 'compact' layout. This contrasts with configurations in which the nacelles are displaced from the fuselage but are near lifting surfaces. Engine intake flow conditions may range from very high Mass Flow Ratio (MFR) at take-off, to very low MFR on approach, and may include zero MFR during inflight shut-downs. The effect of the intake flows on adjacent components will vary with intake MFR, aircraft attitude, and Mach number. Designers need to know the magnitude of these effects to ensure that they can be contained to satisfactory levels within the available control parameters. A first-order panel method was used to analyze the MFR effects on several configurations. These range from simple 'generic' types to complex, Canard-Delta configurations and include various intake and nozzle arrangements. Mach number and asymmetric effects were studied in particular cases. Author

N93-13292*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
RADIAL TURBINE COOLING
RICHARD J. ROELKE Apr. 1992 42 p Presented at the Lecture Series on Radial Turbines at the von Karman Inst. for Fluid Dynamics, Brussels, Belgium, 6-10 Apr. 1992 Original contains color illustrations
(Contract RTOP 535-05-10)
(NASA-TM-105658; E-7022; NAS 1.15:105658) Avail: CASI HC A03/MF A01; 2 functional color pages

Radial turbines have been used extensively in many applications including small ground based electrical power generators, automotive engine turbochargers and aircraft auxiliary power units. In all of these applications the turbine inlet temperature is limited to a value commensurate with the material strength limitations and life requirements of uncooled metal rotors. To take advantage of all the benefits that higher temperatures offer, such as increased turbine specific power output or higher cycle thermal efficiency, requires improved high temperature materials and/or blade cooling. Extensive research is on-going to advance the material properties of high temperature superalloys as well as composite materials including ceramics. The use of ceramics with their high temperature potential and low cost is particularly appealing for radial turbines. However until these programs reach fruition the only way to make significant step increases beyond the present material temperature barriers is to cool the radial blading. Author

N93-13322*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
IN-FLIGHT FLOW VISUALIZATION RESULTS FROM THE X-29A AIRCRAFT AT HIGH ANGLES OF ATTACK
JOHN H. DELFRATE and JOHN A. SALTZMAN (PRC Kentron, Inc., Edwards, CA.) Nov. 1992 17 p Presented at the 6th Biennial Flight Test Conference, Hilton Head, SC, 24-26 Aug. 1992 Previously announced in IAA as A93-11272
(Contract RTOP 533-02-38)
(NASA-TM-4430; H-1825; NAS 1.15:4430; AIAA PAPER 92-4102)
Copyright Avail: CASI HC A03/MF A01

Flow visualization techniques were used on the X-29A aircraft at high angles of attack to study the vortical flow off the forebody and the surface flow on the wing and tail. The forebody vortex system was studied because asymmetries in the vortex system were suspected of inducing uncommanded yawing moments at zero sideslip. Smoke enabled visualization of the vortex system and correlation of its orientation with flight yawing moment data. Good agreement was found between vortex system asymmetries and the occurrence of yawing moments. Surface flow on the forward-swept wing of the X-29A was studied using tufts and flow cones. As angle of attack increased, separated flow initiated at the root and spread outboard encompassing the full wing by 30 deg angle of attack. In general, the progression of the separated flow correlated well with subscale model lift data. Surface flow on the vertical tail was also studied using tufts and flow cones. As angle of attack increased, separated flow initiated at the root and spread upward. The area of separated flow on the vertical tail at angles of attack greater than 20 deg correlated well with the marked decrease in aircraft directional stability. Author

N93-13353*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EFFECTS OF FOREBODY STRAKES AND MACH NUMBER ON OVERALL AERODYNAMIC CHARACTERISTICS OF CONFIGURATION WITH 55 DEG CROPPED DELTA WING
GARY E. ERICKSON and LAWRENCE W. ROGERS (Wright Lab., Wright-Patterson AFB, OH.) Nov. 1992 171 p
(Contract RTOP 505-68-30-03)
(NASA-TP-3253; L-17060; NAS 1.60:3253) Avail: CASI HC A08/MF A02

A wind tunnel data base was established for the effects of chine-like forebody strakes and Mach number on the longitudinal and lateral-directional characteristics of a generalized 55 degree cropped delta wing-fuselage-centerline vertical tail configuration. The testing was conducted in the 7- by 10-Foot Transonic Tunnel at the David Taylor Research Center at free-stream Mach numbers of 0.40 to 1.10 and Reynolds numbers based on the wing mean aerodynamic chord of 1.60 x 10(exp 6) to 2.59 x 10(exp 6). The best matrix included angles of attack from 0 degree to a maximum of 28 degree, angles of sidesip of 0, +5, and -5 degrees, and wing leading-edge flat deflection angles of 0 and 30 degrees. Key flow phenomena at subsonic and transonic conditions were identified by measuring off-body flow visualization with a laser screen technique. These phenomena included coexisting and interacting vortex flows and shock waves, vortex breakdown, vortex flow interactions with the vertical tail, and vortices induced by flow separation from the hinge line of the deflected wing flap. The flow mechanisms were correlated with the longitudinal and lateral-directional aerodynamic data trends. Author

N93-13451 Oxford Univ. (England).
MATHEMATICAL PROBLEMS IN INVISCID HYPERSONIC FLOW Ph.D. Thesis
KEN LOUIE 1991 156 p
Avail: Univ. Microfilms Order No. BRD-95126

Some simple models for inviscid gas flows are studied in the hypersonic limit. Initially, the treatment will be restricted to perfect gases but a major part of the thesis will be concerned with the effects when simple chemical reactions also occur. Unsteady 1-D flows are studied first and the piston problem is examined in detail. When the piston is given a power-law path with time, solutions do not always exist when the exponent in the power-law is less than a critical value. This is shown to be the case whether or not reactions are included. Hence the question of regularization of the piston problem arises and is addressed in a later chapter. Steady 2-D and axisymmetric flow past thin and slender bodies is then studied and its equivalence to unsteady 1-D flow demonstrated. This equivalence is shown to also apply to some reacting flows. For the general piston problem and the steady flow past thick and non-slender bodies, the Newtonian limit enables simple results to be obtained. The usual perfect gas analysis is extended to include the effects of a simple reaction. For steady flow, this does not seem to greatly modify the singularities manifest in this limit, the most important of which is the vanishing of the surface pressure at some point downstream. The resolution of this difficulty is to allow the shock layer to separate at the point where the surface pressure vanishes. This idea is shown to be useful also for the piston problem in the case where the solution breaks down. A novel regularization is presented for the piston problem which enables a scenario to be put forward for those piston motions previously untreatable. The solution is not completely independent of the regularization in the limit as the regularizing parameter tends to zero. Dissert. Abstr.

N93-13463*# Pennsylvania State Univ., University Park. Dept. of Aerospace Engineering.
ANALYSIS AND DESIGN OF PLANAR AND NON-PLANAR WINGS FOR INDUCED DRAG MINIMIZATION Final Progress Report
KARL W. MORTARA, DENNIS M. STRAUSSFOGEL, and MARK D. MAUGHMER Nov. 1992 60 p
(Contract NAG1-1198)
(NASA-CR-191274; NAS 1.26:191274) Avail: CASI HC A04/MF A01

The goal of the work reported herein is to develop and validate computational tools to be used for the design of planar and non-planar wing geometries for minimum induced drag. Because of the iterative nature of the design problem, it is important that, in addition to being sufficiently accurate for the problem at hand, these tools need to be reasonably fast and computationally efficient. Toward this end, a method of predicting induced drag in the presence of a free wake has been coupled with a panel method. The induced drag prediction technique is based on the application of the Kutta-Joukowski law at the trailing edge. Until now, the use of this method has not been fully explored and pressure integration and Trefftz-plane calculations favored. As is shown in this report, however, the Kutta-Joukowski method is able to give better results for a given amount of effort than the more commonly used techniques, particularly when relaxed wakes and non-planar wing geometries are considered. Using these methods, it is demonstrated that a reduction in induced drag can be achieved through non-planar wing geometries. It remains to determine what overall drag reductions are possible when the induced drag reduction is traded-off against increased wetted area. With the design methodology that is described herein, such trade studies can be performed in which the non-linear effects of the free wake are taken into account. Author

N93-13493 Oklahoma State Univ., Stillwater.
CHAOTIC VORTICAL MOTION IN THE NEAR REGION OF A PLANE JET Ph.D. Thesis
JAMES W. CUTBIRTH 1991 157 p
Avail: Univ. Microfilms Order No. DA9220551

The primary objective of this thesis is to understand on a quantitative basis the detailed nonlinear interactions between vortical structures in the near region of a planar jet. For the purpose of this investigation, lowlevel acoustic excitation near the most unstable natural jet shear layer frequency and at three times the jet column mode were introduced in order to organize the initial instability and isolate specific pairing mechanisms. Flow visualization and power spectra were the primary tools used for the investigation. The quantitative analysis based on flow visualization data indicates that the coherent structure formation near the nozzle exit is not exactly periodic. Shortly after the first pairing, the vortex motion becomes chaotic. Thus no long term,

continuously repeating pattern of vortex roll-up, motion and pairing exists. The coherent structures remain strongly two-dimensional until the end of the potential core where the structures breakdown into three-dimensional motion. This is substantially further downstream as compared to the location where chaotic motion was identified. Dissert. Abstr.

N93-13521 Washington Univ., Seattle.
NUMERICAL SIMULATION OF THE ACOUSTIC INSTABILITY IN THE SPATIALLY DEVELOPING, CONFINED, SUPERSONIC MIXING LAYER Ph.D. Thesis
LINDA SIGALLA HEDGES 1991 147 p
Avail: Univ. Microfilms Order No. DA9216120

The spatially developing, confined, two-dimensional, supersonic mixing layer is investigated using both linear stability theory and numerical simulation. The purpose of this work is to further the understanding of the physical instability mechanisms responsible for transition from laminar to turbulent flow (and hence for mixing) in the supersonic mixing layer. Though the type of instability initially responsible for transition to turbulent flow is unknown, a prime candidate is the acoustic instability. The acoustic instability, present in confined, supersonic mixing layers, results from the interaction of the shear layer interface with compression and expansion waves reflecting off of the channel walls. Numerical simulations are used to investigate the supersonic acoustic instability modes and their nonlinear interactions. The subsonic mixing layer is also simulated to provide a basis for comparison and validation. In the simulations, the two-dimensional, nonsteady Euler equations are solved using a total variation diminishing (TVD) finite difference technique. Numerical simulations include simulations of isolated modes, simple modal interactions, and the instability generated with a broadbanded white noise perturbation. Results show that the acoustic instability is robust in the two-dimensional supersonic mixing layer and that the physical instability mechanism responsible for mixing and instability growth is engulfment. The behavior of the acoustic instability seen in the supersonic mixing layer is significantly different from the behavior of the Kelvin-Helmholtz instability seen in the subsonic mixing layer. In the supersonic mixing layer, many acoustic modes grow simultaneously. In the subsonic mixing layer, generally one primary Kelvin-Helmholtz mode grows, followed by its subharmonics as the downstream distance increases. Numerical simulations of interacting pairs of acoustic modes show that the modes interact destructively and suppress each other's growth. At the same time, new modes are excited and grow. The supersonic mixing layer does not exhibit pairing by the subharmonic, as seen in subsonic mixing layers. However, evidence of accretion of vortices is seen in the broadbanded mixing layer. Finally, a one-to-one relationship between the temporally and spatially developing mixing layers is shown. Dissert. Abstr.

N93-13578 Stanford Univ., CA.
DEVELOPMENT AND COMPUTATION OF CONTINUUM HIGHER ORDER CONSTITUTIVE RELATIONS FOR HIGH-ALTITUDE HYPERSONIC FLOW Ph.D. Thesis
XIAOLIN ZHONG 1991 147 p
Avail: Univ. Microfilms Order No. DA9206895

The use of computational fluid dynamics (CFD) to study the aerodynamics of compressible viscous flow in the continuum transitional regime at high altitudes is discussed. The CFD codes are based on continuum higher order constitutive relations, i.e. the Burnett equations, which are more accurate than the conventional Navier-Stokes equations at high altitudes. Until 1988, the Burnett equations were rejected for high-altitude flow computations primarily because no solution could be obtained for hypersonic flow. Recent solutions were possible for low altitudes, but not for high altitudes, because the conventional Burnett equations are unstable to disturbances of short wavelengths. This fundamental instability precludes Burnett flow-field computations above a certain maximum altitude for any given vehicle. Therefore, it is necessary to overcome this Burnett instability. The objective is to develop a set of higher order and nonlinear constitutive equations representing a generalization of the Burnett equations, which would be stable to numerical computations at all altitudes. A new set of equations termed the 'augmented Burnett equations' was developed in order to stabilize and to maintain the accuracy of the conventional Burnett equations. Subsequently, an implicit numerical method was developed to solve the augmented Burnett equations. The first Burnett solutions for 2-D hypersonic flow past blunt bodies were obtained and compared with the corresponding Navier-Stokes and Direct Simulation Monte Carlo solutions. The comparison showed that the Burnett equations provide the same results as the Navier-Stokes equations do at low altitudes, but provide more accurate results at high altitudes. In conclusion, the Burnett equations seem to be able to progress into regions of strong nonequilibrium flow at high altitudes where the Navier-Stokes equations are inaccurate. Further research is needed to resolve some remaining technical issues concerning the Burnett equations, including the issues of the most appropriate surface boundary conditions for their higher derivative terms and their frame dependence. Dissert. Abstr.

N93-13632 Georgia Inst. of Tech., Atlanta.
VELOCITY AND TEMPERATURE MEASUREMENTS IN A NON-PREMIXED REACTING FLOW BEHIND A BACKWARD FACING STEP Ph.D. Thesis
MEN-ZAN BILL WU 1992 150 p
Avail: Univ. Microfilms Order No. DA9223802

A basic design requirement for aerospace propulsion systems is the inclusion of a flame anchoring region in the combustor. This region must be characterized by highly turbulent flow for enhancing extensive mixing of fuel and air for combustion and by flow velocities lower than the flame propagation speed of the mixture. One such configuration, applicable to ramjet type combustion problems, is that of a backward facing step. The application takes advantage of the flow recirculation region for flameholding, and of the high mixing rates in the free shear layer for enhanced combustion efficiency. The specific effort of this research was to investigate experimentally the temperature and velocity distributions in a flow field, generated by the non-premixed hydrogen combustion behind a backward facing step. The region of interest includes turbulent reacting flow with recirculation. The diagnostics used include laser Doppler velocimetry (LDV), Rayleigh scattering and laser Raman spectroscopy (LRS), which permit in-situ measurements with good spatial and temporal resolution. The velocity measurements were carried out using a two component LDV system. Time averaged measurements were used to acquire mean velocities and turbulence intensities. LRS has been utilized to investigate the temperature or species concentration in high temperature reacting flows. The intensity of the Stokes line of nitrogen was used to infer the temperature of the flow in this study. The temperature distribution obtained using LRS measurement is consistent with those using Rayleigh scattering and thermocouple. The following results were obtained in this study: (1) a comparison of velocity fields for the non-reacting and reacting flows has shown that chemical reaction lengthens the reattachment length of the flowfield; (2) combustion occurs primarily in the free shear layer with the flame sheet, as indicated by the location of maximum temperature coinciding with the region of maximum turbulence intensity; (3) the location of maximum temperature fluctuation coincides with the area of steepest mean temperature gradient near the upper edge of the flame; and (4) the presence of chemical reaction in the flow appears to reduce the turbulence intensities inside the free shear layer, resulting in a lower mixing rate for the reacting flow. Dissert. Abstr.

N93-13729 Georgia Inst. of Tech., Atlanta.
HIGH-SPEED AERODYNAMICS OF UPPER SURFACE BLOWING AIRCRAFT CONFIGURATIONS Ph.D. Thesis
LARRY DEAN BIRCKELBAW 1992 209 p
Avail: Univ. Microfilms Order No. DA9223767

Excellent Short Take-Off and Landing (STOL) performance is achieved by Upper Surface Blowing (USB) aircraft as a result of mounting high by-pass turbofan engines over the forward part of the wing. High lift levels are generated by directing the engine exhaust over the wing upper surface to entrain additional airflow and by using the Coanda effect to turn the exhaust flow downward

over a large radius 'Coanda' flap. Commercial application of USB technology could reduce airport congestion and community noise if future configurations can be designed with economically acceptable cruise drag levels. An experimental investigation of the high speed aerodynamics of USB aircraft configurations has been conducted to accurately define the magnitude and causes of the powered configuration cruise drag. A highly instrumented wind tunnel model of a realistic USB configuration has been used which permitted parametric variations in the number and spanwise location of the nacelles and accurately modeled the engine power effects with turbofan propulsion simulators. The measured force data provides an accurate definition of the cruise drag penalty associated with each configuration and the constructed pressure contour plots provide detailed insight into their causes. It was found that the high speed aerodynamics of USB configurations is a complex interaction of jet induced and wing transonic flowfields. The presence of the nacelles on the wing upper surface created a severe drag penalty which increased with freestream Mach number, power setting and angle of attack. The more widely spaced two nacelle configurations exhibited improved flowfields at moderate Mach numbers but suffered from drag levels comparable to the baseline configuration for high speed cruise conditions. At high Mach numbers and power settings, all of the tested configurations displayed strong shocks and separated zones in the wing/nacelle junction regions. Detailed discussions of the causes of the cruise drag penalty and recommended future design improvements are presented. Dissert. Abstr.

N93-13745 Maryland Univ., College Park.
PERFORMANCE AND CONTROL OF ASCENDING TRAJECTORIES TO MINIMIZE HEAT LOAD FOR TRANSATMOSPHERIC AERO-SPACE PLANES Ph.D. Thesis
AHMED ZAFER AL-GARNI 1991 373 p
Avail: Univ. Microfilms Order No. DA9205023

This is a study of the performance and control of ascending trajectories for Transatmospheric Vehicles (TAV), that use air-breathing propulsion. The minimization of heat load per unit area near the stagnation point is addressed. The vehicle is modelled as a variable point mass with parabolic drag polar, and variable lift and thrust. The earth is assumed to be spherical, with an exponential atmosphere. The research is structured in two parts. The first part is analytical, and seeks closed form solutions for the non-linear feedback controls (aerodynamic and thrust), which are necessary to transfer the TAV from one specified state (e.g., altitude, h(sub 1) is approximately 20 km; Mach number M is approximately 5; and heat load, Q(sub 1) is approximately 5 kJ/sq cm, etc.), to a second specific state (e.g., altitude h(sub 2) is approximately 65 km; Mach number M(sub 2) is approximately 25; and heat load, Q(sub 2) is less than or equal to 500 kJ/sq cm, etc.), while satisfying given equality constraints such as constant dynamic pressure with constant rate of climb. Certain algebraic relationships among the state variable and controls have been derived, and the heat load, along with most of the state variable, were integrated analytically. The achieved heat load can be less than 300 kJ/sq cm for most of the cases and situations discussed, which is less than that obtained in previous literature. The analytical results were a useful guide to the numerical studies in the second part. The second part is an extensive numerical optimization study. A feedback law was selected with parameters chosen by computational methods. A heat load Q less than or equal to 300 kJ/sq cm and controls in the reachable domain were achieved in most cases and situations. The trajectories of the aerospace planes or (TAV) were found to be within a reasonable flight corridor given current research and technology. The effect of certain vehicle design parameters were studied. The research has revealed no fundamental barriers in the performance and control of the TAV although improvement is necessary in all of the propulsion, aerodynamic, and cooling systems. Dissert. Abstr.

N93-13746 Stanford Univ., CA.
APPLICATION OF A VECTORIZED PARTICLE SIMULATION TO THE STUDY OF PLATES AND WEDGES IN HIGH-SPEED RAREFIED FLOW Ph.D. Thesis
MICHAEL STANLEY WORONOWICZ 1991 255 p
Avail: Univ. Microfilms Order No. DA9205745

The scientific community has placed a great deal of emphasis on understanding the unique phenomena associated with hypersonic, rarefied flowfields in order to successfully design future high-speed, high-altitude flight vehicles. Scientists are interested in using particle simulation methods to recreate the combinations of speeds and rarefaction associated with flight through the upper atmosphere. Particle methods build up a macroscopic flowfield based on the interactions of thousands or millions of particles that behave as molecules on the microscopic level. Unfortunately, most particle methods employ basic algorithms that are incompatible with the architecture and resources of most high-speed computers. The Stanford Particle Simulation Method (SPSM) overcomes these disadvantages by paying strict attention to details incorporating the advantages of these machines while retaining correct macroscopic physical behavior. Since this method is still quite new, it must be adequately tested in order to gain acceptance in the scientific and engineering communities. The purpose of the current investigation is to use the advantages afforded by the SPSM to help establish the method's legitimacy by thoroughly studying a relatively simple two-dimensional flowfield: high-speed, low-density, viscous flow over a flat plate at zero incidence. The freestream Knudsen number is varied such that the simulation's solutions range from continuum flow all the way to the free-molecule limit. Issues concerning proper implementation of boundary conditions for simulation wind tunnels and geometry models are discussed, and novel approaches are used to develop a diffuse adiabatic boundary condition and make necessary alterations for highly-rarefied and free-molecule conditions. A review of experimental data is present, and a new parameter is developed using aspects of kinetic theory and demonstrated to correlate hypersonic, rarefied drag and heat transfer data better than commonly-used alternatives. Surface-flux quantities, such as drag and heat transfer, obtained by the simulation are compared to experimental data whenever possible. Aspects of the simulation's surface-flux and flowfield results are compared to theories, where available. In addition, a more complicated hypersonic, rarefied, two-dimensional flow over a wedge was studied and compared to experimental results. Dissert. Abstr.

N93-13801 Virginia Univ., Charlottesville.
PLANAR MEASUREMENT OF FLOW FIELD PARAMETERS IN NONREACTING SUPERSONIC FLOWS WITH LASER-INDUCED IODINE FLUORESCENCE Ph.D. Thesis
ROY JAMES HARTFIELD, JR. 1991 187 p
Avail: Univ. Microfilms Order No. DA9219294

Planar measurements of temperature, pressure, velocity, and injectant mole fraction were conducted in cold supersonic milling flow fields using laser-induced iodine fluorescence. The measurements were conducted by seeding the flow fields with iodine, inducing fluorescence with an argon ion laser sheet, and imaging the fluorescence with a liquid nitrogen cooled charge coupled device (CCD) camera. To conduct these measurements, it was necessary to develop and verify new measurement techniques for temperature and pressure suitable for use with planar imaging. Injectant mole fraction and temperature were measured using fluorescence induced by broad band excitation. Pressure and velocity were determined from the profile and position of an absorption transition. The shape and position of the transition were measured using fluorescence resulting from narrow band excitation. The flow fields investigated are configured geometrically as SCRAMJET combustors. Both tangential and transverse injection flow fields were investigated. These measurements provide extensive maps of the thermodynamic parameters and are suitable for the validation of computational fluid dynamic codes. The measurements of injectant mole fraction are spatially complete and provide a measure of milling efficiency. Dissert. Abstr.

N93-13803 Virginia Polytechnic Inst. and State Univ., Blacksburg.
AIRFOIL-VORTEX INTERACTION AND THE WAKE OF AN OSCILLATING AIRFOIL Ph.D. Thesis
MICHAEL CURTIS WILDER 1992 223 p
Avail: Univ. Microfilms Order No. DA9218519

Laser Doppler velocimetry, a non-intrusive flow measurement technique, was employed to experimentally investigate two-dimensional airfoil-vortex interaction. Vortices were generated by sinusoidally oscillating a NACA 0012 airfoil about its quarter-chord at a reduced frequency of k = 2.05 and an amplitude of +/- 10 deg angle of attack. The target airfoil, a NACA 632A015, was immersed in the wake, two chord lengths downstream of the vortex generator's trailing edge. Phase-averaged velocity measurements of the flow around the target airfoil were made with the airfoil at angles of attack of alpha = 0 deg and alpha = 10 deg. A close encounter with a counterclockwise rotating vortex was observed for both angles of attack, and a head-on collision, which split the counterclockwise rotating vortex in two, was observed for alpha = 10 deg. Vorticity fields were constructed from the velocity measurements and the circulation of the vortex was evaluated throughout the interaction. The surface pressure fluctuations on the airfoil were determined by substituting the measured velocities into the Navier-Stokes equations and numerically integrating the resulting pressure gradients. Furthermore, an extensive investigation of the undisturbed wake of the oscillating airfoil was performed in order to determine the effect of oscillation frequency and amplitude on the wake development. Dissert. Abstr.

N93-13822 Georgetown Univ., Washington, DC.
ASSESSMENT OF POTENTIAL AERODYNAMIC BENEFITS FROM SPANWISE BLOWING AT THE WING TIP Ph.D. Thesis
RAYMOND EDWARD MINECK 1992 359 p
Avail: Univ. Microfilms Order No. DA9222636

A comprehensive set of experimental and analytical investigations have been conducted to assess the potential aerodynamic benefits from spanwise blowing at the tip of a moderate aspect ratio, swept wing. An analytical model has been developed to simulate a jet exhausting from the wing tip. The model demonstrated that vorticity added to the flowfield by the jet near the wing tip tends to diffuse the tip vortex and displace it outwards. The diffused and displaced vortex should induce a smaller downwash at the wing and, consequently, the wind should have increased lift and decreased induced drag. An experimental study of a subsonic jet exhausting from the wing tip was conducted to investigate the effect of spanwise blowing from the tip on the aerodynamic characteristics of a moderate aspect ratio, swept wing. Special attention was given to obtaining accurate balance measurements in the presence of the air supply lines. Wing force and moment data and surface pressure data were measured at Mach numbers up to 0.72. Results indicated that small amounts of blowing from small jets increase the lift curve slope a small amount but have little effect on drag. Larger amounts of blowing from longer jet blowing increase lift near the tip and reduce drag at low Mach numbers. These benefits become smaller and vanish as the Mach number increased to 0.5. A Navier-Stokes solver with modified boundary conditions at the tip was used to extrapolate the results to a Mach number of 0.72. Calculations indicated that lift increases with increasing jet momentum coefficient and that a separate flow region develops near the tip which is consistent with the experimental trend that the drag benefit vanishes. With current technology and conventional wing shapes, spanwise blowing at the tip does not appear to be a practical means of reducing drag moderate aspect ratio wings at high subsonic Mach numbers. Dissert. Abstr.

N93-13917 Tennessee Univ., Knoxville.
DYNAMICS OF VORTEX RINGS IN CROSS-FLOW Ph.D. Thesis
YOUNG KEUN CHANG 1991 211 p
Avail: Univ. Microfilms Order No. DA9221743

Vortex rings formed in a cross-flow by continuous and/or single pulsations of a jet were studied. The pulsations were provided by the periodic closing and opening of a jet flow and/or by the sudden movement of a circular piston inside a cylinder, respectively. Single pulsations were selected to investigate the effects of different jet exit geometries on the generation, dynamics and penetration of vortex rings: one geometry was a straight walled tube, and the other was a sharp-edged orifice with the same exit diameter. Continuous pulsation was used to study its effects on the development of vortex rings and their penetration in a cross-flow. Pulsation frequency and the ratio of piston velocity to cross-flow velocity were selected as key parameters for each experiment. Detailed measurements were made using flow visualization techniques, including laser induced fluorescence, and hot-film anemometry. Characteristic parameters investigated consisted of the translational velocity, circulation, diameter and core of the ring. To theoretically simulate the dynamics of vortex rings in cross-flow, a numerical simulation for three-dimensional vortex rings was performed based on a Lagrangian, grid-free, three-dimensional vortex method. For continuous pulsations, it was found that, at low frequencies, the fluid in the vortex rings penetrated into the cross-flow to a height much greater than that for high frequency pulsation or for a steady jet injection (up to five times). Dynamically, the downstream segment of the vortex rings moved upward (tilted) by about 3 degrees to 4 degrees under the effect of interaction between the vortex ring and the cross-flow. This type of motion was also qualitatively predicted by the numerical simulation of three-dimensional vortex rings in cross-flows. The detailed velocity field within a vortex ring generated by pulses at 1 Hz was measured using a hot-film probe. From the study of the velocity field along the exit centerlines it was observed that the vortex rings were fully-formed at Z = 3.0 d(sub j). This is in agreement with other experiments in air as well as computational results. Single pulsations showed that the vortex ring penetration height was much greater for a sharp-edged orifice than for a straight walled tube, for the same piston and cross-flow velocities. Hence, it was seen that the jet exit boundary condition is a key parameter which determines the formation process of a vortex ring, its penetration and characteristic parameters mentioned above. Dissert. Abstr.

N93-13929 Notre Dame Univ., IN.
THE UNSTEADY AERODYNAMICS OF A DELTA WING UNDERGOING LARGE-AMPLITUDE PITCHING MOTIONS Ph.D. Thesis
SCOTT ANDREW THOMPSON 1992 241 p
Avail: Univ. Microfilms Order No. DA9222020

An experimental wind tunnel investigation was performed using a series of 70 deg sweep delta wings. The goal was to examine the relationship between the aerodynamic loads and the vortex flow characteristics of a highly swept wing undergoing both steady and unsteady pitching motions. Extensive testing was conducted consisting primarily of the measurement of surface pressure and vortex breakdown locations as functions of angle of attack. The effects of several parameters were examined, including motion amplitude, pitching frequency, Reynolds number, and leading edge geometry. The data obtained was then correlated to data from the literature on the aerodynamic loads and the surface flow characteristics for similar wings. The effects of wing size and blockage were also examined. The steady and unsteady flow visualization data indicated that the trailing edge of the wing significantly influences the smooth forward or aft motion of breakdown when breakdown is near the trailing edge. The data indicated that this may be caused by the pressure gradient downstream of the wing. The unsteady surface pressure data could be separated into two regimes, dependent on the angle of attack range: a regime where quasisteady behavior occurred, and a regime where significant unsteady effects occurred. The first regime included angle of attack ranges which precluded the occurrence of vortex breakdown, and ranges for which breakdown existed on the wing throughout the motion. The second regime included angle of attack ranges where breakdown moved onto or off of the wing, and ranges which included very high angles of attack involving full scale leeward flow separation. For the second regime, the unsteady effects occurred in the form of a hysteresis in the surface

pressures relative to the steady case. Lags in the unsteady breakdown location relative to the steady location were also measured. It appeared that either the onset of breakdown or the reformation of the vortex system (at very high incidences) was responsible for the unsteady effects. The size of the model relative to the wind was seen to affect the magnitude of the surface pressure coefficients. However, the qualitative trends were not changed significantly. Dissert. Abstr.

N93-13930 McGill Univ., Montreal (Quebec).
OVERALL EFFECTS OF SEPARATION ON THIN AEROFOILS Ph.D. Thesis
MAN-CHUN TSE 1991 211 p
(ISBN-0-315-67464-4) Avail: Univ. Microfilms Order No. DANN67464

The separation bubble at the leading edge of a thin sharp-edged aerofoil in steady, incompressible and two-dimensional flow was studied. A simple method, using irrotational flow and source singularities, has been developed for predicting bubble reattachment length, drag and lift. For a flat-plate aerofoil, predictions compare favorably with new experiments. The non-dimensional reattachment length x(sub r)/c is proportional to the square of the incidence (alpha) and the slope x(sub r)/c(alpha)(exp 2) depends on the growth of the outer part of the separated shear layer. The value of the term x(sub r)/c(alpha)(exp 2) was determined experimentally as pi/0.08. At incidences above 2 deg, the bubble drag becomes increasingly dominant when compared with the skin friction drag. Although the details of the bubble geometry are not simulated, the lift and stall are predicted fairly well. The theory is extended to a circular-arc aerofoil. This part of the study is much less satisfactory. New experimental measurements do not appear to be sufficiently accurate to provide the empiricism to support the extended theory which must now account for regions of separated flow near the trailing edge.
Dissert. Abstr.

N93-14035 Stanford Univ., CA.
NAVIER-STOKES FLOWFIELD COMPUTATION OF WING/ROTOR INTERACTION FOR A TILT ROTOR AIRCRAFT IN HOVER Ph.D. Thesis
IAN GEORGE FEJTEK 1992 159 p
Avail: Univ. Microfilms Order No. DA9217819

The download on the wing produced by the rotor-induced downwash of a tilt rotor aircraft in hover is of major concern because of its severe impact on payload-carrying capability. A method has been developed to help gain a better understanding of the fundamental fluid dynamics that causes this download, and to help find ways to reduce it. In particular, the method is employed in this work to analyze the effect of a tangential leading edge circulation-control jet on download reduction. Because of the complexities associated with modeling the complete configuration, this work focuses specifically on the wing/rotor interaction of a tilt rotor aircraft in hover. The three-dimensional, unsteady, thin-layer compressible Navier-Stokes equations are solved using a time-accurate, implicit, finite difference scheme that employs LU-ADI factorization. The rotor is modeled as an actuator disk which imparts both a radial and an azimuthal distribution of pressure rise and swirl to the flowfield. A momentum theory/blade element analysis of the rotor is incorporated into the Navier-Stokes solution method. Solution blanking at interior points of the mesh has been shown here to be an effective technique in introducing the effects of the rotor and tangential leading edge jet. Results are presented both for a rotor alone and for wing/rotor interaction. The overall mean characteristics of the rotor flowfield are computed including the flow acceleration through the rotor disk, the axial and swirl velocities in the rotor downwash, and the slipstream contraction. Many of the complex tilt rotor flow features are captured including the highly three-dimensional flow over the wing, the recirculation fountain at the plane of symmetry, wing leading and trailing edge separation, and the large region of separated flow beneath the wing. Mean wing surface pressures compare fairly well with available experimental data, but the time-averaged download/thrust ratio is twenty to thirty percent higher than the measured value. This discrepancy is due to a combination of factors that are discussed. Leading edge tangential blowing is shown to be effective in reducing download. Dissert. Abstr.

N93-14160 Maryland Univ., College Park.
A STUDY OF VISCOUS INTERACTION EFFECTS ON HYPERSONIC WAVERIDERS Ph.D. Thesis
JINHWA CHANG 1991 220 p
Avail: Univ. Microfilms Order No. DA9222668

In a continuing effort to generate new and improved classes of viscous optimized hypersonic waveriders, the present work takes a step forward and examines the effects of viscous interaction in the waverider design and analysis process. Parametric runs are made to produce L/D, C(sub L), contour plots for Mach numbers 6.0 to 30.0 at an altitude 30.0 to 80.0 Km, for waverider designer's reference. This is the first work to examine the effects of viscous interactions on hypersonic waveriders, and to generate a new family of waveriders wherein viscous interaction effects are included within the optimization process. Corda's computer program is used to generate viscous optimized hypersonic waveriders from conical flowfields without viscous interaction. Each waverider is optimized for maximum L/D, and comparison studies are made between the cases with and without viscous interaction. Other results of the investigation agreed with viscous interaction theory in showing an increase in the surface pressure near the leading edge of a waverider, and also the tendency for it to approach the freestream value further downstream. This change in the surface pressure distribution as well as increases in the skin friction, resulted in a decrease in the maximum Lift/Drag for the waverider. The influence of viscous interactions on the surface pressure distribution and hence the maximum L/D were found to result in noticeably different viscous optimized waveriders generated without considering viscous interactions. Finally, the results show that aerodynamics performance of the viscous interaction waveriders are greatly reduced due mainly to a large increase in skin-friction drag associated with the viscous interaction phenomena that is increased with increasing the Mach number and altitude, but some of this loss can be recoupled by including viscous interactions within the optimization procedure. When the waverider is optimized for viscous interaction, the shape can change dramatically. The central conclusion of the present work delineates on a velocity-altitude map that region where viscous interaction effects are significant for modern hypersonic waveriders. In particular, viscous interaction effects become important at Mach numbers greater than sixteen and altitudes upwards of 140,000 feet. Dissert. Abstr.

N93-14173 Texas A&M Univ., College Station.
PARAMETRIC STUDY OF AIR SAMPLING CYCLONES Ph.D. Thesis
MURRAY EDWARD MOORE 1991 159 p
Avail: Univ. Microfilms Order No. DA9216981

An improved method has been developed for the design of single and multiple inlet aerosol sampling cyclones. A single inlet design methodology allows aerodynamic particle (AED) cutpoint diameter predictions to be made for a standard Stairmand cyclone which has been an alteration in its outlet tube diameter. Three cyclone body diameters, 38.10 mm, 57.15 mm, 88.90 mm, were tested, while three different exhaust tubes sizes 26.7 mm, 42.9 mm, and 68.3 mm (inside diameter) were used to vary the exhaust tube diameter in the cyclone. Tested cyclone flowrates ranged from 16.3 LPM to 124 LPM. The measured particle AED cutpoints went from a minimum of 4.0 microns to a maximum of 18.8 microns. A functional relation using two nondimensional parameters, the cyclone flow Reynolds numbers and the ratio of the cutpoint particle diameter to the cyclone diameter. A multiple inlet cyclone was tested for two different length ratios, which allows for a degree of flexibility in the design of new systems. The size of the body diameter of the multiple inlet cyclones varied from 38.10 mm to 139.7 mm, where the two different lengths were twice and four times that of the cyclone body diameter. The minimum tested cyclone flowrate was 9.39 LPM, while the maximum tested flowrate was 1027 LPM. Particle AED cutpoints ranged from 3.9 microns to 17.1 microns. The data gathered were used to develop a

technique for predicting the performance for a cyclone which had a length twice that of the cyclone diameter. The predicted flow rate for an 88.90 mm diameter cyclone differed by only 15 percent from the experimentally determined flowrate for a particle cutpoint of 10.0 microns AED diameter. Dissert. Abstr.

N93-14441# Wright Lab., Wright-Patterson AFB, OH.
A COMPILATION OF THE MATHEMATICS LEADING TO THE DOUBLET LATTICE METHOD Final Report, Jun. - Dec. 1991
MAX BLAIR Mar. 1992 145 p
(Contract AF PROJ. 2401)
(AD-A256304; WL-TR-92-3028) Avail: CASI HC A07/MF A02

This report provides a theoretical development of the doublet lattice method, the method of choice for most subsonic unsteady aerodynamic modeling for over twenty years. This is a tutorial based on many-key mathematical developments provided in the references section. An example source code is provided in the appendix. GRA

N93-14451*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
PRESSURE DISTRIBUTION FOR THE WING OF THE YAV-8B AIRPLANE; WITH AND WITHOUT PYLONS
EDWIN J. SALTZMAN (PRC Kentron, Inc., Edwards, CA.), JOHN H. DELFRATE, CATHERINE M. SABSAY, and JILL M. YARGER Nov. 1992 139 p
(Contract RTOP 505-59-53)
(NASA-TM-4429; H-1708; NAS 1.15:4429) Avail: CASI HC A07/MF A02

Pressure distribution data have been obtained in flight at four span stations on the wing panel of the YAV-8B airplane. Data obtained for the supercritical profiled wing, with and without pylons installed, ranged from Mach 0.46 to 0.88. The altitude ranged from approximately 20,000 to 40,000 ft and the resultant Reynolds numbers varied from approximately 7.2 million to 28.7 million based on the mean aerodynamic chord. Pressure distribution data and flow visualization results show that the full-scale flight wing performance is compromised because the lower surface cusp region experiences flow separation for some important transonic flight conditions. This condition is aggravated when local shocks occur on the lower surface of the wing (mostly between 20 and 35 percent chord) when the pylons are installed for Mach 0.8 and above. There is evidence that convex fairings, which cover the pylon attachment flanges, cause these local shocks. Pressure coefficients significantly more negative than those for sonic flow also occur farther aft on the lower surface (near 60 percent chord) whether or not the pylons are installed for Mach numbers greater than or equal to 0.8. These negative pressure coefficient peaks and associated local shocks would be expected to cause increasing wave and separation drag at transonic Mach number increases. Author

N93-14479 Cranfield Inst. of Tech., Bedford (England).
ROTATING STALL INCEPTION IN FANS OF LOW HUB-TIP RATIO Ph.D. Thesis
M. SOUNDRANAYAGAM 1991 257 p
Avail: Univ. Microfilms Order No. BRDX96883

An investigation was carried out to study the process of rotating stall inception in a low hub-tip ratio fan. Such fans are expected, based on an elementary analysis, to stall from the root. However, experimental evidence had led to the belief that the fans stalled from the tip. The effects of streamtube contraction were first studied and this was followed by an experimental investigation on an isolated rotor, with successive build modifications to increase the likelihood of rotating stall inception occurring at the root. A computer based streamline curvature method was used to study the effects of streamtube contraction and streamtube diffusion that commonly occur when a fan is operated at flows below its design flow rate. The results indicated a reduced expectation for the robot to stall first when compared to a simple 2-D flow analysis. Experimental measurements were then carried out to determine how the experimental local characteristics differed from the predicted characteristics. It was apparent that real fluid effects tended to steepen the root characteristic, thus enhancing the stability of the root. The tip characteristics tended to droop and become less stable. The enhancement of the root stability was also seen in the profiles of deviation angle. The axial velocity contours at the rotor exit supported the conclusion that the root stability enhancement was caused by 'centrifuging'. To determine the actual radial location of rotating stall inception, an array of hot wires was used to record events during the inception transient. Inception was first detectable at the tip. This tip stalling behavior persisted for all the build modifications. Measurements of unsteady pressure were also made to study the movement of the overall operating point since it was felt that this could continuously alternate between a pair of closely spaced characteristics. The results indicated that the fan operated along a unique characteristic. The overall conclusion was that a low hub-tip ratio fan shows a strong reluctance to stall at the root due to 'centrifuging' of the blade boundary layer. The inception process appears to be dominated by events in the tip region. Dissert. Abstr.

N93-14514 ESDU International Ltd., London (England).
PROGRAM FOR CALCULATION OF AILERON ROLLING MOMENT AND YAWING MOMENT COEFFICIENTS AT SUBSONIC SPEEDS
Oct. 1992 10 p
(ISSN 0141-397X)
(ESDU-88040; ISBN-0-85679-832-0) Avail: Issuing Activity

ESDU 88040 describes the FORTRAN program ESDUpac A8840 that determines the aileron rolling and yawing moment coefficients for an aircraft. The program implements the empirical prediction methods of ESDU 88013 and 88029, accessing the graphical data in digitized form. Those documents must be consulted to establish the limitations of the program in terms of the geometries and flow conditions over which the methods were tested and the accuracy achieved. ESDU 88040 describes the input required by the program and illustrates the output through a worked example. The source code is provided on disc for use under MS DOS on personal computers. ESDU

N93-14515 ESDU International Ltd., London (England).
PRESSURE DRAG AND LIFT CONTRIBUTIONS FOR BLUNTED FOREBODIES OF FINENESS RATIO 2.0 IN TRANSONIC FLOW (M INFINITY LESS THAN OR EQUAL TO 1.4)
Jul. 1989 45 p
(ISSN 0141-4356)
(ESDU-89033; ISBN-0-85679-850-9) Avail: Issuing Activity

ESDU 89033 presents axial and normal pressure force coefficient data obtained from a computed solution of the Euler equations for inviscid flow about spherically blunted tangent ogive and cone forebodies followed by a cylindrical afterbody in the Mach number range of 0.7 to 1.4. It is found that there is an optimum blunting ratio (ratio of the blunted nose diameter to the afterbody diameter) for which for a given Mach number and angle of attack the axial pressure force is a minimum. Charts show the variation of axial and normal pressure force coefficients around the optimum blunting for angles of attack up to 10 degrees, and axial pressure force coefficient (which is equivalent to the wave drag) at zero incidence. The derivation of the results is discussed, and examples compare forebody pressure distribution and force coefficients with those obtained in wind-tunnel tests so providing guidance on the expected accuracy of the calculations. ESDU

N93-14516 ESDU International Ltd., London (England).
DIRECT PREDICTION OF A SEPARATION BOUNDARY FOR AEROFOILS USING A VISCOUS-COUPLED CALCULATION METHOD
Apr. 1992 26 p
(ISSN 0141-4356)
(ESDU-92008; ISBN-0-85679-813-4) Avail: Issuing Activity

ESDU 92008 describes the features of a viscous-coupled calculation method that are required to predict transonic flow over an aerofoil with some boundary layer separation. One particular method is considered in detail, its technical features are detailed, and the input and output are described together with the computer

requirements. Its performance is compared with selected wind-tunnel data on pressure distribution, shock strength and location, trailing-edge pressure, and a separation boundary associated with trailing-edge pressure divergence together with the drag coefficient near that condition. The separation boundary was predicted to within about 0.08 in lift coefficient and the drag coefficient within 10 percent. Some details and trends were dealt with less satisfactorily; in particular, the often observed gradual increase in trailing-edge pressure prior to its rapid fall as separation becomes more extensive was not predicted and it seemed the extent and effects of shock-induced separation were underestimated. ESDU

N93-14595 Georgia Inst. of Tech., Atlanta.
THE EFFECT OF WAKE DYNAMICS ON ROTOR EIGENVALUES IN FORWARD FLIGHT Ph.D. Thesis
YI-REN WANG 1992 177 p
Avail: Univ. Microfilms Order No. DA9231760

An eigenvalue study can provide stability information for a system, and it is also an important part of aeroelastic analysis. In this work, a 2-D approximation to a set of 3-D generalized dynamic wake equations is studied first to obtain an overview of the characteristics of unsteady aerodynamics in forward flight. The generalized dynamic wake model employed is based on incompressible potential flow theory with an induced flow distribution expanded in a set of harmonic and radial shape functions, including undetermined time dependent coefficients as aerodynamic states. The second part of this work utilizes a 3-D wake eigen-analysis. Results with varying numbers of harmonies are computed, and the mode shapes of each eigenvalue are studied to understand the physical meaning of wake dynamics. The third part of this work is to investigate the damping of a blade-wake coupled system. The frequency response of this coupled model is also studied and compared with results from the 2-D approximation. A set of rigid-blade flapping equations is used to simplify the results. For this eigen-analysis, the blade-wake coupled system is represented by a set of periodic-coefficient differential equations in forward flight. Thus, Floquet Theory is applied to this stability problem. The eigenvalues of this matrix determine system characteristics. The flapping modes can be identified by the corresponding eigenvectors of each eigenvalue, and the stability of the whole aeroelastic system can be analyzed. This work gives us insight into the interaction of blade flapping and wake dynamics. The effect of wake dynamics on rotor eigenvalues in forward flight can be seen by comparison with the no inflow case. One can see from the results of this work that the inflow has a profound effect on blade dynamics even at high advance ratios.
Dissert. Abstr.

N93-14631 Texas A&M Univ., College Station.
A FINITE ELEMENT MODEL FOR ANALYSIS OF THERMOVISCOPLASTIC BEHAVIOR OF HYPERSONIC LEADING EDGE STRUCTURES SUBJECT TO INTENSE AEROTHERMAL HEATING Ph.D. Thesis
TED GARY BYROM 1992 144 p
Avail: Univ. Microfilms Order No. DA9232481

A finite element algorithm is formulated to model a hypersonic leading edge structure subject to severe localized aerothermal heating. The formulation contains nonlinear geometries, thermoviscoplastic material behavior, and inertial effects. The algorithm is tested against several exact solutions for simple test cases. The algorithm is then applied to two cases of a hypothetical leading edge structure with severe localized heating. Both quasistatic and dynamic results are obtained for each of the two cases. The results show that inclusion of the inertial effects are physically justified and also computationally beneficial.
Dissert. Abstr.

N93-14661# Wright Lab., Wright-Patterson AFB, OH.
SUBSONIC AERODYNAMIC RESEARCH LABORATORY Interim Report, Jul. 1983 - May 1992
Aug. 1992 145 p
(Contract AF PROJ. 2404)
(AD-A256060; WL-TR-92-3053) Avail: CASI HC A07/MF A02

In July of 1983 Air Force Systems Command (AFSC) approved construction of the Subsonic Aerodynamic Research Laboratory (SARL). The SARL is designed to provide a low turbulence flow (less than 0.05 percent) for flow visualization and precision measurements. The test section walls are 80 percent optical quality plexiglass. The large viewing area lends the facility to flow measurement by laser velocimetry, a nonintrusive flow measurement technique. A computer system is available for force and pressure data. The octagonal test section is 7'w x 10'h making it possible to test large models at high angles-of-attack. The SARL is designed for efficient low cost operation. The flow conditioning section of the tunnel contains both screens and honeycomb material. The facility was designed to operate up to Mach 0.6. A natural frequency problem with the drive system presently limits top speed to Mach 0.5. The SARL construction project is somewhat unique, being an in-house effort not requiring an MCP. A significant cost savings was realized because several major components needed for the SARL, were available from other unused facilities. The fan was obtained from NASA Langley Research Center. The 20,000 hp drive system was supplied by Wright-Patterson AFB.
GRA

N93-14737*# Barna (P. Stephen), Consultant, Norfolk, VA.
INVESTIGATIONS OF DETAIL DESIGN ISSUES FOR THE HIGH SPEED ACOUSTIC WIND TUNNEL USING A 60TH SCALE MODEL TUNNEL. PART 1: TESTS WITH OPEN CIRCUITS Final Report
P. STEPHEN BARNA Jan. 1991 113 p
(NASA-CR-191671; NAS 1.26:191671) Avail: CASI HC A06/MF A02

This report summarizes the tests on the 1:60 scale model of the High Speed Acoustic Wind Tunnel (HSAWT) performed during the period of November 1989 to December 1990. Throughout the testing the tunnel was operated in the 'open circuit mode', that is when the airflow was induced by a powerful exhaust fan located outside the tunnel circuit. The tests were first performed with the closed test section and were subsequently repeated with the open test section. While operating with the open test section, a novel device, called the 'nozzle-diffuser,' was also tested in order to establish its usefulness of increasing pressure recovery in the first diffuser. The tests established the viability of the tunnel design. The flow distribution in each tunnel component was found acceptable and pressure recovery in the diffusers were found satisfactory. The diffusers appeared to operate without flow separation. All tests were performed at NASA LaRC. Author

N93-14738*# Barna (P. Stephen), Consultant, Norfolk, VA.
INVESTIGATIONS OF DETAIL DESIGN ISSUES FOR THE HIGH SPEED ACOUSTIC WIND TUNNEL USING A 60TH SCALE MODEL TUNNEL. PART 2: TESTS WITH THE CLOSED CIRCUIT Final Report
P. STEPHEN BARNA Oct. 1991 65 p
(NASA-CR-191672; NAS 1.26:191672) Avail: CASI HC A04/MF A01

This report summarizes the tests on the 1:60 scale model of the High Speed Acoustic Wind Tunnel (HSAWT) performed during the period June - August 1991. Throughout the testing the tunnel was operated in the 'closed circuit mode,' that is when the airflow was set up by an axial flow fan, which was located inside the tunnel circuit and was directly driven by a motor. The tests were first performed with the closed test section and were subsequently repeated with the open test section, the latter operating with the nozzle-diffuser at its optimum setting. On this subject, reference is made to the report (1) issued January 1991, under contract 17-GFY900125, which summarizes the result obtained with the tunnel operating in the 'open circuit mode.' The tests confirmed the viability of the tunnel design, and the flow distributions in most of the tunnel components were considered acceptable. There were found, however, some locations where the flow distribution requires improvement. This applies to the flow upstream of the fan where the flow was found skewed, thus affecting the flow

downstream. As a result of this, the flow appeared separated at the end of the large diffuser at the outer side. All tests were performed at NASA LaRC. Author

N93-14767*# Oklahoma Univ., Norman. School of Aerospace and Mechanical Engineering.
COMPUTATIONAL ANALYSIS OF HYPERSONIC FLOWS PAST ELLIPTIC-CONE WAVERIDERS
BOK-HYUN YOON and MAURICE L. RASMUSSEN Jan. 1991 306 p
(Contract NAG1-886)
(NASA-CR-191304; NAS 1.26:191304; OU-AME-91-2) Avail: CASI HC A14/MF A03

A comprehensive study for the inviscid numerical calculation of the hypersonic flow past a class of elliptic-cone derived waveriders is presented. The theoretical background associated with hypersonic small-disturbance theory (HSDT) is reviewed. Several approximation formulas for the waverider compression surface are established. A CFD algorithm is used to calculate flow fields for the on-design case and a variety of off-design cases. The results are compared with HSDT, experiment, and other available CFD results. For the waverider shape used in previous investigations, the bow shock for the on-design condition stands off from the leading-edge tip of the waverider. It was found that this occurs because the tip was too thick according to the approximating shape formula that was used to describe the compression surface. When this was corrected, the bow shock became closer to attached as it should be. At Mach numbers greater than the design condition, a lambda-shock configuration develops near the tip of the compression surface. At negative angles of attack, other complicated shock patterns occur near the leading-edge tip. These heretofore unknown flow patterns show the power and utility of CFD for investigating novel hypersonic configurations such as waveriders. Author

N93-14791*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ESTIMATION OF UNSTEADY LIFT ON A PITCHING AIRFOIL FROM WAKE VELOCITY SURVEYS
K. B. M. Q. ZAMAN, J. PANDA, and C. L. RUMSEY (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.) Jan. 1993 16 p Presented at the 31st Aerospace Sciences Meeting and Exhibit, Reno, NV, 11-14 Jan. 1993
(Contract RTOP 505-52-62)
(NASA-TM-105947; E-7465; NAS 1.15:105947) Avail: CASI HC A03/MF A01

The results of a joint experimental and computational study on the flowfield over a periodically pitched NACA0012 airfoil, and the resultant lift variation, are reported in this paper. The lift variation over a cycle of oscillation, and hence the lift hysteresis loop, is estimated from the velocity distribution in the wake measured or computed for successive phases of the cycle. Experimentally, the estimated lift hysteresis loops are compared with available data from the literature as well as with limited force balance measurements. Computationally, the estimated lift variations are compared with the corresponding variation obtained from the surface pressure distribution. Four analytical formulations for the lift estimation from wake surveys are considered and relative successes of the four are discussed. Author

N93-14836 State Univ. of New York, Buffalo.
MODELING VARIABLE BLOWING ON A SLENDER CONE IN HYPERSONIC FLOW Ph.D. Thesis
JOHN GARY VANOSDOL 1992 197 p
Avail: Univ. Microfilms Order No. DA9228100

A study of the effects of variable blowing in turbulent conical hypersonic boundary layers is presented. Numerical calculations of the skin friction and surface heat transfer rates are compared to the experimental measurements which were reported by Holden, VanOsdol and Rodrigues (1990) for a slender cone at zero angle of attack in steady flows at Mach numbers of 11 and 13. An analysis of the transpiration feed system of the cone model was performed and showed that the blowing rate could be variable along the cone surface. This effect is confirmed by internal pressure measurements which were taken inside the cone model. The blowing rates are re-calibrated using the internal gauge readings and used as the wall boundary condition for a compressible turbulent boundary layer calculation using the low Reynolds number k-epsilon model of Chien (1982). At low blowing rates the boundary layer calculations indicate that a situation where both the effects of suction and blowing are present within the same flow. The results show excellent qualitative prediction of the experimental data. These calculations are compared to earlier calculations made using the BLIMP code which assumed that the blowing rates were constant along the cone surface. Dissert. Abstr.

N93-14911*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
RESULTS OF LOW POWER DEICER TESTS ON A SWEPT INLET COMPONENT IN THE NASA LEWIS ICING RESEARCH TUNNEL
THOMAS H. BOND and JAIWON SHIN Jan. 1993 21 p Presented at the 31st Aerospace Sciences Meeting and Exhibit, Reno, NV, 11-14 Jan. 1993; sponsored by AIAA
(Contract RTOP 505-68-10)
(NASA-TM-105968; E-7495; NAS 1.15:105968; AIAA PAPER 93-0032) Avail: CASI HC A03/MF A01

Tests were conducted under a USAF/NASA Low Power Deicer program on two expulsive technologies to examine system performance on hardware representative of a modern aircraft part. The BF Goodrich Electro-Expulsive Deicing System and Pneumatic Impulse Ice Protection System were installed on a swept, compound curve, engine inlet component with varying leading edge radius, and tested through a range of icing and system operating conditions in the NASA Lewis Icing Research Tunnel. A description of the experimental procedure and results, including residual ice thickness, shed ice particle size, and changes in system energy/pressure characteristics are presented. Author

N93-15101 Notre Dame Univ., IN.
WAKE SIMILARITY AND VORTEX FORMATION FOR TWO-DIMENSIONAL BLUFF BODIES Ph.D. Thesis
JOSE LUIS VILLAFRANC NEBRES 1992 205 p
Avail: Univ. Microfilms Order No. DA9230042

An experimental study of the flow around a cylinder with a single straight perturbation was conducted in a wind tunnel. With this bluff body, positioned in a uniform crossflow, the vortex shedding frequency and other flow characteristics could be manipulated. The Strouhal number has been shown to be a function of the perturbation angular position, theta(p), as well as the perturbation size and Reynolds number. As much as a 50 percent change in Strouhal number could be achieved, simply by changing theta(p) by 1 deg. The perturbation size compared to the boundary-layer thickness, delta, was varied from approximately 1 delta to about 20 delta. The Reynolds number was varied from 10,000 to 40,000. A detailed investigation of the characteristic Strouhal number variations has shown that varying theta(p) had a significant influence on the boundary-layer separation and transition to turbulence. These significant changes occurring in the boundary-layer have been shown to cause variations in the spacing between the shear layers, base pressure, vortex formation length, drag, lift, and the longitudinal spacing between the vortices in the vortex street. The unique ability of the cylinder with a single straight perturbation to control the Strouhal number and other flow characteristics, was used to evaluate several previously proposed wake similarity concepts by Fage and Johansen (1927), Roshko (1955), Bearman (1967) and Griffin (1981). It was shown that these wake similarity concepts did not satisfactorily apply to the bluff body which was used in this study. The experimental results have shown that a wake similarity parameter, S(M) = kf(sub v)d*/U(infinity) has smaller variations from its mean values S(M sub 0) = 0.39, when compared to previously proposed wake similarity parameters. The quantity k is the base pressure parameter, f(sub v) is the vortex shedding frequency, d* is the spacing between the shear layers, and U(infinity) is the free stream velocity. The similarity parameter S(M), when applied to Fage and

Johansen's measurements on a wide range of bluff bodies showed less variance and resulted in numbers near 0.39. The parameter, S(M), when used to evaluate the lateral-to-longitudinal stability of vortices in the vortex street was shown to favor von Karman's over Kronauer's wake stability criterion. Dissert. Abstr.

N93-15131# Max-Planck-Inst. fuer Stroemungsforschung, Goettingen (Germany).
AN EXPERIMENTAL INVESTIGATION OF BASE BLEED EFFECT ON THE WAKE TURBULENT STRUCTURE BEHIND A TWO-DIMENSIONAL BLUNT MODEL
V. L. ZHDANOV and H. ECKELMANN Nov. 1991 59 p
Sponsored by Max-Planck-Inst. fuer Stroemungsforschung
(ISSN 0436-1199)
(MPIS-9/1991; ETN-92-92731) Avail: CASI HC A04/MF A01

The flow pattern behind a two dimensional body with bleeding through a slot in its trailing edge was studied experimentally. Two bleeding modes were investigated. One with the maximum pressure at the body base and one with a zero excess momentum wake. In both cases the slot width, characterized by its width to trailing edge height ratio h/H, varied from 0.095 to 0.01875. Distributions of the mean velocity, longitudinal and transverse fluctuations in the wake were measured at nondimensional distances 3 less than or equal to x/H less than or equal to 30 from the body trailing edge. ESA

N93-15245# Naval Postgraduate School, Monterey, CA.
FLOWFIELD STUDY OF A CLOSE-COUPLED CANARD CONFIGURATION M.S. Thesis
JOHN F. OLEARY Jun. 1992 96 p
(AD-A256311) Avail: CASI HC A05/MF A01

A nulling five-hole pressure probe was used to complete a flowfield survey behind a close-coupled canard and wing model set at 22 degrees angle of attack. The canard and wing were both low-aspect-ratio, highly-swept, delta planforms with rounded leading edges. The model was set at the condition of maximum lift enhancement of the canard/wing configuration over a corresponding wing-alone configuration, based on previous force measurements. For comparison, the pressure measurements were made with the canard on and with the canard off. From the pressure measurements, flowfield velocity-vector, velocity-streamline and total-pressure-coefficient contours were plotted. These plots showed the dramatic effect of the canard vortex on the wing flowfield. The location and interaction of the canard and wing leading-edge vortices were analyzed. Large-scale reattachment of previously reversed flow over the wing was noted, as well as the re-establishment and strengthening of the wing leading-edge vortex. GRA

N93-15338*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SURFACE ROUGHNESS DUE TO RESIDUAL ICE IN THE USE OF LOW POWER DEICING SYSTEMS
JAIWON SHIN and THOMAS H. BOND Jan. 1993 16 p
Presented at the 31st Aerospace Sciences Meeting and Exhibit, Reno, NV, 11-14 Jan. 1993; sponsored by AIAA
(Contract RTOP 505-68-10)
(NASA-TM-105971; E-7494; NAS 1.15:105971; AIAA PAPER 93-0031) Avail: CASI HC A03/MF A01

Thicknesses of residual ice are presented to provide information on surface contamination and associated roughness during deicing events. Data was obtained from low power ice protection systems tests conducted in the Icing Research Tunnel at NASA Lewis Research Center (LeRC) with nine different deicing systems. Results show that roughness associated with residual ice is not characterized by uniformly distributed roughness. Results also show that deicing systems require a critical mass of ice to generate a sufficient expelling force to remove the ice. Author

N93-15404*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AN OVERVIEW OF SHED ICE IMPACT IN THE NASA LEWIS ICING RESEARCH TUNNEL
THOMAS H. BOND and RANDALL K. BRITTON (Sverdrup Technology, Inc., Brook Park, OH.) 14 Jan. 1993 14 p
(NASA-TM-105969; E-7492; NAS 1.15:105969; AIAA PAPER 93-0301) Avail: CASI HC A03/MF A01

One of the areas of active research in commercial and military rotorcraft is directed toward developing the capability of sustained flight in icing conditions. The emphasis to date has been on the accretion and subsequent shedding of ice in an icing environment, where the shedding may be natural or induced. Historically, shed-ice particles have been a problem for aircraft, particularly rotorcraft. Because of the high particle velocities involved, damage to a fuselage or other airframe component from a shed-ice impact can be significant. Design rules for damage tolerance from shed-ice impact are not well developed because of a lack of experimental data. Thus, NASA Lewis (LeRC) has begun an effort to develop a database of impact force and energy resulting from shed ice. This effort consisted of a test of NASA LeRC's Model Rotor Test Rig (MRTR) in the Icing Research Tunnel (IRT). Both natural shedding and forced shedding were investigated. Forced shedding was achieved by fitting the rotor blades with Small Tube Pneumatic (STP) deicer boots manufactured by BF Goodrich. A detailed description of the test is given as well as the design of a new impact sensor which measures the force-time history of an impacting ice fragment. A brief discussion of the procedure to infer impact energy from a force-time trace are required for the impact-energy calculations. Recommendations and future plans for this research area are also provided. Author

N93-15483*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE APPLICAITON OF CFD TO ROTARY WING FLOW PROBLEMS
F. X. CARADONNA (Army Aviation Research and Development Command, Moffett Field, CA.) Mar. 1992 75 p
(Contract RTOP 505-61-51)
(NASA-TM-102803; A-90110; NAS 1.15:102803; USAAVSCOM-TR-92-A-004) Avail: CASI HC A04/MF A01

This report is a review intended to serve as source and reference material for the CFD phase of a short course on rotorcraft aerodynamics. The review is mainly oriented toward engineering application methods. Therefore, emphasis is placed on potential methods and their various types and uses. However, the application of viscous codes is also discussed. These methods are discussed in the context of the various rotorcraft-specific problems including wake prediction, blade/vortex interactions, transonic problems, dynamic stall, and other separation problems. The exposition includes a discussion of the various flow equations and the physical approximations, which they embody. Basic methods of solving these are presented, especially integral and difference approaches to the various potential equations. The treatment of total rotor/wake problems by hybrid difference/integral schemes are discussed. These include both hover flow and forward flight methods requiring a consideration of trim. Unified schemes, which solve an entire rotor/wake flow on a single grid, are also treated. One of these, a vorticity convecting full-potential approach, is capable of predicting complete hover performance polars. Many comparisons are made with data from flight and model tests, to demonstrate the efficacy of the different flow treatments. Finally, advanced flow topics, requiring full viscous solutions, are shown in order to demonstrate the future possibilities and opportunities for CFD as newer methods mature and become practical. Author

N93-15489# Rolls-Royce Ltd., Derby (England).
TIME-DEPENDENT PREDICTIONS AND ANALYSIS OF TURBINE CASCADE DATA IN THE TRANSONIC FLOW REGION
A. BOELCS (Ecole Polytechnique Federale de Lausanne, Switzerland), A. CARGILL, T. FRANSSON (Ecole Polytechnique Federale de Lausanne, Switzerland), A. SUDDHOO, and K. VOGELER (Allmanna Svenska Elektriska A.B. Brown Boveri, Baden, Switzerland) 20 Oct. 1991 24 p
(PNR-90957; ETN-92-92230) Copyright Avail: CASI HC A03/MF A01

Experimentally determined steady state and time dependent blade surface pressures, obtained in an annular test facility, were compared to predictions by a finite element potential flow solver, FINSUP, for two model turbine cascade sections. The studied cascades are geometrically different (camber, thickness), but have a well defined interblade passage and are overlapped for about 35 percent of the chord. Most time dependent predictions were obtained with FINSUP in the two dimensional mode, and no special attempts was made to refine the computational mesh in the vicinity of the expected shock positions. It was concluded from the experimental results that an aerodynamic shock wave has a significant influence on the unsteady pressures in the blade surface. The amplitude can become very large, and a phase shift can appear in the pressure. Results obtained in the traveling wave mode do not always, as they depend on the interblade phase angle, show this clearly. It is thus concluded that the physical understanding of shock influences may be found more easily if the influence coefficients are studied in detail, both as regards to the amplitude and the phase angle. ESA

N93-15588*# Washington Univ., Seattle.
INVESTIGATION OF THE AEROTHERMODYNAMICS OF HYPERVELOCITY REACTING FLOWS IN THE RAM ACCELERATOR Final Report, 17 Jul. 1989 - 30 Apr. 1992
A. HERTZBERG, A. P. BRUCKNER, A. T. MATTICK, and C. KNOWLEN 28 Dec. 1992 101 p
(Contract NAG3-1061)
(NASA-CR-191715; NAS 1.26:191715) Avail: CASI HC A06/MF A02

New diagnostic techniques for measuring the high pressure flow fields associated with high velocity ram accelerator propulsive modes was experimentally investigated. Individual propulsive modes are distinguished by their operating Mach number range and the manner in which the combustion process is initiated and stabilized. Operation of the thermally choked ram accelerator mode begins by injecting the projectile into the accelerator tube at a prescribed entrance velocity by means of a conventional light gas gun. A specially designed obturator, which is used to seal the bore of the gun, plays a key role in the ignition of the propellant gases in the subsonic combustion mode of the ram accelerator. Once ignited, the combustion process travels with the projectile and releases enough heat to thermally choke the flow within several tube diameters behind it, thereby stabilizing a high pressure zone on the rear of the projectile. When the accelerating projectile approaches the Chapman-Jouguet detonation speed of the propellant mixture, the combustion region is observed to move up onto the afterbody of the projectile as the pressure field evolves to a distinctively different form that implies the presence of supersonic combustion processes. Eventually, a high enough Mach number is reached that the ram effect is sufficient to cause the combustion process to occur entirely on the body. Propulsive cycles utilizing on-body heat release can be established either by continuously accelerating the projectile in a single propellant mixture from low initial in-tube Mach numbers (M less than 4) or by injecting the projectile at a speed above the propellant's Chapman-Jouguet detonation speed. The results of experimental and theoretical explorations of ram accelerator gas dynamic phenomena and the effectiveness of the new diagnostic techniques are presented in this report. Author

03

AIR TRANSPORTATION AND SAFETY

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

A93-14064
AIRCRAFT LIGHTNING INITIATION AND INTERCEPTION FROM IN SITU ELECTRIC MEASUREMENTS AND FAST VIDEO OBSERVATIONS
JEAN-PATRICK MOREAU, JEAN-CLAUDE ALLIOT (ONERA, Chatillon, France), and VLADISLAV MAZUR (NOAA, National Severe Storms Lab., Norman, OK) Journal of Geophysical Research (ISSN 0148-0227) vol. 97, no. D14 Oct. 20, 1992 p. 15,903-15,912. refs
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Multipoint electric-field measurements on the French C-160 research airplane presented additional verification for a physical model of aircraft-triggered lightning as a bidirectional leader initiated on the aircraft. For the few lightning strikes to aircraft that were not aircraft-triggered, the multipoint electric-field measurements proved that these strikes resulted from interception of the aircraft by natural lightning flashes. Video images of lightning channels at 200 frames per second provided physical evidence of the presence of a positive leader exiting from the positive pole of the airplane's electrical dipole. The existence of a small (less than 1 A) positive leader current had been predicted in the physical model but had not yet been measured. Weak pulse processes found in magnetic-field variations during positive leader development confirm the presence of small amplitude streamers in addition to a continuous leader process. Author

A93-14218
HUMAN FACTORS OF AIRCRAFT CABIN SAFETY
HELEN C. MUIR (Cranfield Inst. of Technology, Bedford, United Kingdom) and ARTHUR G. THORNING (Department of Transport, London, United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 519-524. refs
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Attention is given to a British program of research into the human factors involved in aircraft cabin safety in the U.K. Results are presented of an extensive experimental program in which the influence of passenger evacuation on rates of changes to the cabin configurations adjacent to the exits, the presence of smoke in the cabin, the range of weights of the type II hatch, and the presence of an injured and immobile passenger seated adjacent to an exit are investigated. Other studies include the influence of changing the format and content of the information included in the preflight briefing and the influence of practice on the ability of volunteers from the public to operate a type III hatch. P.D.

A93-14220
THE METHODS OF REDUCING IMPACT LOADS ON OCCUPANTS IN THE CIVIL AIRCRAFT CRASH CONDITION
SHIGERU MACHIDA, JUNJI TAKAKI, TAKASHI UGAI (Fuji Heavy Industries, Ltd., Utsunomiya, Japan), YUKIO SUGIYAMA, and YOSHIHISA SHIMIZU (Japan Airlines Co., Ltd., Tokyo) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 530-540. Research supported by Japan Shipbuilding Industry Foundation refs
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In order to prevent the occupants from injury or loss of lives, impact loads should be reduced to sufficiently low levels. Four feasible reduction methods, which are protectors, brace positions, a shoulder-harness and a rear facing seat, were selected and evaluated by both impact tests and analyses. To analyze the dynamic behavior of a occupant on a seat, two-dimensional

simulation computer program was developed. The total of thirty impact tests were carried out. Anthropomorphic test dummies sit on the two seats on the sled of HYGE impact tester were loaded forward at several acceleration levels. The maximum acceleration level was 30G. The results obtained from impact tests and analyses gave us useful information to improve design of air transport seat-restraint system and occupant's crash protectors. Some recommendations were provided for greater survivability in future accidents. Author

A93-14221* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RADIATION SAFETY IN AIRCRAFT OPERATIONS
J. W. WILSON and J. E. NEALY (NASA, Langley Research Center, Hampton, VA) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 541-552. refs

Data from a 7-yr flight experiment program to measure the significant biological components (tissue ionization rates, neutron flux, and nuclear reaction star rates) as a function of solar cycle, altitude, latitude and longitude from which biological risk from radiation is estimated are used to evaluate radiation dose and dose equivalents along specific flight trajectories. The data base used and the corresponding time-dependent global model are described. Ionization rates in air measured by argon filled chambers at solar minimum and maximum, and radiation measurements of the Brookhaven National Laboratory instrument compared to the present model are illustrated in tabular form. The global pressure distribution for solstice conditions at 14 km is shown. P.D.

A93-14317
THE HAZARD AND ALARM OF WINDSHEAR
H. ZHANG and C. J. JIN (Beijing Univ. of Aeronautics and Astronautics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1311-1316. refs
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In this paper, a simplified windshear hazard criterion is developed based on the mechanism of the effects of windshear on aircraft flight and the CAT I worst landing limits specified by FAA. The effects of longitudinal and vertical wind-shear components on the performance of aircraft are analyzed to investigate the hazard of windshear components. After careful study of the correlationship between the hazard criterion and the performance deteriorating parameter J2, the threshold and the principle for the predictive airborne windshear detecting and alerting system are also discussed. Author

A93-14374
PROGRESS AND TABOOS IN AIR SAFETY ORIENTATIONS OF RESEARCH IN HUMAN FACTORS IN AIR TRANSPORT
JEAN PINET (Aeroformation, Blagnac, France) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1806-1809.
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This discussion examines the distinction between ergonomic and behavioral aspects of human-factors issues in air transport, and a methodology is set forth for correcting behavioral problems. Recent trends in human-factors research are shown to lean heavily towards ergonomic solutions to recurring aircraft mishaps. Observation and psychological analysis of pilot and crew behavior in the cockpit is shown to provide the basis for training methods designed to simulate critical in-flight situations. Crew Resource Management (CRM) is described as a program for enhancing crew behavioral responses in important air-safety situations. CRM is proposed as a means for studying pilot and crew psychological behavior qualitatively and quantitatively to complement the ergonomic approach to air safety. C.C.S.

A93-14376
AIRCREW INTEGRATED MANAGEMENT
EDDY L. RACCA (Aeroformation, Blagnac, France) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1819-1825.
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A review of the human factors module recently introduced for application in flight crew transition courses is presented. Attention is given to an aircrew integrated management course focusing on the integration of the human factors elements of in-flight management by flight crews. Consideration is given to such specific areas of coordination as safety factors, efficiency, schedule, passenger comfort, regulations, and operating specifications. R.E.P.

A93-14394
AIR TRANSPORTATION SYSTEM FOR SHIPPING OUTSIZED CARGOES
L. M. SHKADOV, V. E. DENISOV, and V. I. MAVRITSKII (TsAGI, Zhukovski, Russia) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1973-1978.
Copyright

The advantages of airlifting heavy bulky products with airplanes of 500 ton capacity and helicopters capable of lifting 250 tons payload are analyzed. Such an air transportation system reduces delivery time, eliminates the necessity for dividing cargo into parts and the need to provide trans-shipment bases. The cost-efficiency of the advanced air transport is analyzed and compared with that of ground-water heavy transport systems. R.E.P.

A93-15058
TOMORROW'S SECURITY [LA SURETE DE DEMAIN]
JEAN-FRANCOIS BOUISSET (Direction Generale de l'Aviation Civile, Paris, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 145 1990 p. 49-51. In French.
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An overview is presented of the airport and aircraft security measures being implemented and those under consideration for the immediate future. Attention is given to the nature of terrorist activities and the need to counteract those attacks before they can occur. R.E.P.

A93-15801
LIGHTNING PROTECTION OF COMPOSITE STRUCTURE
JIM H. COVEY (Boeing Co., Seattle, WA) *In* International SAMPE Symposium and Exhibition, 37th, Anaheim, CA, Mar. 9-12, 1992, Proceedings Covina, CA Society for the Advancement of Material and Process Engineering 1992 p. 1018-1027. refs
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The need to provide an effective lightning protection scheme to protect composite vehicles from the effects of lightning and other transients is increasing with more wide spread use of structural composite materials. This problem was attacked from the perspective of having structural integrity, thermal resistance to degradation, environmental resistance, repairability and meeting MIL SPEC requirements for flight vehicle airworthiness. A description of the math models, strategies, and materials are discussed. All of the schemes were tested and evaluated. Author

A93-16860
FLIGHT SAFETY AND HUMAN ERRORS [SECURITE AERIENNE ET ERREURS HUMAINES]
PIERRE LECOMTE (DGA, Paris, France), NICOLE WANNER (Ecole Polytechnique Feminine, Sceaux, France), and JEAN-CLAUDE WANNER (DGA, Paris, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 153 1992 p. 72-76. In French.
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A review is presented of aviation accident causative factors with particular regard to the human error factor. Attention is focused on the three principal human error areas involved in aircraft

accidents, i.e., external/internal disturbances, individual idiosyncrasies, and aircraft maneuvers. R.E.P.

A93-17301
FIXED AND ROTARY WING ALL WEATHER OPERATIONS; PROCEEDINGS OF THE CONFERENCE, LONDON, UNITED KINGDOM, APR. 23, 24, 1991
London Royal Aeronautical Society 1991 149 p.
(ISBN 0-903409-90-9) Copyright

The present conference discusses the Autoland commercial aircraft landing system, all-weather commercial operations, the certification of HUDs for Category 3 operation, the development and implementation of a HUD guidance system for manual CAT III landings, and landing guidance systems for CAT III operations. Also discussed are ATC and ground-movement control in low visibility, helicopter fog-flying trials, helicopter approaches in low visibility using Relative GPS and the Electronic Flight Instrumentation System, helicopter automatic flight control systems for all weather operations, and ground visual aids. (For individual items see A93-17302 to A93-17311) O.C.

A93-17302
AUTOLAND, THE DEVELOPING NEED
A. FISHER (British Airways, PLC, London, United Kingdom) *In* Fixed and rotary wing all weather operations; Proceedings of the Conference, London, United Kingdom, Apr. 23, 24, 1991 London Royal Aeronautical Society 1991 p. 1.1-1.8. refs
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A development history and development prospects evaluation is presented for the British 'Autoland' autopilot mode, which was initially developed for the Trident airliner but is currently being superceded by Category 3 airliner systems capabilities. Attention is given to the economics of implementation and operation for Autoland relative to competing systems, as well as the emerging performance requirements that follow-on Autoland developments must conform to. O.C.

A93-17303
FIXED AND ROTARY WING ALL WEATHER OPERATIONS SYSTEM REQUIREMENTS
K. G. LILLEY (Civil Aviation Authority, London, United Kingdom) *In* Fixed and rotary wing all weather operations; Proceedings of the Conference, London, United Kingdom, Apr. 23, 24, 1991 London Royal Aeronautical Society 1991 p. 2.1-2.11.
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An account is given of system requirements for aircraft category 2 and 3 operations, with a view to prospective developments. Attention is given to alert height, categories of precision approach and landing operations, fail-operational and fail-passive landing systems, HUD approach and landing guidance, and the certification of onboard equipment. Runway and operational criteria for safe all-weather landing operations of fixed and rotary wing aircraft are also noted. O.C.

A93-17304
THE CERTIFICATION OF HEAD UP DISPLAYS FOR CATEGORY 3 OPERATION
J. RYE (Civil Aviation Authority, Gatwick, United Kingdom) *In* Fixed and rotary wing all weather operations; Proceedings of the Conference, London, United Kingdom, Apr. 23, 24, 1991 London Royal Aeronautical Society 1991 p. 5.1-5.7.
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New airworthiness requirements must be formulated in order to implement a HUD system as a means of achieving category 3 approaches and landings. If the use of a HUD employs the human *pilot in place of autopilot servos, it is judged reasonable to require* that the HUD/pilot combination should meet the same performance and safety requirements as an 'autoland' system; compliance must accordingly be shown through a computer simulation of winds and turbulence, the aircraft, and the autopilot. A series of 100 *landings with the prototype HUD system is also required.* O.C.

A93-17305
A REVIEW OF ALTERNATIVE PHILOSOPHIES
R. B. LUMSDEN (Royal Aerospace Establishment, Bedford, United Kingdom) *In* Fixed and rotary wing all weather operations; Proceedings of the Conference, London, United Kingdom, Apr. 23, 24, 1991 London Royal Aeronautical Society 1991 p. 6.1-6.15.
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An evaluation is conducted of alternative methods for operating in ICAO category 3 weather conditions without fail-operational automatic landing systems. Attention is given to a resort to manual landings after automatic approach, fail-passive automatic approach and landing, HUD-employing manual landing after automatic approach, manual approach and landings using HUD, fail-passive autolanding with HUD reversion, and synthetic vision. Synthetic vision is the most radical departure from the other methods, and is based on immature technology. O.C.

A93-17309
HELICOPTER APPROACHES IN LOW VISIBILITY USING RGPS AND EFIS
M. DOWNES and C. BROWN (Royal Aerospace Establishment, Bedford, United Kingdom) *In* Fixed and rotary wing all weather operations; Proceedings of the Conference, London, United Kingdom, Apr. 23, 24, 1991 London Royal Aeronautical Society 1991 p. 12.1-12.15. refs
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This paper describes the development of a guidance system using the Global Positioning System (GPS). The system is aimed specifically at providing precision guidance for the recovery of helicopters to small ships at sea. The background to this work, and the method of deriving the guidance and displaying it to the pilot is described. The use of an electronic display system and the development of various approach profiles to reduce pilot workload are also discussed. The results of recent sea trials are examined. Author

N93-12816# *Aerodyne Research, Inc., Billerica, MA.*
ICING PREVENTION BY ULTRASONIC NUCLEATION OF SUPERCOOLED WATER DROPLETS IN FRONT OF SUBSONIC AIRCRAFT
DOUGLAS R. WORSNOP, RICHARD MIAKE-LYE, and ZEEV HED Oct. 1992 58 p
(Contract DTFA03-91-C-00038)
(DOT/FAA/CT-TN92/38) Avail: CASI HC A04/MF A01

Experiments were performed in the NASA Lewis Research Center (LeRC) Icing Research Tunnel (IRT) to explore the possible application of an icing prevention technique. This technique is based on nucleation ice crystallization in supercooled cloud droplets upstream of the impingement surface and relying on evaporative cooling to remove the latent heat of fusion from the droplet so that it can completely freeze before striking the solid surface. Ice accretion on the impingement surface was measured to quantify the changes due to induced nucleation. A flow duct was designed to provide a uniform, parallel flow from the nucleation excitation volume to the test surface, a simple symmetric airfoil. The distance between the excitation volume and the airfoil in the flow duct could be varied, but the maximum length of over 2 m was chosen to maximize the time for freezing. Ice accretion was measured over a range of tunnel parameters, including tunnel velocities of 50-100 mph and temperatures from 0 to -36 F. At colder temperatures, spontaneous freezing of supercooled droplets led to reductions in observed ice accretion. However, the range of active nucleation parameters explored in this set of experiments had no measurable effect on ice accretion on the subject airfoil. Suggested future work includes expanding the measurement parameter space and obtaining static measurements in a cloud chamber. Author

N93-13364 Toledo Univ., OH.
SIMULATION OF TWO-DIMENSIONAL ICING, DE-ICING AND ANTI-ICING PHENOMENA *Ph.D. Thesis*

WILLIAM BENJAMIN WRIGHT 1991 134 p
Avail: Univ. Microfilms Order No. DA9216671

An algorithm has been developed to numerically model the concurrent phenomena of two-dimensional transient heat transfer, ice accretion and ice shedding which occur in the operation of an electrothermal pad. The Alternating Direction Implicit method is used to simultaneously solve the heat transfer and accretion equations for a multilayered body covered with ice. In order to model the phase change between ice and water, a technique was used which assumes a phase for each node. This allows the governing equations to be linearized such that a direct solution is possible. This technique requires an iterative procedure to find the correct phase at each node. Numerical solutions illustrating deicer performance for various conditions are presented. Comparisons are made with previous numerical models and with experimental data. The computer program developed to determine this solution has been integrated with the NASA-Lewis flow/trajectory code LEWICE to provide a more complete analysis of de-icing and anti-icing phenomena. Dissert. Abstr.

N93-13426# National Transportation Safety Board, Washington, DC.
AIRCRAFT ACCIDENT REPORT: BRITT AIRWAYS, INC., D/B/A, CONTINENTAL EXPRESS FLIGHT 2574, IN-FLIGHT STRUCTURAL BREAKUP, EMB-120RT, N33701, EAGLE LAKE, TEXAS, SEPTEMBER 11, 1991
21 Jul. 1992 91 p
(PB92-910405; NTSB/AAR-92/04) Avail: CASI HC A05/MF A01

The structural breakup is examined in flight and crash of Continental Express Flight 2574, an Embraer 120, in a cornfield near Eagle Lake, Texas. The safety issues discussed include the feasibility of developing a means to advise flightcrews of recent maintenance work on aircraft and the need for reviewing regulations, policies and practices for establishing required inspection items (RIIs) with a view toward developing more specific identification of RIIs. Safety recommendations concerning these issues were made to the Federal Aviation Administration. GRA

N93-13470# National Transportation Safety Board, Washington, DC.
AIRCRAFT ACCIDENT/INCIDENT SUMMARY REPORT: CONTROLLED FLIGHT INTO TERRAIN, BRUNO'S INC., BEECHJET, N25BR, ROME, GEORGIA, DECEMBER 11, 1991
8 Jul. 1992 34 p
(PB92-910404; NTSB/AAR-92/01/SUM) Avail: CASI HC A03/MF A01

The report explains the crash of N25BR into mountainous terrain near Rome, Georgia. The safety issues discussed include the policies and procedures in corporate flight operations, the role of the first officer in corporate flight operations, and the use of ground proximity warning systems in FAR Part 91 operations of turbojet-powered airplanes. GRA

N93-13787# Transportation Research Board, Washington, DC.
PUBLIC-SECTOR AVIATION ISSUES: GRADUATE RESEARCH AWARD PAPERS, 1990 - 1991
ROBERT S. DODD, MICHAEL T. DROLLINGER, JULIE ANNE YATES HEGWOOD, SUSAN J. HEIDNER, and VIRGINIA STOUFFER 1992 56 p
(ISSN 0361-1981)
(PB92-222629; TRB/TRR-1332; LC-92-15610;
ISBN-0-309-05171-1) Avail: CASI HC A04/MF A01

Factors Involved in Emergency Medical Service Helicopter Occupant Crash Survival; Land Use Planning Approaches to Mitigating General Aviation Accidents; Trends at United States International Gateway Airports to Europe; Commercial Aviation Safety and Risk. GRA

N93-14024# Massachusetts Inst. of Tech., Lexington.
BIRDS MIMICKING MICROBURSTS ON 2 JUNE 1990 IN ORLANDO, FLORIDA
M. A. ISAMINGER 10 Jul. 1992 74 p
(Contract DTFA01-89-Z-02033)
(AD-A255703; ATC-184) Avail: CASI HC A04/MF A01

During 1990 and 1991, the Terminal Doppler Weather Radar (TDWR) testbed collected Doppler radar measurements in Orlando, Florida in support of the TDWR Project. The main focus of the project is to develop algorithms that automatically detect wind shears such as microbursts anti gust fronts. While the primary goal of the TDWR is to detect scattering from raindrops, the sensitivity of the system allows for the detection of biological echoes as well. Previous research has shown that under certain conditions the scattering from birds and insects will lead to divergent signatures that mimic microbursts. This type of pattern has been documented in Alabama (Rinehart, 1986), Illinois (Larkin and Quine, 1989), and Missouri (Evans, 1990). In the Alabama and Illinois events, a divergent pattern similar to a microburst was produced when a large number of birds departed in the early morning hours from an overnight roosting site. On 2 June 1990 in Orlando, Florida, there were 11 surface divergent signatures similar to microbursts detected by the TDWR testbed radar. The maximum differential velocity of these events ranged from 11 to 36 m/s, while the maximum reflectivity varied from 0 to 44 dBz. There was light rain in the area and low-reflectivity returns aloft; however, the reflectivity was more like low-reflectivity microbursts in Denver than high-reflectivity microbursts that generally are observed in Orlando. These divergences were not detected by the microburst algorithm since the TDWR site adaptation parameters have been adjusted to avoid issuing alarms for signatures such as those on 2 June. Detailed investigation was conducted of two events to verify that these were not actual microbursts. GRA

N93-14026# Federal Aviation Administration, Oklahoma City, OK. Civil Aeromedical Inst.
POSTMORTEM ALCOHOL PRODUCTION IN FATAL AIRCRAFT ACCIDENTS Final Report
DENNIS V. CANFIELD, THOMAS C. KUPIEC, and EDWIN F. HUFFINE Jul. 1992 5 p
(AD-A255766; DOT/FAA/AM-92/24) Avail: CASI HC A01/MF A01

During 1989 and 1990, the Civil Aeromedical Institute (CAMI) received specimens from 975 victims of fatal aircraft accidents. The maximum concentration of ethanol allowed Linder FAA regulations (0.04 percent, 40mg/dL) was exceeded in 79 of these cases (8 percent). It was determined based on the distribution of ethanol in urine, vitreous, blood, and tissue that 21 of the positive cases (27 percent) were from postmortem alcohol production. Twenty-two of the positive cases (28 percent) were found to be from the ingestion of ethanol. In 36 cases (45 percent) no determination could be made in regards to the origin of the ethanol. In two cases, postmortem alcohol production exceeded 0.15 percent (150mg/dL). The opinion held by some toxicologists that postmortem alcohol production can be inferred from the presence of acetaldehyde, acetone, butanol, and other volatiles was found to be incorrect. Several cases with postmortem ethanol had no other volatiles. Volatile compounds were found in several cases where no ethanol was present. In addition, a case was found where the relative ethanol concentrations in blood, bile, and vitreous humor were solely consistent with the ingestion of ethanol, but acetaldehyde, acetone, and 2-butanol were also found in blood. This clearly indicates that the presence or absence of other volatiles does not establish postmortem ethanol production. GRA

N93-14277# Federal Aviation Administration, Washington, DC. Office of Aviation Medicine.
EFFECTS OF SEATING CONFIGURATION AND NUMBER OF TYPE 3 EXITS ON EMERGENCY AIRCRAFT EVACUATION Final Report
GARNET A. MCLEAN, CHARLES B. CHITTUM, GORDON E. FUNKHOUSER, GREGORY W. FAIRLIE, and EARL W. FOLK Aug. 1992 27 p
(AD-A256616; DOT/FAA/AM-92/27) Avail: CASI HC A03/MF A01

An increase in the required pathway width from aircraft center aisles to Type 3 overwing exits is being weighed by the FAA. To

augment the analysis, an examination of seat/exit configuration effects on simulated emergency egress was conducted in the CAMI Evacuation Research Facility. Four subject groups traversed four different seat/exit configurations in a counter-balanced, repeated-measures design. Pathway width was modified by altering seat pitch. In single-exit trials the fastest times and highest flow-rates occurred with a 20 pathway between triple seats or a 10 inch pathway between double seats. Double exits produced 36 percent shorter egress times (p less than .007), although flow-rates declined 11 percent and exit plug removal times increased 32 percent, compared to single exits. Efficient egress requires optimization of the space around the exit. Generally, wider pathways and fewer obstructions enhance this process; however; when available space exceeds individual passenger needs, conflicts may be produced which inhibit egress. GRA

N93-14693 Columbia Univ., New York, NY.
AVIATION ACCIDENTS, INCIDENTS, AND VIOLATIONS: PSYCHOLOGICAL PREDICTORS AMONG US PILOTS Ph.D. Thesis
MAXINE ESTA LUBNER 1992 509 p
Avail: Univ. Microfilms Order No. DA9232119

A retrospective case-control survey discovered candidate risk factors for pilots having aviation accidents, incidents and/or violations during 1987-1988. Risk factors included personal disposition, flight background, and demographic variables. A randomly selected sample from Federal Aviation Administration data bases of 1,049 civil aviation U.S. male pilots received anonymous questionnaires. Response rate was 46.3 percent. A check of threats to validity found negligible bias arising from non--response, exclusion of respondents, missing data, and power requirements. The final sample size was 394. Analyses were conducted by univariate inspection of variables, comparison of cases and controls using bivariate parametric and non-parametric tests on original and transformed data, and multivariate analyses of case-control status using selected variables. Logistic and multiple regressions tested predictors in tiered models: (1) personal disposition variables; (2) personal dispositions and demographics; and (3) personal dispositions, demographics, and flight backgrounds. Additional logistic regression tests were conducted within strata of three flight background variables: Experience, Exposure, and Skill. Within case bivariate and some multiple regression tests compared more severe with less severe cases. Severity of case status outcomes included: (1) type of concurrence; (2) Pilot-in-Command or not; (3) severity of accident/incident; (4) pilot- vs. other-caused occurrence; (5) number of occurrences ever had; and (6) rates of occurrences had, using experience and years flown as denominators. Environmental context predictors appeared in separate multiple regression models using occurrence rates outcomes. Certain variables consistently predicted case status offering a Risk Profile: high Thrill and Adventure Seeking, many ailments, not married, many years flown, many recent hours flown, and possibly, Eastern FAA Region. Stratified and within-cases analyses suggested several predictors of case status including low Superego, few safety behaviors, Private certificate, Personal flying, less education, and fewer pilot friends. The Five Hazardous Thoughts measure had little validity and requires refinement. Future research on theoretical and preventive issues should focus on risk-taking, conscientiousness, judgement, and learning. Methodological recommendations include using measures with improved psychometric properties and validity. Dissert. Abstr.

N93-14844*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AIRBORNE WIND SHEAR DETECTION AND WARNING SYSTEMS. FOURTH COMBINED MANUFACTURERS' AND TECHNOLOGISTS' CONFERENCE, PART 2
DAN D. VICROY, comp., ROLAND L. BOWLES, comp., and ROBERT H. PASSMAN, comp. (Federal Aviation Administration, Washington, DC.) Sep. 1992 416 p Conference held in Williamsburg, VA, 14-16 Apr. 1992; cosponsored by FAA Prepared in cooperation with FAA, Washington, DC
(Contract RTOP 505-64-12-01)
(NASA-CP-10105-PT-2; NAS 1.55:10105-PT-2; DOT/FAA/RD-92/19-PT-2) Avail: CASI HC A18/MF A04

The Fourth Combined Manufacturers' and Technologists' Conference was hosted jointly by NASA Langley Research Center (LaRC) and the Federal Aviation Administration (FAA) in Williamsburg, Virginia, on April 14-16, 1992. The meeting was co-chaired by Dr. Roland Bowles of LaRC and Bob Passman of the FAA. The purpose of the meeting was to transfer significant ongoing results of the NASA/FAA Joint Airborne Wind Shear Program to the technical industry and to pose problems of current concern to the combined group. It also provided a forum for manufacturers to review forward-look technology concepts and for technologists to gain an understanding of the problems encountered by the manufacturers during the development of airborne equipment and the FAA certification requirements. The present document has been compiled to record the essence of the technology updates and discussions which follow each.

N93-14847*# Lockheed Missiles and Space Co., Palo Alto, CA.
NASA/LMSC COHERENT LIDAR AIRBORNE SHEAR SENSOR: SYSTEM CAPABILITIES AND FLIGHT TEST PLANS
PAUL ROBINSON *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Fourth Combined Manufacturers' and Technologists' Conference, Part 2 p 659-671 Sep. 1992
Avail: CASI HC A03/MF A04

The primary objective of the NASA/LMSC Coherent Lidar Airborne Shear Sensor (CLASS) system flight tests is to evaluate the capability of an airborne coherent lidar system to detect, measure, and predict hazardous wind shear ahead of the aircraft with a view to warning flight crew of any impending dangers. On NASA's Boeing 737 Transport Systems Research Vehicle, the CLASS system will be used to measure wind velocity fields and, by incorporating such measurements with real-time aircraft state parameters, identify regions of wind shear that may be detrimental to the aircraft's performance. Assessment is to be made through actual wind shear encounters in flight. Wind shear measurements made by the class system will be compared to those made by the aircraft's in situ wind shear detection system as well as by ground-based Terminal Doppler Weather Radar (TDWR) and airborne Doppler radar. By examining the aircraft performance loss (or gain) due to wind shear that the lidar predicts with that actually experienced by the aircraft, the performance of the CLASS system as a predictive wind shear detector will be assessed. Author

N93-14848*# Coherent Technologies, Inc., Boulder, CO.
SOLID-STATE COHERENT LASER RADAR WIND SHEAR MEASURING SYSTEMS
R. MILTON HUFFAKER *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Fourth Combined Manufacturers' and Technologists' Conference, Part 2 p 673-684 Sep. 1992
Avail: CASI HC A03/MF A04

Coherent Technologies, Inc. (CTI) was established in 1984 to engage in the development of coherent laser radar systems and subsystems with applications in atmospheric remote sensing, and in target tracking, ranging and imaging. CTI focuses its capabilities in three major areas: (1) theoretical performance and design of coherent laser radar system; (2) development of coherent laser radar systems for government agencies such as DoD and NASA; and (3) development of coherent laser radar systems for commercial markets. The topics addressed are: (1) 1.06 micron solid-state coherent laser radar system; (2) wind measurement using 1.06 micron system; and flashlamp-pumped 2.09 micron solid-state coherent laser radar system. I.I.C.

N93-14849*# Turbulence Prediction Systems, Boulder, CO.
DEVELOPMENT OF THE ADVANCE WARNING AIRBORNE SYSTEM(AWAS)
H. PATRICK ADAMSON *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Fourth

Combined Manufacturers' and Technologists' Conference, Part 2 p 687-780 Sep. 1992
Avail: CASI HC A05/MF A04

The thermal characteristics of microbursts are utilized by the AWAS IR and OAT features to provide predictive warning of hazardous microbursts ahead of the aircraft during landing or take off. The AWAS was evaluated satisfactorily in 1990 on a Cessna Citation that was intentionally flown into a number of wind shear events. The events were detected, and both the IR and OAT thermal features were shown to be effective. In 1991, AWAS units were flown on three American Airline MD-80's and three Northwest Airlines DC-9's to study and to decrease the nuisance alert response of the system. The AWAS was also flown on the NASA B737 during the summer of 1991. The results of these flights were inconclusive and disappointing. The results were not as promising as before because NASA conducted research flights which were outside of the normal operating envelope for which the AWAS is designed to operate. In an attempt to compensate for these differences in airspeed and mounting location, the automatic features of the system were sometimes overridden by NASA personnel during the flight. Each of these critical factors is discussed in detail. The effect of rain on the OAT signals is presented as a function of the air speed. Use of a 4 pole 1/20 Hertz filter is demonstrated by both the IR and thermal data. Participation in the NASA 1992 program was discussed. FAA direction in the continuing Certification program requires the addition of a reactive feature to the AWAS predictive system. This combined system will not require flight guidance on newer aircraft. The features of AWAS-IV, with the NASA algorithm included, were presented. Expected completion of the FAA Certification plan was also described. Author

N93-14850*# Georgia Tech Research Inst., Atlanta.
A MILLIMETER-WAVE RADIOMETER FOR DETECTING MICROBURSTS
ROBERT MCMILLAN *In* NASA. Langley Research Center, Airbourne Wind Shear Detection and Warning Systems. Fourth Combined Manufacturers' and Technologists' Conference, Part 2 p 781-803 Sep. 1992
Avail: CASI HC A03/MF A04

This paper describes a millimeter-wave radiometer for the detection of wind shear from airborne platforms or at airport terminals. This proposed instrument will operate near the group of atmospheric oxygen absorptions centered near 60 GHz, which it will use to sense temperature from a distance. The instrument will use two channels to provide two different temperature measurements, providing the basis for solution of two equations in two unknowns, which are range to the wind shear plume and its temperature. A third channel will measure ambient atmospheric temperature. Depending on the temperature difference between the wind-shear plume and ambient, the standard deviation of range measurement accuracy is expected to be about 1 km at 5 km range, while the temperature measurement standard deviation will be about one-fourth the temperature difference between plume and ambient at this range. The instrument is expected to perform usefully at ranges up to 10 km, giving adequate warning of the presence of wind shear even for high performance jet aircraft. Other atmospheric hazards which might be detected by this radiometer include aircraft wakes and vortices, clear-air turbulence, and wind rotors, although the latter two phenomena would be detected by an airborne version of the instrument. A separate radiometer channel will be provided in the proposed instrument to detect aircraft wakes and vortices based on perturbation of the spectrum of microscopic atmospheric temperature fluctuations caused by the passage of large aircraft. Author

N93-14851*# Massachusetts Inst. of Tech., Cambridge.
THE ORLANDO TDWR TESTBED AND AIRBORNE WIND SHEAR DATE COMPARISON RESULTS
STEVEN CAMPBELL, ANTHONY BERKE, and MICHAEL MATTHEWS *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Fourth Combined Manufacturers' and Technologists' Conference, Part 2 p 811-846 Sep. 1992
Avail: CASI HC A03/MF A04

The focus of this talk is on comparing terminal Doppler Weather Radar (TDWR) and airborne wind shear data in computing a microburst hazard index called the F factor. The TDWR is a ground-based system for detecting wind shear hazards to aviation in the terminal area. The Federal Aviation Administration will begin deploying TDWR units near 45 airports in late 1992. As part of this development effort, M.I.T. Lincoln Laboratory operates under F.A.A. support a TDWR testbed radar in Orlando, FL. During the past two years, a series of flight tests has been conducted with instrumented aircraft penetrating microburst events while under testbed radar surveillance. These tests were carried out with a Cessna Citation 2 aircraft operated by the University of North Dakota (UND) Center for Aerospace Sciences in 1990, and a Boeing 737 operated by NASA Langley Research Center in 1991. A large data base of approximately 60 instrumented microburst penetrations has been obtained from these flights. Author

N93-14852*# National Center for Atmospheric Research, Boulder, CO.
TDWR 1991 PROGRAM REVIEW
KIM ELMORE *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Fourth Combined Manufacturers' and Technologists' Conference, Part 2 p 847-875 Sep. 1992
Avail: CASI HC A03/MF A04

The topics addressed are: (1) Terminal Doppler Weather Radar (TDWR) 1991 program review; (2) TDWR demonstrations notable results/events; (3) TDWR demonstration Denver chronology; (4) overview of generic integration concepts; (5) TDWR 1991 program review; (6) Denver operation 1991; and (7) FY-92 plans. I.I.C.

N93-14853*# Massachusetts Inst. of Tech., Cambridge.
EXPERIMENTAL EVALUATION OF CANDIDATE GRAPHICAL MICROBURST ALERT DISPLAYS
CRAIG WANKE and R. JOHN HANSMAN *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Fourth Combined Manufacturers' and Technologists' Conference, Part 2 p 879-904 Sep. 1992
Avail: CASI HC A03/MF A04

The topics addressed are: (1) experimental evaluation of candidate graphical microburst displays; (2) microburst detection and alerting; (3) previous part-task simulator experiment-comparison of presentation modes; (4) presentation mode comparison-results; (5) advantages of graphical mode of presentation; (6) graphical microburst alert experiment-objectives; and graphical microburst alert experiment-overview; and (7) candidate display design. I.I.C.

N93-14854*# Princeton Univ., NJ.
WIND SHEAR RELATED RESEARCH AT PRINCETON UNIVERSITY
ROBERT STENGEL *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Fourth Combined Manufacturers' and Technologists' Conference, Part 2 p 905-955 Sep. 1992
Avail: CASI HC A04/MF A04

The topics addressed are: (1) real-time decision aiding-aircraft guidance for wind shear avoidance; (2) reducing the thrust-manual recovery strategies; and (3) dynamic behaviour of and aircraft encountering a single axis vortex. I.I.C.

N93-14855*# Massachusetts Inst. of Tech., Cambridge.
SYSTEMS ISSUES IN AIRBORNE DOPPLER RADAR/LIDAR CERTIFICATION
JAMES EVANS *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Fourth Combined Manufacturers' and Technologists' Conference, Part 2 p 959-969 Sep. 1992
Avail: CASI HC A03/MF A04

This report outlines: (1) thesis; (2) ground clutter challenge; (3) moving scatters (birds, bugs); (4) range ambiguities; and rain attenuation. I.I.C.

N93-14856*# Northwest Airlines, Inc., Saint Paul, MN.
RESULTS OF IN-SERVICE EVALUATION OF WIND SHEAR SYSTEMS
TODD MURR *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Fourth Combined Manufacturers' and Technologists' Conference, Part 2 p 977-995 Sep. 1992
Avail: CASI HC A03/MF A04

The objective is to collect data in the operational environment to determine the capability of windshear systems and their effectiveness. I.I.C.

N93-14857*# Continental Airlines, Inc., Los Angeles, CA.
IN-SERVICE EVALUATION OF WIND SHEAR SYSTEMS
SAM SHIRCK *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Fourth Combined Manufacturers' and Technologists' Conference, Part 2 p 997-1005 Sep. 1992
Avail: CASI HC A02/MF A04

A comprehensive study undertaken by Continental Airlines Flight Operations to establish procedures to prevent a re-occurrence of accident due to windshear is addressed. Some display and alerting scenarios that the predictive systems will provide is presented. I.I.C.

N93-14858*# American Airlines Flight Academy, Fort Worth, TX.
ADVANCED TECHNOLOGY WIND SHEAR PREDICTION SYSTEM EVALUATION
GREG GERING *In* NASA. Langley Research Center, Airborne Wind Shear Detection and Warning Systems. Fourth Combined Manufacturers' and Technologists' Conference, Part 2 p 1007-1015 Sep. 1992
Avail: CASI HC A02/MF A04

The program overviews: (1) American Airline (AA)/Turbulence Prediction Systems (TPS), which have installed forward looking infrared predictive windshear system on 3 MD-80 aircraft; (2) AA/TPS AWAS III evaluation, which is a joint effort and is installed in the noise landing gear (NLG) area and a data recorder installed in the E/E compartment. I.I.C.

N93-15013# Advanced Aviation Concepts, Jupiter, FL.
WORKSHOP ON AERONAUTICAL DECISION MAKING (ADM). VOLUME 2: PLENARY SESSION WITH PRESENTATIONS AND PROPOSED ACTION PLAN Final Report
RICHARD J. ADAMS and CATHERINE A. ADAMS Aug. 1992 270 p Workshop held in Denver, CO, 6-7 May 1992
(Contract DTFA01-90-C-00042)
(DOT/FAA/RD-92/14-VOL-2) Avail: CASI HC A12/MF A03

This report analyzes the accomplishments and needs of ADM from the perspectives of the operators, researchers, the military and the FAA. Both the airplane and helicopter communitys' experiences are considered. The presentations and background material in this volume were a part of the Plenary Session conducted on the first day of the workshop. They were meant to provide a detailed understanding of the status and needs of ADM from both operational and research perspectives. Problem areas identified by the workshop participants which defined the need for basic research included: Can we define what constitutes a 'good decision'? Can we identify different decision 'nodes' during a flight? This volume presents the participants perspectives on the behavioral psychology and human factors work that has been done in these areas as well as in the area of new decision making models and concepts.

N93-15014# Air Force Inspection and Safety Center, Norton AFB, CA.
DOES COCKPIT MANAGEMENT TRAINING REDUCE AIRCREW ERROR?
ALAN E. DIEHL *In* Advanced Aviation Concepts, Workshop on Aeronautical Decision Making (ADM). Volume 2: Plenary Session With Presentations and Proposed Action Plan p 3-24 Aug. 1992
Avail: CASI HC A03/MF A03

Human factors problems continue to be involved in majority of mishaps. Thus, the causes and cures for aircrew 'error' are widely discussed topics. Several experts have noted that labels like pilot 'error' are often misapplied in describing ergonomic, management, regulatory or systems design shortcomings. This paper uses the generic term 'cockpit management' when referring to the wide variety of programs which are designed to reduce aircrew errors. In fact, recent evidence suggests Cockpit Resource Management (CRM) and Aeronautical Decision making (ADM) training may help reduce aircrew error accident rates by as much as 81 percent. These programs have only emerged in the last decade largely because of the fundamental problems associated with detecting and controlling human error. Many of us have lamented the greater difficulties of accurately documenting human vis-a-via mechanical failures, (e.g., mental fatigue is usually tougher to prove than metal fatigue). It is also often harder for us as air safety investigators to specify effective countermeasures in the human factors domain. Thus, some organizations unfortunately have assumed such errors are 'the price of doing business'. This paper addresses these issues by: (1) examining the prevalence of major types of contemporary errors and reviewing the traditional methods which have been used to improve human reliability; (2) discussing how innovative cockpit management training programs were developed and implemented; and (3) describing the current evidence on the effectiveness of such programs. Author

N93-15015# Air Force Inspection and Safety Center, Norton AFB, CA.
COCKPIT DECISION MAKING
ALAN E. DIEHL *In* Advanced Aviation Concepts, Workshop on Aeronautical Decision Making (ADM). Volume 2: Plenary Session With Presentations and Proposed Action Plan p 25-29 Aug. 1992
Avail: CASI HC A01/MF A03

The categorical distinctions between Cockpit Resource Management (CRM) and Aeronautical Decision Making (ADM) training are becoming blurred. Most current versions of these programs have five common elements which deal with attention, crew, stress, attitude, and risk management issues. The results of six empirical and six operational evaluations provide strong evidence that these training programs can help reduce aircrew errors and thereby prevent accidents. While additional research and development continues, there is a growing realization that these programs ideally need to be introduced rarely in flight training, reinforced during upgrade training, and reviewed during recurrent training and accident prevention sessions. Author

N93-15016# Naval Safety Center, Norfolk, VA.
TRANS-COCKPIT AUTHORITY GRADIENT IN NAVY/MARINE AIRCRAFT MISHAPS
ROBERT A. ALKOV, MICHAEL S. BOROWSKY, DANA W. WILLIAMSON, and DAVID W. YACAVONE *In* Advanced Aviation Concepts, Workshop on Aeronautical Decision Making (ADM). Volume 2: Plenary Session With Presentations and Proposed Action Plan p 56-66 Aug. 1992
Avail: CASI HC A03/MF A03

Navy and Marine Corps aircraft mishaps which have an aircrew causal factor assigned were analyzed to determine if the relative military rank of the pilot and copilot or Naval Flight Officer was associated with the rate of occurrence per 100,000 flight hours. All class A and B helicopter flight mishaps for the elevent calendar year period 1980-1990 were examined. Although statistically significant differences were not found, pairing helicopter pilots who were of equal rank yielded the lowest rate (2.81), seemingly refuting Elwyn Edward's notion that a flat 'trans-cockpit authority gradient' may lead to greater problems in the cockpit than his hypothetical 'optimum gradient'. When there was one rank difference in the cockpit the rate was 2.340. When copilots flew with pilots who

differed by two or more ranks, the largest pilot error rate (3.45) was revealed. These findings seem to support Edward's hypothesis that a steeper 'trans-cockpit authority gradient' may be detrimental to helicopter flight safety. Data from fighter and attack jet aircraft, where there is only one pilot flying with a radar intercept officer or a bombardier/ navigator, were also studied for the calendar years 1986-91. It was discovered that the lowest aircrew error rate (1.80) occurred when the pilot and the other aircrew member differed by more than one rank. When the aircrew were of the same rank the rate was 3.51. For those crews in which there was a one rank difference the rate was 3.85. Reasons for these findings are discussed. Author

N93-15017# Advanced Aviation Concepts, Jupiter, FL.
HOW EXPERT PILOTS THINK
RICHARD J. ADAMS *In its* Workshop on Aeronautical Decision Making (ADM). Volume 2: Plenary Session With Presentations and Proposed Action Plan p 68-87 Aug. 1992
Avail: CASI HC A03/MF A03

This paper provides an overview of the conceptual cognitive psychology research that defines and delineates the important characteristics of expertise. It is hoped that the understanding of the cognitive processes associated with 'experts', will increase the awareness of these processes in the pilot training community. The importance of the attainment of a higher level of cognitive skills by pilots is the opportunity to enhance performance and further reduce human error accidents through improved decision making training. Author

N93-15018# Colorado Univ., Boulder. Inst. of Cognitive Science.
METHODOLOGY FOR STUDYING AND TRAINING EXPERTISE
K. ANDERS ERICSSON *In* Advanced Aviation Concepts, Workshop on Aeronautical Decision Making (ADM). Volume 2: Plenary Session With Presentations and Proposed Action Plan p 88-108 Aug. 1992
Avail: CASI HC A03/MF A03

The topics addressed are: (1) brief historical background for the study of eminent people and experts-some approaches and issues; (2) the study of superior expert performance; and (3) sketch of a proposal for diagnosis and training of expert decision-making in pilots. I.I.C.

N93-15019# Advanced Aviation Concepts, Jupiter, FL.
ENHANCED AERONAUTICAL RESOURCE MANAGEMENT TRAINING ALTERNATIVES
RICHARD J. ADAMS *In its* Workshop on Aeronautical Decision Making (ADM). Volume 2: Plenary Session With Presentations and Proposed Action Plan p 109-128 Aug. 1992
Avail: CASI HC A03/MF A03

Expert cognitive performance is characterized by rapid access to a well organized body of conceptual and procedural knowledge. This is a modifiable information structure based upon knowledge that is experienced. This experience allows the perception of large meaningful patterns in familiar and new situations which help the expert match goals to task demands. This means they can respond creatively or with opportunistic solutions when the situation requires such a response. Author

N93-15020# Klein Assoiciates, Inc., Fairborn, OH.
A COGNITIVE MODEL FOR TRAINING DECISION MAKING IN AIRCREWS
GARY A. KLEIN *In* Advanced Aviation Concepts, Workshop on Aeronautical Decision Making (ADM). Volume 2: Plenary Session With Presentations and Proposed Action Plan p 129-144 Aug. 1992
Avail: CASI HC A03/MF A03

The topics addressed are: (1) prescriptions for effective decision making; (2) Recognition-Primed Decision (RPD) model; (3) key features of RPD model; (4) factors affecting the use of recognitional and analytical decisions; (5) team research and observations; (6) aspects of teamwork; (7) cognitive process of teams; (8) advanced team decision making- a development model; (9) key features and critical processes of decision making teams; (10) myths about team decision making; and (11) recommendations for team decision training. I.I.C.

N93-15021# Honeywell, Inc., Minneapolis, MN. Systems and Research Center.
ELEMENTS OF A THEORY OF NATURAL DECISION MAKING
JOHN R. BLOOMFIELD *In* Advanced Aviation Concepts, Workshop on Aeronautical Decision Making (ADM). Volume 2: Plenary Session With Presentations and Proposed Action Plan p 145-164 Aug. 1992
Avail: CASI HC A03/MF A03

The preliminary theory provides a framework that can incorporate a broad range of decisions and decision situations: ranging from the tightly-defined situations investigated by classical decision theorists all the way to complex real-world situations, involving proficient decision-makers, under a great deal of stress, and/or time pressure. Author

N93-15022# Honeywell, Inc., Minneapolis, MN.
TAXONOMY OF FLIGHT VARIABLES
JOHN R. BLOOMFIELD, LEE LEVITAN, BARRY COOPER (America West Airlines, Tempe, AZ.), ELIZABETH A. LYALL (America West Airlines, Tempe, AZ.), and ELEANA EDENS (Federal Aviation Administration, Washington, DC.) *In* Advanced Aviation Concepts, Workshop on Aeronautical Decision Making (ADM). Volume 2: Plenary Session With Presentations and Proposed Action Plan p 165-171 Aug. 1992
(Contract DTFA01-91-C-00040)
Avail: CASI HC A02/MF A03

Controlled Flight Into Terrain (CFIT) accidents and Controlled Flight Toward Terrain (CFTT) incidents, particularly those that occur when the flight crew believe that the autopilot, flight director, and/or flight management system is in use are investigated. The first step was to develop a taxonomy of flight variables. The taxonomy developed for CFIT accidents and incidents will also be of use in considering other air accidents and as a strawman taxonomy of flight of operations general. I.I.C.

N93-15023*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SHARED MENTAL MODELS AND CREW DECISION MAKING
JUDITH ORASANU *In* Advanced Aviation Concepts, Workshop on Aeronautical Decision Making (ADM). Volume 2: Plenary Session With Presentations and Proposed Action Plan p 172-181 Aug. 1992
Avail: CASI HC A02/MF A03

The topics addressed are: (1) structure of decisions tasks in the cockpit and their cognitive requirements; (2) what is known about effective crew decision making?; and (3) implications for training Aeronautical Decision Making (ADM). The model implies that effective crew decision making training would include different foci such as Situational Awareness, Planning, Communication, Resource Assessment and Prioritizing. I.I.C.

N93-15024# Textron Bell Helicopter, Fort Worth, TX.
EMBEDDED ADM REDUCES HELICOPTER HUMAN ERROR ACCIDENTS
ROY G. FOX *In* Advanced Aviation Concepts, Workshop on Aeronautical Decision Making (ADM). Volume 2: Plenary Session With Presentations and Proposed Action Plan p 182-229 Aug. 1992
Avail: CASI HC A03/MF A03

The basic outlines are: (1) Who is responsible for safety?; (2) measuring risk; (3) means of reducing risk; and (4) crash survival; (5) accident causes (2/3 are Human); (6) judgement training; and heliprops effects on 206 human error accident rates. The conclusion made is that, Judgement Training has more safety improvement potential than the total elimination of all airworthiness failure causes (a primary goal since the start of aviation). I.I.C.

N93-15025# Textron Bell Helicopter, Fort Worth, TX.
MEASURING RISK IN SINGLE-ENGINE AND TWIN-ENGINE HELICOPTERS
ROY G. FOX *In* Advanced Aviation Concepts, Workshop on Aeronautical Decision Making (ADM). Volume 2: Plenary Session With Presentations and Proposed Action Plan p 230-253 Aug. 1992
Avail: CASI HC A03/MF A03

Safety is the management of risk. Many decisions are made by businesses, government agencies and individuals using their perceptions of an aircraft's safety. Public perception of safety can deny the introduction of expansion of aviation in specific areas. Decisions to buy, use, repair, install improvements, insure, sell, and replace aircraft are all related to perceived safety. Likewise, governmental restrictions and rule-making are based on the perceived deterioration of safety, as in the proposed single-engine helicopter restrictions of ICAO Annex 6. Accurate aircraft safety measurements are thus essential to bring perceived and actual safety together. Such accuracy also provides realistic corrective actions for safety problems and evaluation of desirable and undesirable aspects of different aircraft configurations, as well as allowing individuals to determine their risk in flying in specific types of aircraft. Existing safety measuring methods are discussed, along with the advantages, disadvantages, and correctness of each method. Recent safety training and its effects are discussed, related to improved pilot judgment and significant reductions in accident rates--without any regulatory changes. Author

N93-15026# *Advanced Aviation Concepts, Jupiter, FL.*
PROPOSED ACTION PLAN TO IMPROVE ADM EFFECTIVENESS, PART 3: DEVELOPING A NEW ADM PARADIGM ON WHICH TO BUILD ADVANCED OR EXPERT DECISION MAKING TRAINING
In its Workshop on Aeronautical Decision Making (ADM). Volume 2: Plenary Session With Presentations and Proposed Action Plan p 254-267 Aug. 1992
Avail: CASI HC A03/MF A03

Aeronautical Decision Making (ADM) training benefits in terms of reducing human error accident rates were documented during the presentations at the workshop. Basic research needs, training implementation problems and the need for additional modeling work were also identified. This document provides the aviation industry and the FAA with a suggested roadmap to assist in the development of improved ADM concepts and training methods. The basic questions that will be addressed are: (1) Can decision making tasks be identified and defined?; (2) What are the training objectives?; (3) What are the appropriate training strategies?; and (4) How can the training effectiveness be evaluated? Author

N93-15164# Aeritalia S.p.A., Naples (Italy). Flight Safety.
THE FAIR (FLIGHT ANIMATED AND INTERACTIVE RECONSTRUCTION) TOOL [DIE INTERAKTIVE UND MIT HILFE VON TRICKFILMTECHNIKEN ARBEITENDE FLUGREKONSTRUKTION FAIR]
SILENZI SILVANO *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 219-235 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

Flight safety is an endless task, and its achievement calls for the use of every means possible. One of these is the flight data recorder system. The most important parameters are registered. Once they are processed with specific programs, they are listed in a long data sheet. It is important to be able to understand the relevant flight information and data. FAIR, an instrument capable of simplifying the analysis of an event, is considered. Details are given for the following: features, technical characteristics, visualization, animation, examples of satellite images, and power vision specifications. ESA

N93-15345*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NUMERICAL MODELING OF ANTI-ICING SYSTEMS AND COMPARISON TO TEST RESULTS ON A NASA 0012 AIRFOIL
KAMEL M. AL-KHALIL and MARK G. POTAPCZUK Jan. 1993 14 p Presented at the 31st Aerospace Sciences Meeting and Exhibit, Reno, NV, 11-14 Jan. 1993; sponsored by AIAA
(Contract RTOP 505-68-10)
(NASA-TM-105975; E-7498; NAS 1.15:105975; AIAA PAPER 93-0170) Avail: CASI HC A03/MF A01

A series of experimental tests were conducted in the NASA Lewis IRT on an electro-thermally heated NACA 0012 airfoil. Quantitative comparisons between the experimental results and those predicted by a computer simulation code were made to assess the validity of a recently developed anti-icing model. An infrared camera was utilized to scan the instantaneous temperature contours of the skin surface. Despite some experimental difficulties, good agreement between the numerical predictions and the experiment results were generally obtained for the surface temperature and the possibility for each runback to freeze. Some recommendations were given for an efficient operation of a thermal anti-icing system. Author

N93-15354*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ICE ACCRETION AND PERFORMANCE DEGRADATION CALCULATIONS WITH LEWICE/NS
MARK G. POTAPCZUK, KAMEL M. AL-KHALIL (National Academy of Sciences - National Research Council, Washington, DC.), and MATTHEW T. VELAZQUEZ (Massachusetts Inst. of Tech., Cambridge.) Jan. 1993 22 p Presented at the 31st Aerospace Sciences Meeting and Exhibit, Reno, NV, 11-14 Jan. 1993; sponsored by AIAA
(Contract RTOP 505-68-10)
(NASA-TM-105972; E-7497; NAS 1.15:105972; AIAA PAPER 93-0173) Avail: CASI HC A03/MF A01

The LEWICE ice accretion computer code has been extended to include the solution of the two-dimensional Navier-Stokes equations. The code is modular and contains separate stand-alone program elements that create a grid, calculate the flow field parameters, calculate the droplet trajectory paths, determine the amount of ice growth, calculate aeroperformance changes, and plot results. The new elements of the code are described. Calculated results are compared to experiment for several cases, including both ice shape and drag rise. Author

N93-15360*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CLOSE-UP ANALYSIS OF AIRCRAFT ICE ACCRETION
R. JOHN HANSMAN (Massachusetts Inst. of Tech., Cambridge.), KENNETH S. BREUER (Massachusetts Inst. of Tech., Cambridge.), DIDIER HAZAN (Massachusetts Inst. of Tech., Cambridge.), ANDREW REEHORST, and MARIO VARGAS Jan. 1993 15 p Presented at the 31st Aerospace Sciences Meeting and Exhibit, Reno, NV, 11-14 Jan. 1993; sponsored by AIAA
(Contract NAG3-666; NGL-22-0069-640; RTOP 505-68-10)
(NASA-TM-105952; E-7473; NAS 1.15:105952; AIAA PAPER 93-0029) Avail: CASI HC A03/MF A01

Various types of ice formation have been studied by analysis of high magnification video observations. All testing was conducted in the NASA Lewis Icing Research Tunnel (IRT). A faired 8.9 cm (3.5 in.) diameter metal-clad cylinder and a 5.1 (2 in.) aluminum cylinder were observed by close-up and overview video cameras for several wind tunnel conditions. These included close-up grazing angle, close-up side view, as well as overhead and side overview cameras. Still photographs were taken at the end of each spray along with tracings of the subsequent ice shape. While in earlier tests only the stagnation region was observed, the entire area from the stagnation line to the horn region of glaze ice shapes was observed in this test. The modes or horn formation have been identified within the range of conditions observed. In the horn region, Horn Type A ice is formed by 'dry' feather growth into the flow direction and Horn Type B is formed by a 'wet' growth normal to the surface. The feather growth occurs when the freezing fraction is near unity and roughness elements exist to provide an initial growth site. Author

N93-15390# Federal Aviation Administration, Washington, DC. Office of Aviation Policy and Plans.
TERMINAL AREA FORECASTS FY 1992 - 2005
Jul. 1992 495 p
(AD-A255797) Avail: CASI HC A21/MF A04

This report contains forecasts of aviation activity of 869 airports in the United States for fiscal years 1992-2005. These include 400 airports with FAA air traffic control towers and radar approach control service and 26 FAA contract towers. For each airport, detailed forecasts are made for the four major users of the air traffic system: air carriers, air taxi/commuters, general aviation, and military. Summary tables contain national, FAA regional, and state aviation data and other airport specific highlights. The forecasts have been prepared to meet the budget and planning needs of the FAA and provide airport-specific information that can be used by state and local aviation authorities, the aviation industry, and the general public. GRA

N93-15522*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ICE ACCRETION PREDICTION FOR A TYPICAL COMMERCIAL TRANSPORT AIRCRAFT
C. S. BIDWELL Jan. 1993 23 p Presented at the 31st Aerospace Sciences Meeting and Exhibit, Reno, NV, 11-14 Jan. 1993; sponsored by AIAA
(Contract RTOP 505-68-10)
(NASA-TM-105976; E-7499; NAS 1.15:105976; AIAA PAPER 93-0174) Avail: CASI HC A03/MF A01

Ice accretion calculations were made for a modern commercial transport using the NASA Lewis LEWICE3D ice accretion code. The ice accretion calculations were made for the wing and horizontal tail using both isolated flow models and flow models incorporating the entire airplane. The isolated flow model calculations were made to assess the validity of using these simplified models in lieu of the entire model in the ice accretion analysis of full aircraft. Ice shapes typifying a rime and a mixed ice shape were generated for a 30 minute hold condition. In general, the calculated ice shapes looked reasonable and appeared representative of a rime and a mixed ice conditions. The isolated flow model simplification was good for the main wing except at the root where it overpredicted the amount of accreted ice relative to the full aircraft flow model. For the horizontal tail the size and amount of predicted ice compared well for the two flow models, but the position of the accretions were more towards the upper surface for the aircraft flow model relative to the isolated flow model. This was attributed to downwash from the main wing which resulted in a lower effective angle of attack for the aircraft tail. Author

N93-15577# National Transportation Safety Board, Washington, DC.
SPECIAL INVESTIGATION REPORT: PIPER AIRCRAFT CORPORATION PA-46 MALIBU/MIRAGE ACCIDENTS/INCIDENT, 31 MAY 1989 - 17 MARCH 1991
21 Jul. 1992 101 p
(PB92-917007; NTSB/SIR-92/03) Avail: CASI HC A06/MF A02

Between May 31, 1989 and March 17, 1991, Piper PA-46 series Malibu and Mirage airplanes were involved in seven fatal accidents in the United States, Mexico, and Japan following departures from controlled flight. In addition to the seven accidents, another PA-46 airplane was involved in an incident that included substantial departures from controlled flight. In July 1990, following the fourth U.S. fatal accident, the Safety Board initiated a special investigation of the facts, conditions, and circumstances that led to the loss of the four Malibu/Mirage airplanes in the U.S. As other accidents occurred, they were included in the special investigation. Two of the seven fatal accidents occurred in Japan and Mexico, and the available information on the accidents was included in the special investigation. The special investigation included a review of the relevant design features of the Malibu and Mirage airplanes, including structural integrity, flight control systems, and operating limitations. The investigation also focused on the flight experience and training of the pilots of the airplanes, particularly as these factors related to flying the Malibu/Mirage airplanes in instrument meteorological conditions (IMC) at and above the freezing level with relatively sophisticated integrated flight guidance and control systems. As a consequence of the accidents, the Federal Aviation Administration, with the Safety Board's encouragement, conducted a special certification review of the airplanes, and the results are included in the report. GRA

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AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

A93-14157
PRECISION INCREASING AND INTEGRITY MONITORING OF NAVIGATION DATA FOR GPS/INERTIAL HYBRID SOLUTION
V. G. VARAVVA (TsAGI, Zhukovski, Russia), O. V. VINOGRADOV, and V. A. KIREICHIKOV (Inst. of Aviation Equipment, Zhukovski, Russia) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1-8. Research supported by Tekhnopribor-Sekunda Enterprise refs
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The autonomous integrity monitoring of the receiver for the Global Navigation Satellite System (GNSS) is investigated by means of a least-squares method. A modified cumulative-sum algorithm is proposed for determining the most efficient detection of biases in satellite measurement with an assigned mean time. Receiver-autonomous integrity monitoring (RAIM) presently used is based on a least-squares residual method, and the cumulative sum algorithm is expected to minimize the mean time delay of fault detection. A simulation is conducted to compare the two methods, and the RAIM algorithm based on a combination of least squares and cumulative sum is found to be more effective than the existing GNSS algorithm. The proposed RAIM methodology is shown to require a relatively large number of satellites to insure satisfactory fault detection and isolation characteristics. C.C.S.

A93-14234
FLIGHT SIMULATOR RESEARCH INTO ADVANCED MLS APPROACH AND DEPARTURE PROCEDURES
LOUIS J. J. ERKELENS and JAN-HEIN VAN DRONKELAAR (National Aerospace Lab., Amsterdam, Netherlands) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 637-646. refs
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Results of a flight simulator program carried out with 19 airline crews to evaluate various test scenarios concerning curved approaches and departures are presented. The main features of the tests were simulated failures occurring during curved approaches. Crew ability to detect insidious failure and to respond to them are investigated. Crew performance and perception data are also measured in the case of a simulated failure of the flight management computer during the execution of a curved approach. Findings are obtained for both glass cockpit aircraft and aircraft equipped with electromechanical instruments. It is found that, when an anomaly leading to a missed approach occurs, position awareness suffers, and desired ground track is the first performance item to be abandoned. A moving map display not only improves position awareness during a complex approach but also greatly enhances situation awareness during the missed approach. P.D.

A93-14235
BUAA INERTIAL TERRAIN-AIDED NAVIGATION (BITAN) ALGORITHM

Z. CHEN, P. J. YU, and H. YANG (*Beijing Univ. of Aeronautics* and Astronautics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 647-654. refs
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The BUAA BITAN algorithm, which is based on the Sandia inertial terrain-aided navigation algorithm, is presented. Several improvements on the theoretical and algorithmic aspects are made. The local observability concept is presented, and the square root Kalman filtering technique is adopted. A new adaptive terrain stochastic linearization technique is developed, and both acquisition *and track modes, in which the system models are different, are* investigated. The BITAN system simulations are performed by the Monte Carlo method. The position accuracy updating is 50.3 m. The system accuracy is increased by more than one order of magnitude by means of terrain upgrading. P.D.

A93-14236
A NEW AIRCRAFT INTEGRATED POSITIONING AND COMMUNICATION SYSTEM BASED ON SATELLITE
BOYING LU and FANG CHEN (Beijing Univ. of Aeronautics and Astronautics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 655-659. Research supported by Civil Aviation Administration of China refs
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Positioning systems based on satellite in developing and application are reviewed. By using very small aperture terminal technology, a new scheme of integrated positioning and communication system based on satellite is presented. The dynamic mathematical model of the system has been derived. In order to improve the precision of the Kalman filter algorithm in the calculation, adaptive filtering estimates of acceleration mean and noise Variance are proposed. Further studies show that the *U-D fractorization algorithm is efficient in improving the accuracy.* Further studies show that the U-D fractorization algorithm is efficient in improving accuracy and numerical stability. The computer simulation study indicate that the utilization of various improved Kalman filter algorithms is successful. Author

A93-14320
DEVELOPMENT OF LASER CONDUCTING LANDING SYSTEM
PEI-REN CHEN, HONG-HONG XING, and XIN-HONG HU (Naval Aeronautical Engineering Academy, Yantai, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1336-1340.
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The prospects for laser-based guidance and landing systems are reviewed with attention given to feasible laser-guidance principles. laser systems, and microcomputer control systems. The laser landing system envisaged comprises two identical laser systems emitting widening and collimated laser beams along both sidelines of the landing course. The intensity and frequency of the laser is controlled by the onboard control system, and the laser beams are used for landing guidance. The requirements of the laser system are given for this application, and the theoretical principles of the visibility-detecting system are given based on an *air-absorption coefficient. The system is effective for controlling* the course of aircraft during landing and is therefore a suitable complement for microwave systems which control the descent height of the aircraft. C.C.S.

A93-14661* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HUD GUIDANCE FOR THE ASKA EXPERIMENTAL STOL AIRCRAFT USING RADAR POSITION INFORMATION
KENJI YAZAWA, YUSHI TERUI (National Aerospace Lab., Chofu, Japan), and GORDON H. HARDY (NASA, Ames Research Center, Moffett Field, CA) Apr. 1992 13 p. SAE, Aerospace Atlantic *Conference, Dayton, OH, Apr. 7-10, 1992 refs*
(SAE PAPER 921041) Copyright

The paper describes a high performance HUD guidance system installed on the experimental powered-lift STOL aircraft Aska. Since the maiden flight in October 1985, the HUD system has been used in all the flight tests. The HUD has an accurate flight path *symbol generated by inertial velocity from the IRS which is updated* by up-linked precision radar position data. The flight path symbol is very useful for precise approach and flare control for Aska which has large ground effects. A synthetic runway is also presented, which is conformal with the real runway, using the position data from the ground tracking radar system. Under *instrument meteorological conditions, the pilot can approach and* land using the HUD synthetic runway as well as in visual meteorological conditions. The HUD system proved to be a valuable aid to the pilot for all the Aska flight tests. A NASA Ames Research Center test pilot demonstrated touch down accuracy of less than 8 meters (peak to peak) for a series of three landings. Author

A93-15037
LOCSTAR - A SATELLITE RADIODETERMINATION SYSTEM FOR EUROPE [LOCSTAR - UN SERVICE DE RADIOREPERAGE PAR SATELLITES POUR L'EUROPE]
RAYMOND ROSSO (CNES, Toulouse, *France*) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 142 1990 p. 21-27. In French. Previously announced in STAR as N90-23436 refs
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The LOCSTAR radiodetermination satellite service is described. It is designed to provide accurate location information to mobile users and their home bases, and a two-way exchange of short messages between these segments. The results of market surveys in Europe are presented. They show a potential market of 400,000 to 800,000 mobile users after six years of operation. These users are essentially in the field of road transport. The LOCSTAR system is based on the same concept as the GEOSTAR system developed in the U.S. LOCSTAR is expected to be operational in 1992, and should cover western Europe and the Mediterranean basin.
Author

A93-15052
FUTURE SYSTEMS FOR AIR TRAFFIC CONTROL [LES SYSTEMES FUTURS DU CONTROLE DU TRAFIC AERIEN]
GEORGES MAIGNAN (Eurocontrol, Brussels, Belgium) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 145 1990 p. 6-9. In French.
Copyright

An overview of ATC developments up to the introduction of radars and computers, leading to the composite processing of all flight progress data for the controller is presented. When this processing is implemented in all high traffic density regions, it will significantly enhance the capacity of the ATC system. Attention is given to an air traffic management system approach that fully integrates airborne and ground systems, man and machine, and ground ATC with anticollision airborne systems. R.E.P.

A93-15053
IN THE PURSUIT OF A SINGLE EUROPEAN AIR TRAFFIC CONTROL SYSTEM
KARL-HEINZ NEUMEISTER (Association of European Airlines, Brussels, Belgium) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 145 1990 p. 10-12.
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A study conducted to determine the reasons for the near doubling of flight delays in Europe in the years from 1986 to 1989 is discussed. The study concludes that the inefficiency of European ATC is mainly due to the fragmentation of the system. Deficiencies in the infrastructure were the principal reason for the deteriorating services. It is shown that all evidence points to a joint self-sustaining authority for ATC as being the solution to the most pressing current and future problems. R.E.P.

A93-15224
PRINCIPLES OF THE DESIGN OF AUTOMATED METEOROLOGICAL SUPPORT SYSTEMS FOR AVIATION [PRINTSIPY POSTROENIIA AVTOMATIZIROVANNYKH SISTEM METEOROLOGICHESKOGO OBESPECHENIIA AVIATSII]
G. G. SHCHUKIN (Glavnaia Geofizicheskaia Observatoriia, St. Petersburg, Russia) St. Petersburg Gidrometeoizdat 1991 373 p. In Russian. refs
(ISBN 5-286-00342-7) Copyright

The principles of the general hardware and software design of computerized meteorological support systems for flight operations are examined, with the KAS-METEO system used as an example. The discussion covers the fundamentals of the automation of meteorological support, the main requirements for the quality, format, and timeliness of meteorological data, and the main subsystems of the KAS METEO system and their functions. Attention is also given to the ultrashort-range forecasting of dangerous weather systems from radar, aerological, and ground-based observations; measurement of the intensity and amount of precipitation; and the use of KAS METEO in computerized air traffic control systems. V.L.

A93-17306
THE DEVELOPMENT AND IMPLEMENTATION OF A HEAD-UP GUIDANCE SYSTEM (HGS) FOR MANUAL CAT III LANDINGS
JOHN DESMOND (Flight Dynamics, Inc., Portland, OR) and ROGER HOH (Hoh Aeronautics, Inc., Lomita, CA) *In* Fixed and rotary wing all weather operations; Proceedings of the Conference, London, United Kingdom, Apr. 23, 24, 1991 London Royal Aeronautical Society 1991 p. 7.1-7.8. refs
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The recently developed HGS obviates a pilot's transitioning in and out of the cockpit during various stages of an instrument approach, and furnishes a single source of guidance to the pilot in all types of approach. HGS furnishes quantitative guidance and enhances situational awareness. Attention is given to flight path symbology, controllability and performance requirements, workload apportionment, and HGS operational experience with respect to training requirements, low visibility takeoffs, and growth potential. O.C.

A93-17307
LANDING GUIDANCE SYSTEMS FOR CAT III OPERATIONS
P. J. TAYLOR (Siemens Plessey Radar, Ltd., Chessington, United Kingdom) *In* Fixed and rotary wing all weather operations; Proceedings of the Conference, London, United Kingdom, Apr. 23, 24, 1991 London Royal Aeronautical Society 1991 p. 9.1-9.6. refs
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An evaluation is made of the ILS limitations which led the ICAO to formulate requirements for the Microwave Landing System in the early 1970s, and an account is given of the full capabilities of the MLS with reference to the most demanding Category III operation. The consideration of current and future MLS prospects must be conducted within the framework of the GPS navigation system, and such major new developments as a harmonization of GPS with Glonass by international civil aviation. The use of GPS as an alternative to the MLS is discussed from the viewpoints of system reliability and integrity. O.C.

A93-17308
AIR TRAFFIC CONTROL GROUND MOVEMENT CONTROL IN LOW VISIBILITY
S. R. SHERRATT (National Air Traffic Services, Directorate of Requirements, London, United Kingdom) *In* Fixed and rotary wing all weather operations; Proceedings of the Conference, London, United Kingdom, Apr. 23, 24, 1991 London Royal Aeronautical Society 1991 p. 10.1-10.12.
Copyright

The Systems Approach demands that all aspects of an extensive system such as All Weather Operations should be examined in their totality. Surface Movement Guidance and Control are just two essential elements of the overall AWOPS system, but they form the vital first and last stages of flight. This paper considers Air Traffic Control on the Aerodrome surface as a part of the overall Surface Movement Guidance and Control system. Ground Movement Control technique and its supporting tools are described, along with complementary elements of the guidance mechanisms such as lighting and markings. Some history is related to illustrate the influences driving development over the years. The short and long term future evolution of the SMGCS sub-system is also discussed. Author

A93-17501* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
VISION-BASED RANGE ESTIMATION USING HELICOPTER FLIGHT DATA
PHILLIP N. SMITH, BANAVAR SRIDHAR, and BASSAM HUSSEIN (NASA, Ames Research Center, Moffett Field, CA) *In* IEEE Conference on Computer Vision and Pattern Recognition, Champaign, IL, June 15-18, 1992, Proceedings New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 202-208. Previously announced in STAR as N92-32424 refs
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Pilot aiding during low-altitude flight depends on the ability to detect and locate obstacles near the helicopter's intended flightpath. Computer-vision-based methods provide one general approach for obstacle detection and range estimation. Several algorithms have been developed for this purpose, but have not been tested with actual flight data. This paper presents results obtained using helicopter flight data with a feature-based range estimation algorithm. A method for recursively estimating range using a Kalman filter with a monocular sequence of images and knowledge of the camera's motion is described. The helicopter flight experiment and one of four resulting datasets is briefly discussed. Finally the performance of the range estimation algorithm is explored based on comparison of the range estimates with true range measurements collected during the flight experiment. Author

N93-13377# Federal Aviation Administration, Atlantic City, NJ.
TERMINAL DOPPLER WEATHER RADAR (TDWR) OPERATIONAL TEST AND EVALUATION (OT/E) INTEGRATION TEST PLAN
ERIC HESS and PETER GUTHLEIN Nov. 1992 67 p
(Contract DTFA01-89-C-00002)
(DOT/FAA/CT-TN92/6) Avail: CASI HC A04/MF A01

The Terminal Doppler Weather Radar (TDWR) Operational Test and Evaluation (OT&E) Integration Test Plan provides the overall philosophy and approach to the TDWR OT&E Integration portion of Technical Field Test and Evaluation (TFT&E) to be conducted at the Federal Aviation Administration Aeronautical Center (FAAAC) in Oklahoma City, OK. This plan identifies the necessary support that is required to accomplish OT&E Integration; test roles and responsibilities of personnel requirements, and overall schedule of activities. This plan identifies the National Airspace System (NAS) operational and integration requirements of the TDWR. These requirements are contained in a Test Verification Requirements Traceability Matrix (TVRTM). Author

N93-14275# Federal Aviation Administration, Washington, DC. Office of Aviation Medicine.
PERFORMANCE OF COLOR-DEPENDENT TASKS OF AIR TRAFFIC CONTROL SPECIALISTS AS A FUNCTION OF TYPE AND DEGREE OF COLOR VISION DEFICIENCY Final Report
HENRY W. MERTENS and NELDA J. MILBURN Aug. 1992 18 p
(AD-A256614; DOT/FAA/AM-92/28) Avail: CASI HC A03/MF A01

This experiment was conducted to expand initial efforts to validate the requirement for normal color vision in Air Traffic Control Specialist (ATCS) personnel who work at en route center, terminal, and flight service station facilities. An enlarged data base was developed involving 121 individuals with normal color vision, 31 simple and 44 extreme anomalous trichromats, and 48 dichromats; both protans and duetans were included. The performance of

subjects with normal color vision was compared with the performance of individuals in various classifications of color vision deficiency on a battery of color-dependent ATCS tasks. Simulations of the ATC color tasks concerned color coding in flight progress strips (at en route centers), aircraft lights and Aviation Signal Light indicator (in tower operations), and color weather radar (at flight service stations). Errors were rare among normal trichromats. Mean errors were significantly higher at every level (degree) of color vision deficiency than in normals. Approximately 6 percent of color deficient subjects were able to perform ATC color tasks without error. The six percent were all from the simple anomalous trichromat category; all extreme anomalous trichromats and dichromats were prone to error on ATC tasks. These findings provide support for the requirement of normal color vision in initial medical screening of ATCS personnel. GRA

N93-14276# Federal Aviation Administration, Washington, DC. Office of Aviation Medicine.
IDENTIFYING ABILITY REQUIREMENTS FOR OPERATORS OF FUTURE AUTOMATED AIR TRAFFIC CONTROL SYSTEMS
Final Report
CAROL A. MANNING and DANA BROACH Aug. 1992 27 p
(AD-A256615; DOT/FAA/AM-92/26) Avail: CASI HC A03/MF A01

This study was conducted to anticipate the impact on air traffic controller ability requirements that may result from implementation of a future stage of air traffic control automation. If important changes occur in ability requirements, it will be necessary to develop or modify selection procedures for future air traffic controllers. Accurate identification of ability requirements depends on knowledge of the job tasks to be performed, but only general information is currently available about the job tasks associated with later stages of air traffic control automation. In this study, nine air traffic controllers who had analyzed operational requirements for a future stage of automation described how controllers would perform four job tasks using the automation, assessed the degree to which nine specific abilities were likely to be required to perform the automated tasks, and assessed whether the amount of each ability required to perform the automated tasks would be different than the amount of the ability required to perform the equivalent tasks in the current system. The controllers thought that some changes will occur in the presentation of information, much of the requirement for verbal coordination will be removed, and much of the detailed information that the controller must be present will be supplanted by automation aids. At the same time, these controllers suggested that the future controller will have to have about the same levels as required today of the abilities discussed in the study to perform the tasks included in the study. GRA

N93-14729# University of Technology, Leicester (England). Dept. of Transport Technology.
INFORMATION SYSTEMS FOR AIRPORT OPERATIONS
J. SHELTON, D. GILLINGWATER, and N. J. ASHFORD May 1992 69 p
(TT-9202; ISBN-0-904747-37-8) Avail: CASI HC A04/MF A01

The aims of this research were threefold: (1) to undertake a systems analysis of the information requirements of a medium sized airport, serving between one and five million passengers per year; (2) to develop a generic model of airport information flows; and (3) to evaluate existing interactive software and hardware systems used at airports. The main product of the research is a report on the information requirements of an airport information system (APIS), using an approach based on 'structured systems analysis and design methods' (SSADM). It is divided into four sections: (1) an account of airport information system functions and system design objectives; (2) a case study of the information requirements of East Midlands International Airport (EMIA); (3) the definition and development of a generic model for an airport information system (APIS); and (4) the main conclusions arising from the research, together with recommendations for further development of the generic model towards a successful software implementation. Author

N93-15005# Army Topographic Engineering Center, Fort Belvoir, VA.
PROPOSED REVISIONS TO RTCM SC-104 RECOMMENDED STANDARDS FOR DIFFERENTIAL NAVSTAR/GPS SERVICE FOR CARRIER PHASE APPLICATIONS
FRED GLOECKLER, A. J. VANDIERENDONCK, and RONALD R. HATCH 18 Sep. 1992 11 p
(AD-A255276; TEC-R-191) Avail: CASI HC A03/MF A01

The Radio Technical Commission for Maritime Services (RTCM) Recommended Standards for Differential NAVSTAR/GPS Service have been widely adopted for code based differential GPS applications. To accommodate the present and expected future growth in use of differential carrier phase technology for high accuracy applications, it has been recognized that revisions to the RTCM standards are needed. A working group has been established to develop changes to the standards for carrier phase data. This is a report on the recommendations of the Carrier Phase Communications Working Group. GRA

N93-15186# Airbus Industrie, Toulouse (France).
AIRBUS INDUSTRIE TCAS EXPERIENCE
H. GANZ *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 647-674 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

TCAS 2 equipment (Traffic Alert and Collisional Avoidance System) is viewed as a supplement to the pilot who, with the aid of air traffic control system, has the primary responsibility for avoiding mid air collisions. A description of the system is given. Installation principles and experience gained on several aircraft types before obtaining approval of TCAS 2 installation are provided. The integration of this system raised a lot of problems, ranging from European airworthiness/operational approval requirements, missing top level specification, a not mature system and integration/compatibility problems. ESA

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AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A93-14102
SUPPORT OF COMPOSITE FUEL CELLS
E. A. WESTERMAN (Boeing Defense & Space Group, Military Airplanes Div., Seattle, WA) Jan. 1992 9 p. Society of Manufacturing Engineers, Conference on Composites in Manufacturing '92, Anaheim, CA, Jan. 7, 8, 1992
(SME PAPER EM92-101) Copyright

Techniques to replate electrically conductive surfaces employed for lightning protection and safely cure a hot bonded repair in a potentially explosive environment are presented. These techniques provide technicians with the ability to safely and quickly restore damaged fuel tanks on future fuel aircraft. R.E.P.

A93-14185
DEVELOPMENT OF GENERIC HELICOPTER PERFORMANCE METHODOLOGY FOR REAL TIME MISSION ANALYSES
KAYDON A. STANZIONE and RANDALL F. SMITH (Praxis Technologies Corp., Woodbury, NJ) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 209-218. refs
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This paper describes the methodology and technical approach used to develop a portable mission performance and planning computer for military helicopter operations. Advanced developments in microprocessor technology, software language, and mathematical techniques are combined to offer a highly

sophisticated system which is pilot friendly, lightweight (one pound), compact in size, high speed, and has communication interfaces for ground-based or on-board mission processors. The Computerized Handheld Integrated Mission Performance (CHIMP) system has been developed for a variety of USMC and USA helicopters. CHIMP's flight management system functionality integrates comprehensive helicopter performance, operating limitations, navigation, and weight and balance capabilities.
Author

A93-14203
APPLICATION OF CAD SYSTEM IN GEOMETRIC MODELING FOR HELICOPTER PRELIMINARY DESIGN
LIJUN XU and MENGSHAN SHEN (Nanjing Aeronautical Inst. China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 381-387. Research supported by Nanjing Aeronautical Inst refs
Copyright
A Computer program HEGMCAD (Helicopter Geometric Model Computer-Aided Design) has been developed with CAD system for automatic geometric modeling. This paper introduces HEGMCAD in detail. HEGMCAD is capable of rapidly generating various helicopter models and corresponding sizing data. Three orthographic views and a 3D wireframe are produced for four helicopter configurations: single-rotor, tandem-rotor, coaxial-rotor and titl-rotor. In order to generate more smooth fuselage, a new cross-section shape called superellipse was introduced into HEGMCAD. In addition to the four views, a solid model is produced. From the solid model, designers can get more information than from the 3D wireframe model. With HEGMCAD, designers also can arrange the location of mission equipment packages, crew stations, and passenger stations. Author

A93-14204
DESIGNING TO AIRCRAFT SYSTEM EFFECTIVENESS/COST/TIME WITH VERT - THE SYSTEM ANALYSIS METHOD FOR AIRCRAFT
CHANGYAO GU, QUIN WANG, and YUNFENG CHU (Beijing Univ. of Aeronautics and Astronautics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 388-393. refs
Copyright
This paper presents a kind of the R&D Management Decision Analysis System for Aircraft Design which is based on the ideas of design-to-effectiveness/cost/time and VERT (the venture evaluation and review technique). This system can provide the means for a friendly interactive interface which allows the decision maker to conduct the design for system effectiveness/cost/time under uncertainty perfectly and also to carry out the analysis, monitoring, and control of the engineering design. Author

A93-14205* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AIRCRAFT OPTIMIZATION BY A SYSTEM APPROACH - ACHIEVEMENTS AND TRENDS
JAROSLAW SOBIESZCZANSKI-SOBIESKI (NASA, Langley Research Center, Hampton, VA) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 394-407. Previously announced in STAR as N92-25995 refs
Recently emerging methodology for optimal design of aircraft treated as a system of interacting physical phenomena and parts is examined. The methodology is found to coalesce into methods for hierarchic, non-hierarchic, and hybrid systems all dependent on sensitivity analysis. A separate category of methods has also evolved independent of sensitivity analysis, hence suitable for discrete problems. References and numerical applications are cited. Massively parallel computer processing is seen as enabling technology for practical implementation of the methodology.
Author

A93-14208
INTEGRATED UTILITIES MANAGEMENT SYSTEM FOR AIRCRAFT
S. KLEIMAN and D. MILSTEIN (Israel Aircraft Industries, Ltd., Lod) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 428-435. refs
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An approach to aircraft utility systems is developed in which the whole aircraft space is divided into several operational areas with a high density of electrical components. The latter include electrical sensors, command devices, electrically controlled devices of utility systems, and other electrical loads. Local control units of each area are interconnected with all the electrical components in the area by data and power buses providing the utility systems' control, monitoring, BIT, and fault-tolerance management and communication with avionic systems and with the pilot. It is concluded that this approach significantly saves weight, improves system fault-tolerance, and enhances maintainability. O.G.

A93-14219
INTERRELATIONSHIPS BETWEEN COMMERCIAL AIRPLANE DESIGN AND OPERATIONAL REQUIREMENTS AND PROCEDURES
F. C. FICKEISEN (Boeing Commercial Airplane Group, Seattle, WA) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 525-529.
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Commercial airplane design and operational requirements and processes have traditionally been handled as separate entities. The increased capability, complexity and integration of airplane, satellite and ground based systems results in the need to systematically account for the principle design and operational interrelationships. This need is illustrated by consideration of two examples: (1) airplane collision avoidance systems and procedures and (2) airplane icing encounter design and operational considerations. The development of these examples is used to suggest general conclusions: (1) the need for improved information relative to environmental conditions, (2) the need for improved information relative to human response characteristics and (3) the need to adjust procedures and organizations to better account for interrelationship considerations. Author

A93-14223* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RESEARCH AND APPLICATIONS IN STRUCTURAL DYNAMICS AND AEROELASTICITY
IRVING ABEL (NASA, Langley Research Center, Hampton, VA) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 557-570. refs
Results of some recently completed research programs in aeroelasticity and structural dynamics at the NASA Langley Research Center are presented. It is shown that multifunctional active controls can be used to control flutter and loads on future advanced fighter configurations. A description and early results of an experimental program are presented in order to provide a well documented data base for validating unsteady aerodynamic codes. It is shown that the degradation in aeroelastic behavior due to thermal effects on a hypersonic vehicle can be offset by the use of active controls. The feasibility of using adaptive materials to control flutter is demonstrated experimentally. A description of the latest unstructured grid methods for use in advanced computational unsteady aerodynamic codes is presented. A program to improve the ability of FEMs to predict rotorcraft vibrational characteristics is described. The use of aeroelastic tailoring to improve the performance of tilt rotor vehicles is examined. P.D.

A93-14226
NONLINEAR ROTOR-FUSELAGE COUPLED RESPONSE TO GENERIC PERIODIC CONTROL MODES USING ADVANCED COMPUTATION TECHNIQUES

S. M. BARKAI and O. RAND (Technion - Israel Inst. of Technology, Haifa) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 587-598. refs
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The paper presents a theoretical study of the interactive periodic vibratory response of a helicopter rotor/fuselage system. The rotor blades and the fuselage are assumed to be fully elastic and the periodic cyclic pitch controls are generic and may contain any number of harmonics. Emphasis is placed on a complete and consistent formulation of all dynamic contributions. This results in highly nonlinear expressions of high harmonic content which are implemented in an advanced computer code. The paper demonstrates a successful combination of two powerful numerical techniques: the method of 'Harmonic Variables' and advanced algorithms for solutions of nonlinear systems. This merger minimizes the required analytical effort while preserving high accuracy solution. The potential of the present model to serve as an efficient analytical tool for advanced control concepts such as the High Harmonic Control (HHC) is well established. Author

A93-14227
ENGINEERING OPTIMIZATION OF AERONAUTICAL STRUCTURES

HUILIANG DING, XIASHENG SUN, XIANXUE SUN (Aircraft Strength Research Inst., Xian, China), GUANSHENG LI (Chengdu Aircraft Co., China), GUANGMAO WU, and BINGCHEN PAN (Aeronautical Computing Technique Research Inst., Xian, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 599-607. refs
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The paper introduces the configuration for COMPASS, a program system for the analysis and design optimization of composite structures, and the technique used in COMPASS for structural tailoring design optimization under aeroelastic and strength constraints on the lamina level. A structural/sensitivity analysis by substructuring methods, and an approximate numerical model for each optimization stage and series of approximation concepts are presented. Some sample problems, including a simplified composite wing design under static aeroelasticity, flutter speed, and other constraints for minimum weight are given to verify the general applicability of this system for development study and engineering applications. P.D.

A93-14231
JET STREAMS AND ASSOCIATED TURBULENCE AND THEIR EFFECTS ON AIR TRANSPORT FLIGHT OPERATIONS

RONALD C. C. HOUGHTON (Sydney Univ., Australia) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 626a-626g. refs
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Flight data was used to investigate the effective use of jet stream winds to shorten flight times and conserve fuel, thus reducing direct operating costs. Emphasis was placed on the aerodynamic features of modern jet aircraft, and to use these features to utilize the kinetic energy of high speed winds. Initial results have shown savings of 1-2 percent, when flying downwind. Savings have also been made flying into strong headwinds; however, the benefits are not as great as when flying downwind. Author

A93-14253
DAMAGE SEVERITY OF MONITORED FATIGUE LOAD SPECTRA

J. B. DE JONGE (National Aerospace Lab., Amsterdam, Netherlands) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 790-794. refs
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This paper describes the development of a simple method to quantify the severity of aircraft use in terms of 'potential crack growth' of recorded load spectra. This 'Crack Severity Index' (CSI) accounts for load interaction effects under spectrum loading. Crack growth tests under a variety of different load spectra have proved the validity of the CSI concept. It is shown that the CSI concept can also be used as a tool in studies to influence fatigue life consumption by operational measures. Author

A93-14254
THE METHOD FOR DEVELOPING F-BY-F LOAD SPECTRA OF FIGHTER AIRCRAFT BASED ON MANOEUVERS

ZHI WANG and ZHIWEI CHEN (Beijing Aeronautical Technology Research Center, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 795-798. refs
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Fighter aircraft fatigue loads are presently standardized within the framework of a series of highly typical load sequences based on flight samples. Different flight missions are then envisioned for well-structured maneuvers, and a complete F-by-F load spectrum is created by connecting flight missions in a determinate fashion. A comparative evaluation is presented of two methods for the determination of standard maneuvers, in light of several groups of specimens which have been fatigue-tested under different load spectra. O.C.

A93-14256
RESEARCHES ON SONIC FATIGUE OF THE AIR-INLET DUCT OF XX AIRCRAFT

Q. H. YAO, S. GE, D. W. GUO, CH. SHAO, J. J. BAI (Aircraft Strength Research Inst., Yaoxian, China), and X. Y. ZHANG (Shenyang Aircraft Research Inst., China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 821-828. refs
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An account is given of the collaborative research effort mounted by the Chinese Aircraft Strength Research Institute and Shenyang Aircraft Reasearch Institute to address the sonic fatigue failure problem of the XX aircraft's air inlet duct inner-wall pannel. An effort was made to obtain the acoustic loads to which the channel is subjected, as well as its fatigue characteristics. Induced noise-loading spectra from aerial measurements were used to perform sonic fatigue tests in a model simulating the actual structure. The results thus obtained are generalizable for analogous cases. O.C.

A93-14258
AEROSERVOELASTIC ANALYSIS OF AN AIRCRAFT MODEL INCORPORATING THE MINIMUM STATE METHOD FOR APPROXIMATING UNSTEADY AERODYNAMICS

R. P. ROBERTS (Stirling Dynamics, Ltd., Bristol, United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 832-843. refs
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The minimum state method for approximating the frequency parameter of unsteady aerodynamics is shown to add considerably fewer states than alternative methods; its primary disadvantage is the need for greater computation time than those alternatives, since iteration is required for the solution. The minimum state method is also sensitive to elements that are difficult to fit in the matrix, and these tend to degrade the overall approximation. The technique allows control system nonlinearities to be included in the same model as the unsteady aerodynamics. O.C.

A93-14261
THE INFLUENCE OF MAIN DESIGN PARAMETERS ON HELICOPTER AIR RESONANCE AND ITS SOURCE OF INSTABILITY

XIAOGU ZHANG (Nanjing Aeronautical Inst., China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings.

Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 869-878. refs

Helicopter air resonance, a serious airborne rotor/body coupled dynamic instability problem, is studied with complex multiblade coordinates. The source of instability is the mutual excitation between two degrees of freedom. A method to analyze the excitation (work done by one degree-of-freedom on another degree-of-freedom) is developed. The source of instability, the influence of main design parameters and their physical explanation are investigated through the analysis of mutual excitation, eigenvalue, and eigenvector (mode shape). One source of instability is the mutual excitation between regressive lead-lag motion and body forward whirling motion (stemming from their inertial coupling). Another source is the mutual excitation between lead-lag motion and flap motion which is proportional to rotor lift. The rotor with low flap frequency and high lead-lag frequency is more vulnerable to air resonance instability. The influence of other parameters is also discussed. Author

A93-14280
AEROELASTIC INVESTIGATIONS AS APPLIED TO AIRBUS AIRPLANES

HELMUT ZIMMERMANN, SIEGFRIED VOGEL, and DETLEF SCHIERENBECK (Deutsche Airbus GmbH, Bremen, Germany) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1022-1032. refs

An account is given of some of the aeroelastic certification procedures undertaken for Airbus aircraft. Transonic unsteady aerodynamics in the flutter calculation are established by either (1) matching the doublet lattice (DL) airloads with steady local lift-curve slopes and aerodynamic centers, or (2) by correction of DL pressures by means of quasi-steady pressure distributions. Methods have been devised for the calculation of aerodynamic forces in the transonic speed range on the basis of higher-order aerodynamic equations and boundary layer considerations. Suitable structural weight-savings are achievable only by simultaneous stress and flutter optimization. O.C.

A93-14285
IN-FLIGHT TAILLOAD MEASUREMENTS

P. A. VAN GELDER (National Aerospace Lab., Amsterdam, Netherlands) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1058-1066. Research supported by Netherlands Agency for Aerospace Programs, Fokker Aircraft, and KLM Royal Dutch Airlines refs

Tail-load measurements have been conducted with a commercially operated civil aircraft equipped with a microprocessor-based data recorder; these data were combined with flight parameters from the aircraft-condition monitoring system to create a data base for further analysis. The results presented are illustrative of the usefulness of the information obtainable via relatively straightforward procedures that are easily incorporated into an aircraft and do not interfere with other onboard systems. A limited batch of 163 flights has been recorded. O.C.

A93-14289
MPC75 - THE EVOLUTION OF A NEW REGIONAL AIRLINER FOR THE LATE NINETIES

BERTRAM FISCHER (Deutsche Airbus GmbH, Hamburg, Germany) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1084-1093. refs

The interactive technical-definition process used for the development of the MPC 75 aircraft is examined in this review. Specific attention is given to the determination of fleet requirements for the aircraft transport market which led to the choice of 80-130-seat capacity. Other technology options considered include: rear-mounted propfan propulsion, Al-Li alloys, fly-by-wire flight controls, and the use of CFRP-wing box and empennage. The project considerations led to the definition of an aircraft family with specific but mutable design ranges. The configurations for the two selected options are presented, and advanced technological targets are given for the final versions including: (1) a low-drag transonic wing design; (2) high-bypass ratio turbofans; (3) extensive use of composite materials; and (4) fly-by-wire controls for a two-person cockpit. The aircraft is expected to provide good performance and efficiency in terms of fuel consumption, operational flexibility, noise, and emissions. C.C.S.

A93-14313
AN INTERACTIVE NUMERICAL PROCEDURE FOR ROTOR AEROELASTIC STABILITY ANALYSIS USING ELASTIC LIFTING SURFACE

KYUNG M. YOO (Korea Inst. of Aeronautical Technology, Seoul, Republic of Korea), DEWEY H. HODGES, and DAVID A. PETERS (Georgia Inst. of Technology, Atlanta) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1272-1280. refs

A thin lifting-surface code based on the unsteady vortex-lattice method coupled with a prescribed wake geometry is developed and verified through a number of code-validation procedures for applications to the aeroelastic analysis of helicopter rotor blades. The present thin lifting-surface code is coupled to a structural dynamic model of elastic hingeless rotor blades to analyze the stability behavior. This is done by using a moving-block analysis and comparing the results predicted by 2D theory. The effects of interblade unsteady wake dynamics beneath the rotor blades (including the far returning wake of both the reference blade and the preceding one) on aerodynamic loadings are essential. The result shows the overprediction of lead-lag damping by 2D quasi-steady aerodynamics is due to lack of both the tip-relief effect and the unsteady wake-dynamics effects among the blades. Author

A93-14318
THE SIMULATION OF AIRCRAFT LANDING GEAR DYNAMICS

ALAN SHEPHERD, TYRONE CATT, and DAVID COWLING (Stirling Dynamics, Ltd., Bristol, United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1317-1327. Research supported by British Aerospace /Airbus/, Ltd refs

A software package is described for comprehensive modeling of dynamic interactions between aircraft landing-gear subsystems as well as total landing-gear dynamics simulations. The software is organized as a series of individual modules for such subcomponents as wheels, legs, oleos, antiskid control, and braking effects. The mass and stiffness matrices are described for the subsystems of typical landing gear, and typical results are given with references to experimental references used for validation. Typical responses for realistic cases are given for single-wheel dynamometer testing, single-leg and bogie with braking, and whole aircraft landing and braking. The highly generalized results give information on the effectiveness of landing gear configurations during the design phase. The software simulation package can be used to simulate the behavior of a given landing-gear configuration during: drop tests, dynamometer tests, whole aircraft touchdowns, braking, and takeoffs. C.C.S.

A93-14321
SOME DYNAMIC PROBLEMS IN DESIGN OF AIRCRAFT LANDING GEAR

DEPEI ZHU (Northwestern Polytechnical Univ., Xian, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1341-1345. Research supported

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The effect of initial pressure in the air-oil shock absorber of the landing gear on the lateral inertial load of the main structure, due to the dynamic response to the roughness of the runway, is investigated. Particular attention is given to the role of the dynamic properties of the wheel with pneumatic tire (such as the rolling relaxation length and the longitudinal stiffness of the tire, and the inertial moment of the wheel) on the load during the landing impact. It is concluded that these factors may significantly influence the relationship between the maximum horizontal load point and the maximum vertical load point, but have little effect on the magnitude of the load peak. I.S.

A93-14322
DRAG/THRUST ESTIMATION VIA AIRCRAFT PERFORMANCE FLIGHT TESTING

T. MENDELBOIM, M. BETTOUN, B. ENGLANDER, M. GABEL (Israeli Air Force, Tel Aviv, Israel), and Y. OSHMAN (Technion - Israel Inst. of Technology, Haifa) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1346-1354. refs
Copyright

This paper presents a procedure for drag/thrust estimation via aircraft performance flight testing using weighted least square estimation method. This procedure was applied to estimate the drag of certain F-16 configurations and the thrust of certain modified engines. The estimated drag/thrust were in good agreement with their predictions. The statistical evaluation of the estimate confidence intervals proved to be a reliable tool for assessing the quality of the results. The estimated drag/thrust values were later used to evaluate aircraft performance with great accuracy.
Author

A93-14324
PARAMETER ESTIMATION TECHNIQUES FOR FLIGHT FLUTTER TEST ANALYSIS

S. S. VIVIERS (Council for Scientific and Industrial Research, Pretoria, South Africa) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1362-1370. refs
Copyright

Flutter flight tests are both time consuming and costly as result of the large number of flight tests performed. This involves a careful increase in flight speeds at different flight levels to open up and establish a flutter-free flight envelope. The introduction of powerful 386 and 486 personal computers enabled the development of algorithms for parameter identification techniques in a user friendly environment. This paper mainly describes the implementation of the half power bandwidth method in the on-line modal analysis system to provide rapid estimates of structural damping and frequency trends. Other parameter estimation methods are available to assist the flight test engine but are not utilized in the on-line system. The performance of the different evaluation methods is illustrated from flight flutter test data.
Author

A93-14336
NEW MODEL OF BIRD IMPACT RESPONSE ANALYSIS AND ITS ENGINEERING SOLUTION

YAO-NAN GONG and CHUN QIAN (Beijing Univ. of Aeronautics and Astronautics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1476-1481. refs
Copyright

The modeling and analytic methods for the response of the windshield transparency to bird impact are studied. The interaction between the impact load and the transparency response, as well as the nonlinearity effect, is considered. To employ conveniently the existing general-purpose nonlinear finite element analysis programs and to dispel the oscillatory phenomenon arising in numerical solution, the momentum equilibrium method is used, other than the conventional Lagrangian and penalty methods. Meanwhile, instead of the incompressible irrotational fluid, a rubberlike hyperelastic Mooney-Rivlin material is suggested for the first time to simulate the bird body behavior in impact; thus, the difficulty of continuously updating the contact point pairs and adjusting the discretized FE-mesh during the analysis process can be avoided. Conclusions similar to those given in other published papers are made. In addition, a solution method for the dynamic response under the derivative dynamic load is studied and compared with the coupling solution. Author

A93-14339
DESIGN AND FABRICATION OF A COMPOSITE TRANSMISSION HOUSING FOR A HELICOPTER TAIL ROTOR

A. F. JOHNSON and B. HINZ (DLR, Inst. fuer Bauweisen- und Konstruktionsforschung, Stuttgart, Germany) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1497-1504. Research supported by Henschel Flugzeug-Werke GmbH refs
Copyright

The paper describes a development carried out for Henschel Flugzeug-Werke GmbH for the design and fabrication of a prototype carbon fiber reinforced epoxy (CFRP) transmission housing for the drive gear of a helicopter tail rotor. Design requirements were for a CFRP housing shell with reduced weight, improved dynamic fatigue strength, and better vibration damping compared with a cast aluminum shell. The study shows the feasibility of using carbon fiber fabric reinforcement in a nonaxisymmetric shell structure and demonstrates relevant design analysis procedures for the laminated shell structure under complex load conditions. Author

A93-14346
HYPERSONIC DESIGN

DAVE HAMM and DANA BEST (McDonnell Aircraft Co., Saint Louis, MO) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1554-1564.
Copyright

The major items usually considered in the configuration of hypersonic vehicles are reviewed. These include the mission, aerodynamic shape, aerodynamic drag, stability and control, the crew station, the internal arrangement, the ejection system, the payload bay, the secondary power, and the thermal protection system. C.D.

A93-14361
PARAMETRIC AEROELASTIC ANALYSIS OF COMPOSITE WING-BOXES WITH ACTIVE STRAIN-ENERGY TUNING

F. PERSIANI (Bologna Univ., Italy), P. SANTINI, and G. M. SAGGIANI (Rome I Univ., Italy) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1678-1692. refs
Copyright

The general equations for the static aeroelastic behavior of a general planform wing, with an adaptive structural box in composite material containing strain controlled fibers, are written. Upper skin and lower skin fibers can be controlled independently, giving both in plane and bending strains. The expressions for strain-energy associated with in plane active stresses and with bending stresses respectively are computed, by using a set of describing functions; for each of them a modal amplitude is defined and it is ranked among the unknowns. Thus a set of nonlinear finite equations is obtained. For practical applications, the maximum value of the active forces is prescribed and there results a set of algebraic equations, from which the structural response can be computed. Numerical examples show the effect of the activation upon structural deformations and upon total aerodynamic forces.
Author

A93-14385
CASE STUDIES IN COMPOSITE MATERIAL STRUCTURAL DESIGN, MANUFACTURE AND TESTING
G. CORDERLEY and A. DA S. CARDOSO (Council for Scientific and Industrial Research, Div. of Aeronautical Systems Technology, Pretoria, South Africa) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1907-1916.
Copyright

Two projects utilizing carbon fiber in composite materials technology are presented. The specific projects involve a technology demonstrator aircraft and a drop tank. The design, testing and manufacturing phases of these projects are described. R.E.P.

A93-14386
AEROELASTIC ANALYSIS OF COMPOSITE WING WITH CONTROL SURFACE
HAISONG ANG, SHING CHIAO, LIPING JIANG, and YIN YU (Nanjing Aeronautical Inst., China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1917-1922. refs
Copyright

A set of computer program package is made of analysis and design of composite structure, including the finite element analysis, vibration analysis, static and dynamic aeroelastic analysis, and optimal design. A special method is presented to deal with the joint of wing and control surface. The computational program has the ability to get the influence of temperature and humidity to the composite structure. Two practical aircraft structures are given by successful application of the program package. Author

A93-14395
HIGH CAPACITY AIRCRAFT
W. OELKERS (Deutsche Airbus GmbH, Hamburg, Germany) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1979-1988.
Copyright

A study performed on very high capacity aircraft, based on the current A330/340 technology standard is presented. Various design targets are developed after initial airline targets and the 747-400 is used as the yardstick for economic and performance requirements such as a 10 percent improvement in blockfuel and DOC. Three case airplanes (500/600/700 seats) are examined with regard to configuration, infrastructure, and economic aspects. R.E.P.

A93-14593
MODIFIED SPARSE TIME DOMAIN TECHNIQUE FOR ROTOR STABILITY TESTING
FREDERICK A. TASKER and INDERJIT CHOPRA (Maryland Univ., College Park) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090) vol. 15, no. 6 Nov.-Dec. 1992 p. 1366-1374. Previously cited in issue 11, p. 1614, Accession no. A90-29405 refs
(Contract DAAL03-88-C-002)
Copyright

A93-14636
LOW-COST APPROACHES TO PROVING OF HIGH-RISK FAST VTOL DESIGNS
FRANK HURLEY (U.S. Army, Research Office, Research Triangle Park, NC) and ANTHONY M. CORGIAT (U.S. Army, Aviation Systems Command, Saint Louis, MO) Apr. 1992 8 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992 refs
(SAE PAPER 920989) Copyright

Design concepts for fast VTOL aircraft which were addressed at a joint industry-government workshop held by the United States Army Research office in September 1991 are reviewed. It is concluded that the state-of-the-art technologies are capable of providing free-wheeling flight without jeopardizing human life at low cost. O.G.

A93-14638* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
DEVELOPMENT OF A HYDROGEN EXTERNAL BURNING FLIGHT TEST EXPERIMENT ON THE NASA DRYDEN SR-71A AIRCRAFT
JOHN W. HICKS (NASA, Flight Research Center, Edwards, CA) Apr. 1992 10 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992 refs
(SAE PAPER 920997) Copyright

A captive-carry flight test experiment of the transonic external burning concept using gaseous hydrogen fuel has ben proposed for the SR-71A flight research test bed aircraft at the NASA Dryden Flight Research Facility, Edwards, California. This program will be the first large-scale, near-field flight test investigation of this base drag reduction technique at Mach numbers up to 3. Low-speed base drag reduction for supersonic and hypersonic flight vehicles is important in reducing vehicle drag and improving nozzle efficiency. Flight data will be correlated with a concurrent wind tunnel ground test of a similar test apparatus to confirm geometry and component performance scalability predictions and to investigate design parametrics under actual flight conditions. This paper describes the problem of transonic base drag for supersonic and hypersonic aircraft, a planned flight research program to address this problem, the test bed aircraft, and the flight experiment apparatus. Author

A93-14641
SAE AERO DESIGN '92
BRANDON W. KAERCHER (Cedarville College, OH) Apr. 1992 10 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992 refs
(SAE PAPER 921009) Copyright

A high wing tail dragging monoplane presented at the SAE Aerodesign Competition by Cedarville College students is described. The aircraft features a sweptback horizontal stabilizer which occupies 19 percent of the wing area and a substantially oversized vertical stabilizer to provide an extra stability margin. The monoplane is characterized by a wing span of 342.9 cm, an aspect ratio of 20, a wing area of 0.558 sq m, a weight of about 3.6 kg, and an estimated payload capability of 10.34 kg. O.G.

A93-14642
A SHORT RANGE PASSENGER/FREIGHTER CANARD - SOME PROBLEMS OF A PRELIMINARY AERODYNAMIC CONCEPT
PIOTR KULICKI, MACIEJ LASEK, and JACEK WINIECKI (Warsaw Univ. of Technology, Poland) Apr. 1992 14 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992 refs
(SAE PAPER 921012) Copyright

Problems encountered during the student team study of a preliminary design for a light transport aircraft are presented. Requirement considerations that provided a canard configured concept are discussed. Attention is given to the research and design process that evolved during the study. R.E.P.

A93-14643
RESULTS OF TESTING OF MODELS OF JOINT-WING UTILITY CLASS AIRCRAFT
CEZARY GALINSKI (Warsaw Univ. of Technology, Poland) Apr. 1992 10 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992
(SAE PAPER 921013) Copyright

A preliminary design is presented of a small transport aircraft which is characterized by low fuel consumption at a cruising speed of about 400 km/h, simplicity of loading and unloading, take off and landing on unprepared landing fields, STOL capability, and a high-rate of climb. Strength and torsional-flexural rigidity of a folding-wing model were analyzed and compared to those of a conventional aircraft. O.G.

A93-14649
ADVANCED COOLING FOR HIGH POWER ELECTRIC ACTUATORS
T. J. BLAND and K. D. FUNKE (Sundstrand Aerospace, Rockford, IL) Apr. 1992 11 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992 refs
(SAE PAPER 921022) Copyright

A passive cooling approach for aircraft electromechanical actuators (EMAs) is described which supports technology development under the Air Force More Electric Airplane program. The approach is capable of enhancing the thermal conductance from the electric motors of EMAs to ambient air and allows the motors to operate under more benign thermal conditions which should improve the operating life and reliability of the actuator. An energy storage system that can be readily incorporated into the structure makes it possible to further reduce the operating temperature by load leveling the actuator heat loads throughout its duty cycle. O.G.

A93-14650
A THERMAL ANALYSIS OF AN F/A-18 WING SECTION FOR ACTUATOR THERMAL MANAGEMENT
NELSON J. GERNERT and DAVID B. SARRAF (Thermacore, Inc., Lancaster, PA) Apr. 1992 13 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992 Research supported by U.S. Navy refs
(SAE PAPER 921023) Copyright

This paper presents the design and performance of a flexible heat pipe cold plate (FHPCP) that was developed for transporting heat from electronics mounted directly on an F/A-18 aileron actuator to a nearby heat sink. The most obvious heat sink is surrounding structure. A one dimensional steady state heat conduction analysis presented in this paper indicates that utilizing structure is feasible for this application. Author

A93-14656* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
BRAKING, STEERING, AND WEAR PERFORMANCE OF RADIAL-BELTED AND BIAS-PLY AIRCRAFT TIRES
THOMAS J. YAGER, PAMELA A. DAVIS, SANDY M. STUBBS, and VELORIA J. MARTINSON (NASA, Langley Research Center, Hampton, VA) Apr. 1992 7 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992 refs
(SAE PAPER 921036) Copyright

Preliminary steering, braking, and tread wear performance results from testing of radial-belted and bias-ply aircraft tires at NASA Langley are described. An overview of the joint NASA/FAA/industry START program is presented. Attention is given to the Langley Test Facility, equipment and future activities. R.E.P.

A93-14657
HIGH SPEED AIRCRAFT TIRE DYNAMICS/ISSUES
JOHN MEDZORIAN (USAF, Wright-Patterson AFB, OH) Apr. 1992 17 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992 refs
(SAE PAPER 921037) Copyright

The critical speed of aircraft tires was approximated with the use of the finite element method. The model used shell elements with a Fourier expansion in the circumferential direction and included moderate rotation and transverse shear deformation effects. The model linearized the equations of motion about an equilibrium point with the assumption of small dynamic displacements superimposed onto a large nonlinear equilibrium state. Application models were created for main landing gear (MLG) bias tires for the F-16, Space Shuttle Orbiter and Hypervelocity Vehicle (HVV) aircraft. The model performed well in all cases with adequate agreement with experimental results. Author

A93-14783
THE ROTOR BLADE FLAP BENDING PROBLEM - AN ANALYTICAL TEST CASE
FRANKLIN D. HARRIS (F.D. Harris and Associates, Fountain Hills, AZ) American Helicopter Society, Journal (ISSN 0002-8711) vol. 37, no. 4 Oct. 1992 p. 64-67. refs
Copyright

There is growing interest in solving the rotary wing aeroelastic equations using finite element theories. To test or validate these finite element solutions, as well as other solution approaches such as normal modes, a numerically exact solution for the simple, uncoupled, out-of-plane, flap bending of a rotor blade in forward flight is provided. The analytical test case was created by defining a representative deflection and solving backwards for the forcing function that satisfied the governing fourth-order equation. Author

A93-14784
INFLUENCE OF PITCH-LAG COUPLING ON DAMPING REQUIREMENTS TO STABILIZE 'GROUND/AIR RESONANCE'
MARK D. ZOTTO and ROBERT G. LOEWY (Rensselaer Polytechnic Inst., Troy, NY) American Helicopter Society, Journal (ISSN 0002-8711) vol. 37, no. 4 Oct. 1992 p. 68-71. refs
(Contract DAAL03-88-L-0004)
Copyright

Pitch-lag coupling is known to affect the damping required to stabilize 'ground resonance' or hover 'air resonance', but published design information is lacking. Trends are examined here using a linear analysis. The influence of pitch-lag coupling is shown to depend on fuselage and blade lag natural frequencies and hub height above the fuselage c.g. It can reduce the lag damping required in hover to stabilize one mode but can also destabilize another to the extent that more lag damping is required for stability with certain values of pitch-lag coupling. More landing gear damping can be required for 'ground resonance' stability if advantage is taken of reduced lag damping requirements for hover. Nonetheless, parametric variations show that, for certain configurations, pitch-lag coupling can be used to reduce overall lag damping requirements. Author

A93-14820
ON THE STATIC AEROELASTIC TAILORING OF COMPOSITE AIRCRAFT SWEPT WINGS MODELLED AS THIN-WALLED BEAM STRUCTURES
LIVIU LIBRESCU and OHSEOP SONG (Virginia Polytechnic Inst. and State Univ., Blacksburg) Composites Engineering (ISSN 0961-9526) vol. 2, no. 5-7 1992 p. 497-512. refs
Copyright

The sub-critical static aeroelastic response and the divergence instability of swept-forward aircraft wing structures constructed of anisotropic composite materials is analyzed. The new element distinguishing this study from the previous, existing ones is the structural model in which framework this problem is treated. In this sense, in contrast to the classical plate-beam or solid-beam models traditionally used in the study of these problems, the thin-walled anisotropic composite beam model is adopted here. The model used incorporates a number of non-classical effects. Among these are the anisotropy of the material of the constituent layers, the transverse shear deformation and the primary and secondary warping effects. Within the framework of this study, in addition to an assessment of the influence of the previously mentioned effects, the aeroelastic tailoring technique is applied and as a result, a series of conclusions concerning the enhancement of the static aeroelastic response characteristics of aeronautical wing structures made of advanced composite materials are outlined. Author

A93-15028
CHOICE OF MATERIALS FOR MILITARY HELICOPTERS [LE CHOIX DES MATERIAUX SUR LES HELICOPTERES MILITAIRES]
MANUEL TORRES (Aerospatiale, Div. Helicopteres, Marignane, France) and FRIEDRICH OCH (MBB GmbH, Munich, Germany) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 140 1990 p. 44-51. In French.
Copyright

An overview is presented of the special requirements and

constraints to be considered in the selection of structural materials for military helicopters. Attention is given to the various metals and composites examined for use in rotor blades, gear boxes, landing gears, engine inlets, exhaust linings, and fuel tanks. Exploded-view drawings of various major helicopter sections with their proposed composite materials are provided. R.E.P.

A93-15049
OPTIMIZATION OF PNEUMATIC SUBSYSTEMS FOR TRANSPORT AIRCRAFT [OPTIMISATION DES SOUS-SYSTEMES PNEUMATIQUES POUR LES AVIONS DE TRANSPORT]
GEORGE MCDONALD (Allied-Signal Aerospace Co., AiResearch Div., Los Angeles, CA) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 144 1990 p. 52-55. In French.
Copyright
Due to the attendant engine penalties it is necessary that an optimized, integrated approach be followed for subsystem designs, including bleed air control, environmental control, APU, engine starters, anti-ice control, and cabin pressure control. Typical flight profiles are presented to show how pneumatic system design points are determined. R.E.P.

A93-15737
SANDWICH CONSTRUCTION IN THE STARSHIP
RICHARD WONG (Beech Aircraft Corp., Wichita, KS) *In* International SAMPE Symposium and Exhibition, 37th, Anaheim, CA, Mar. 9-12, 1992, Proceedings Covina, CA Society for the Advancement of Material and Process Engineering 1992 p. 186-197. Research supported by Beech Aircraft Corp. and Raytheon Co refs
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The development of the sandwich (graphite/epoxy laminate as face sheet and the Nomex honeycomb as the core material) construction design concepts in the Beech Starship all-composite airplane is presented. Examples of the sandwich construction applications throughout the airframe (main wing, forward wing, pressure cabin, vertical stabilizer and the control surfaces) are given. This paper also describes the qualification and certification testing program of the honeycomb structure and the test results are discussed. Author

A93-15782
THE DESIGN DEVELOPMENT OF THE MONOLITHIC CFRP CENTRE FUSELAGE SKIN OF THE EUROPEAN FIGHTER AIRCRAFT
L. LEMMER and G. KAGERBAUER (MBB GmbH, Munich, Germany) *In* International SAMPE Symposium and Exhibition, 37th, Anaheim, CA, Mar. 9-12, 1992, Proceedings Covina, CA Society for the Advancement of Material and Process Engineering 1992 p. 747-759. refs
Copyright
The monocoque of the center fuselage is a one piece carbon fiber composite skin with simultaneously cured frames and longerons loaded by the overall fuselage shear, bending, torque and internal pressure. Some design constraints are given by the fact, that the monocoque also forms the outer boundary of the integral fuselage fuel tank. In this paper the design of the monocoque will be presented, together with the material selection, the utilized design allowables, the structural design rules and details of the stiffening substructure with supporting structural tests. With respect to production costs and fuel tightness the number of detail parts and mechanical fasteners are minimized and the sealing concept will be outlined. Author

A93-15812* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EXPERIMENTAL INVESTIGATIONS INTO COMPOSITE FUSELAGE IMPACT DAMAGE RESISTANCE AND POST-IMPACT COMPRESSION BEHAVIOR
E. F. DOST, S. R. FINN (Boeing Commercial Airplane Group, Seattle, WA), J. J. STEVENS, K. Y. LIN (Washington Univ., Seattle), and C. E. FITCH (Zetec, Inc., Issaquah, WA) *In* International SAMPE Symposium and Exhibition, 37th, Anaheim, CA, Mar. 9-12, 1992, Proceedings Covina, CA Society for the Advancement of Material and Process Engineering 1992 p. 1199-1212. refs (Contract NAS1-18889)
Impact damage resistance and residual strength of laminated composite transport aircraft fuselage structure was studied experimentally. Techniques to quantify impact damage discretely and non-discretely are described. Experimental techniques to three-dimensionally map matrix damage and determine the sublaminate structure are illustrated. Impact damage was also quantified non-discretely, using characteristics of flexural wave propagation. Strain distributions in compressively loaded impact damaged laminates were experimentally measured. Author

A93-16859
TOULOUSE - FLIGHT TESTS OF THE AIRBUS A340 [TOULOUSE - LES ESSAIS EN VOL DE L'AIRBUS A340]
JACQUES MORISSET L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 153 1992 p. 59, 60. In French.
Copyright
This paper recounts the successive flight tests begun in October 1991 of the new 253 ton max TOGW A340 long range commercial transport. Consideration is given to wind tunnel aerodynamic tests, structural fatigue tests, and simulator systems tests in conjunction with continuous integrated systems evaluation tests on an 'iron bird' rig. R.E.P.

A93-17502
BREAKING THE STALL BARRIER
GUY NORRIS Flight International (ISSN 0015-3710) vol. 142, no. 4344 Nov. 11, 1992 p. 34-37.
Copyright
The high angle-of-attack flight research conducted at NASA's Ames-Dryden facility is reviewed and the high-alpha characteristics of the three main programs are compared. All three aircraft (X-29, X-31A, F-18 HARV) are being employed for examining controllability in high-alpha regimes and poststall combat maneuvering. Comparative flight test results from the three aircraft are presented and some of the early lessons learned are described. R.E.P.

N93-12602# Search Technology, Inc., Norcross, GA.
SPECIFICATION OF ADAPTIVE AIDING SYSTEMS Final Report
ROBERT C. ANDES and WILLIAM B. ROUSE 1 Mar. 1992 32 p
(Contract F33615-88-C-3612)
(AD-A254537; NAWCADWAR-92034-60) Avail: CASI HC A03/MF A01
Designers' decision making in specifying adaptive aiding systems is considered. A study of design decision in specifying aiding for a fighter aircraft mission scenario is discussed. Results indicate a high degree of consistency on the part of individual designers. However, there was substantial variations among designers in terms of both decisions made and information used to make the decisions. The implications of these results for development of design tools, as well as the type of research studies whose results would be valued by designers, are considered. GRA

N93-12605# Air Force Environmental Technical Applications Center, Scott AFB, IL.
SAC CONTRAIL FORMATION STUDY
BRIAN M. BJORNSON May 1992 55 p
(AD-A254410; USAFETAC/PR-92/003) Avail: CASI HC A04/MF A01
This report documents the results of a study that compares the Appleman contrail forecasting method used at the Air Force Global Weather Central (AFGWC) with the SAC method using pilot report (PIREP) data collected by SAC/DOW between March 1990 and July 1991. The study resulted in development of two other contrail forecasting techniques. The first (ETACFCST) was developed using discriminant analysis schemes to obtain best fit curves of contrail formation as a function of altitude and

temperature, or altitude, temperature, and vertical motion. Statistics showed ETACFCST to be better than either the Appleman or SAC contrail prediction curves. But another technique developed near the end of the study incorporated aircraft engine type as a factor for the first time. The new engine-specific contrail forecasting technique is recommended as a replacement for the Appleman method used at AFGWC. GRA

N93-12613# Catholic Univ. of America, Washington, DC. Cognitive Science Lab.
THEORY AND DESIGN OF ADAPTIVE AUTOMATION IN AVIATION SYSTEMS Progress Report
RAJA PARASURAMAN, TOUFIK BAHRI, JOHN E. DEATON, JEFFREY G. MORRISON, and MICHAEL BARNES 17 Jul. 1992 48 p
(Contract N62269-90-0022-5931)
(AD-A254595; NAWCADWAR-92033-60) Avail: CASI HC A03/MF A01

Recent technological advances have made viable the implementation of intelligent automation in advanced tactical aircraft. The use of this technology has given rise to new human factors issues and concerns. Errors in highly automated aircraft have been linked to the adverse effects of automation on the pilot's system awareness, monitoring workload, and ability to revert to manual control. However adaptive automation, or automation that is implemented dynamically in response to changing task demands on the pilot, has been proposed to be superior to systems with fixed, or static automation. This report examines several issues concerning the theory and design of adaptive automation in aviation systems, particularly as applied to advanced tactical aircraft. An analysis of the relative costs and benefits of conventional (static) aviation automation provides the starting point for the development of a theory of adaptive automation. This analysis includes a review of the empirical studies investigating effects of automation on pilot performance. The main concepts of adaptive automation are then introduced, and four major methods for implementing adaptive automation in the advanced cockpit are described and discussed. GRA

N93-12752# Wright Lab., Wright-Patterson AFB, OH.
X-29 LINEAR AERODYNAMIC PERTURBATION MODEL
THOMAS A. GENTRY Jul. 1992 152 p
(AD-A254810; WL-TM-92-338-FIGC) Avail: CASI HC A08/MF A02

This memo documents the linear aerodynamic and thrust perturbation model of the X-29 simulation model resident in the Control Integration and Assessment Branch of Wright Laboratory (WL/FIGD) at Wright-Patterson Air Force Base, Ohio. This model was used to perform flying qualities evaluations of the X-29 aircraft at Wright Laboratory during the airplane's development in the early to mid-1980s. This work was conducted in order to document the X-29 longitudinal and lateral-directional linear aero model at numerous trim flight conditions for use in future research work in flying qualities. The X-29 is representative of typical fighter aircraft, even with its forward-swept wing, although the airframe is very unstable longitudinally. This memo is divided into four sections: Introduction, Definition of Terms, Explanation of Computer Printouts, and Computer Printouts sections. Definitions of all terms associated with the linear model are given in the Definition of Terms section. Explanation of all of the data in the computer printouts is given in the Explanation of Computer Printouts section. The Computer Printouts section contains the actual computer printouts for each trim flight condition. GRA

N93-13140 Michigan Univ., Ann Arbor.
MINIMUM-TIME FLIGHT PATHS OF SUPERSONIC AIRCRAFT Ph.D. Thesis
DONGLONG SHEU 1992 169 p
Avail: Univ. Microfilms Order No. DA9227000

In this dissertation, the methods of analysis for the minimum-time flight of supersonic aircraft are presented. There are at least two substantial contributions in this study. First, a method called 'increment algorithm' is exploited. Second, the conditions for a reduced-space subarc are explicitly derived. With the first development, the starting procedure for the second-order gradient method becomes easy. This method needs to satisfy three conditions: the convexity condition, the normality condition, and the no-conjugate-point condition. In addition, the concept of this development is very helpful in dealing with a problem which involves many parameters. With the second development, a theoretical basis is provided for artificially imposing a reduced-space subarc in the analysis when a sensitivity problem is encountered. With both significant developments, the computational technique is successfully applied to solve problems of minimum-time maneuvers of supersonic aircraft in both two-dimensional and three-dimensional formulations. The various problems differ in the final conditions imposed. From the analysis in each problem, the optimal aerodynamic and thrust controls are obtained and the piloting technique to achieve the minimum time is explained. Dissert. Abstr.

N93-13207# Deutsche Airbus G.m.b.H., Bremen (Germany).
RECENT DEVELOPMENTS IN LOW-SPEED TPS-TESTING FOR ENGINE INTEGRATION DRAG AND INSTALLED THRUST REVERSR SIMULATION
W. BURGSMUELLER, C. CASTAN (Aerospatiale, Toulouse, France), J. W. KOOI (Duits-Nederlandse Windtunnel, North East Polder.), and J. P. BECLE (Office National d'Etudes et de Recherches Aerospatiales, Paris, France) *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 15 p Sep. 1992
Copyright Avail: CASI HC A03/MF A04

In accordance with the steady increase in bypass ratio and hence fan nacelle diameter of engines for modern transport aircraft, also the investigation of engine-airframe interference effects is of increasing importance. This covers not only the interferences between the wing and nacelle plus pylon bodies, but also the effects due to the presence of the engine jet flow field. In the low speed range of an aircraft, i.e., take-off, second segment climb, landing and roll out with thrust reversing, the jet interference investigations require wind tunnels with special high quality equipment, highly instrumented models with engine simulators and test setups outside the tunnel for special investigations. Concerning the different possibilities for engine simulation, the use of turbine-powered-simulators (TPS) has proven as the best and most flexible instrument. The paper presented here describes the technical progress made in the last years in testing techniques, based on close cooperation between Deutsche Airbus, Aerospatiale, DNW and ONERA. Further, a survey about the possible applications for low speed jet interference testing is given, mainly based on the Airbus A340 development program. Finally, some of these recent test results concerning performances and understanding of the aerodynamic and thermodynamic phenomena, especially concerning second segment climb jet interference, thrust reverser efficiency and plume reingestion effects are shown and discussed. It can be summarized, that a high level of technical test standard has been achieved and this together with a better understanding of the flow phenomena gives a viable basis for the integration of the coming generations of aircraft and engines. Author

N93-13208# Fokker B.V., Schipol-Oost (Netherlands). Aerodynamics and Aeroelasticity Dept.
AERODYNAMIC INTEGRATION OF THRUST REVERSERS ON THE FOKKER 100
J. VANHENGST *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 9 p Sep. 1992
Copyright Avail: CASI HC A02/MF A04

The Fokker 100 is a twin engined T-tailed aircraft developed as a short to medium haul passenger and cargo transport. The engines are located on the aft fuselage. The development of thrust reversers on this type of aircraft was accomplished through different types of wind tunnel model tests and full scale tests. Model tests on an isolated exhaust configuration, scale 1:5, were conducted at Fluidyne in order to establish nozzle suppression and thrust

reverser efficiency and side plume effects. Effects on directional and longitudinal stability characteristics were investigated by model tests on a complete mode, scale 1:12, in the LST of NLR. Reingestion tests were performed on the same complete model in the RR low speed facility at Hucknall. Attached photographs show the model in the NLR and RR facilities. This paper discusses the integration process, showing test results from wind tunnel model tests as well as full scale boiler plate and flight tests. A successful means to control side plume effects on the directional stability and a configuration change to suppress induced reverse plume empennage buffet is also discussed. Author

N93-13212# Societe Nationale d'Etudes et de Construction de Moteurs Aeronautiques, Moissy-Cramayel (France).
FLIGHT ANALYSIS OF AIR INTAKE/ENGINE COMPATIBILITY [ANALYSE EN VOL DE LA COMPATIBILITE ENTREE D'AIR-MOTEUR]
H. JOUBERT and J. L. EYRAUD *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 12 p Sep. 1992 In FRENCH
Copyright Avail: CASI HC A03/MF A04

Performance improvement of the combat aircraft/engine unit rests on the optimization of intake/engine compatibility. This optimization requires specific flight tests in which the loss of the pumping margin of the compressors due to distortion is determined. The general methodology for the intake/engine compatibility analysis is described from the first wind tunnel tests to the flight tests. In order to determine the loss of the pumping margin due to the distortion of the air intake, an extensive instrumentation set was installed on the Mirage 2000 (Dassault Aviation) aircraft equipped with the M53-P2 (SNECMA) engine. The test procedures as well as the processing of the nonstationary signals are described. The correlations binding the nonstationary coefficients of distortion to the loss of pumping margin of the low pressure compressor are presented. It is shown that a correlation to only one parameter makes it possible to reach an accuracy of plus or minus 2 percent. On the other hand, the use of a correlation of two parameters (circumferential and radial) makes it possible to reduce the precision to plus or minus 1 percent. The use of an engine test stand in an altitude chamber with channels simulating nonstationary distortion makes it possible to reproduce in a satisfactory way the phenomena observed in flight and, in particular, to measure values of sensitivity to the distortion similar to the values obtained in flight. This method makes it possible to improve the optimization of the engine while reducing the number of flight tests. Transl. by FLS

N93-13219# Aircraft Research Association Ltd., Bedford (England).
SOME ASPECTS OF INTAKE DESIGN, PERFORMANCE AND INTEGRATION WITH THE AIRFRAME
E. L. GOLDSMITH *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 19 p Sep. 1992
Copyright Avail: CASI HC A03/MF A04

A selection of topics has been made from the state of the art review in the Fluid Dynamics Panel Working Group 13 Report on Intakes for High Speed Vehicles. The first topic is a brief account of results from a program of research on internal and external flow in pitot intakes conducted in the UK over the period 1978-88. The main topic is that of intake airframe integration and is illustrated by examples from systematic work done in the USA and Europe on agile strike fighters and multi-intake missiles. Author

N93-13224# Wright Lab., Wright-Patterson AFB, OH.
SURVEY ON TECHNIQUES USED IN AERODYNAMIC NOZZLE/AIRFRAME INTEGRATION
DOUGLAS L. BOWERS and JAMES A. LAUGHREY *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 11 p Sep. 1992
Copyright Avail: CASI HC A03/MF A04

Building on a survey conducted in 1984 of the state-of-the-art of experimental and computational tools used to evaluate aerodynamic nozzle/airframe integration, this paper critically re-assesses these techniques in 1991. For experimental techniques, there have not been significant developments in the intervening seven years, and these mature techniques still serve the design engineer well. On the computational side, Euler techniques are now being applied as design tools in nozzle problems where there are not strong viscous interactions. Computation of the viscous regions, especially the nozzle boattail, with Navier-Stokes algorithms is still lacking. Author

N93-13228# Wright Lab., Wright-Patterson AFB, OH.
PROPULSION INTEGRATION RESULTS OF THE STOL AND MANEUVER TECHNOLOGY DEMONSTRATOR
J. A. LAUGHREY and D. J. MOORHOUSE *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 12 p Sep. 1992
Copyright Avail: CASI HC A03/MF A04

The STOL and Maneuver Technology Demonstrator program has achieved its original goals established to demonstrate the benefits of thrust vectoring and reversing on a fighter aircraft. It has been shown that thrust vectoring will enhance up-and-away aircraft maneuverability at low speeds and can be used to improve tracking and capture tasks plus contribute significantly to improve takeoff performance and rough or damaged runway operations. Thrust reversing has been shown to permit quicker changes in energy states that could provide an advantage in tactical arena and can greatly reduce landing distances. It was also demonstrated that an integrated flight and propulsion control system that incorporates the appropriate control laws can significantly simplify pilot workload during all vectoring and reversing operations, including the approach, landing, and stopping tasks. Results of this program are being used to transition these proven technologies into future fighter systems. Author

N93-13253# General Accounting Office, Washington, DC.
NATIONAL AERO-SPACE PLANE: KEY ISSUES FACING THE PROGRAM. TESTIMONY BEFORE THE SUBCOMMITTEE ON TECHNOLOGY AND COMPETITIVENESS, COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY, HOUSE OF REPRESENTATIVES
31 Mar. 1992 17 p
(GAO/T-NSIAD-92-26) Avail: CASI HC A03/MF A01; GAO, PO Box 6015, Gaithersburg, MD 20877 HC

Since its inception in December 1985, the NASP (National Aero-Space Plane) Program has undergone significant evolutionary changes. Its cost estimates have increased dramatically and some key schedule milestones may be delayed up to 11 years. While the program has achieved technical progress, it has also encountered problems with its weight and propulsion system. These problems, in conjunction with budget constraints and increasing costs, have resulted in various options being explored to reduce program costs and technical risks. As a part of this assessment, the primary goal of the program--to conduct single-stage-to-orbit flight testing of the X-30--is being reconsidered. Even without additional technical problems, potential cost increases and budget constraints are likely to be significant contributors to future schedule delays in the NASP Program. Furthermore, determining how much funding is needed and when, focusing development activities on needed technologies, and developing achievable long-range plans are complicated by the lack of a determination of whether the X-30 will conduct single-stage-to-orbit flight testing. For these reasons, we believe that a timely decision on this issue is critical. The Joint Program Office's recent proposal to concentrate on the X-30's propulsion system in the near term and defer a decision to build the X-30 until 1996 would likely reduce the program's near-term technical risk. Nevertheless, testing of several critical components and an analysis of the test results are not expected to occur until after the scheduled Phase 3 go-ahead decision in September 1993. Author

N93-13256 Aeronautical Research Labs., Melbourne (Australia). Dept. of Defence.
STRUCTURAL FATIGUE ASPECTS OF THE P-3 ORION

J. M. GRANDAGE May 1992 28 p
(ARL-STRUC-TM-558; AR-007-068) Copyright Avail: Issuing Activity

Material relevant to continuing Aeronautical Research Laboratory/Headquarter Logistics Command (ARL/HQLC) work on structural fatigue of the Royal Australian Air Force (RAAF) P-3 fleet is presented. In 1991 the RAAF developed a proposal to refurbish the avionics of the P-3 fleet and to extend its life to year 2015. As part of the project definition study for the refurbishment, ARL/HQLC investigated the fatigue implications of the proposal. This investigation produced a project report which drew conclusions on cost and operational implications arising from fatigue considerations and recommended a structural fatigue work program aimed at justifying the life extension on airworthiness grounds. The investigation has generated extensive information on the P-3 fatigue status, and this information is presented here. The discussion focusses mainly on the Lockheed service life evaluation program (SLEP) and the US Navy service life assessment program (SLAP). Author

N93-13565*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MULTIPLE-FUNCTION MULTI-INPUT/MULTI-OUTPUT DIGITAL CONTROL AND ON-LINE ANALYSIS
SHERWOOD T. HOADLEY, CAROL D. WIESEMAN, and SANDRA M. MCGRAW (Lockheed Engineering and Sciences Co., Hampton, VA.) Oct. 1992 16 p Presented at the DSP(sup x) Exposition and Symposium, San Jose, CA, 14-16 Oct. 1992
(Contract RTOP 505-63-50-15)
(NASA-TM-107697; NAS 1.15:107697) Avail: CASI HC A03/MF A01

The design and capabilities of two digital controller systems for aeroelastic wind-tunnel models are described. The first allowed control of flutter while performing roll maneuvers with wing load control as well as coordinating the acquisition, storage, and transfer of data for on-line analysis. This system, which employs several digital signal multi-processor (DSP) boards programmed in high-level software languages, is housed in a SUN Workstation environment. A second DCS provides a measure of wind-tunnel safety by functioning as a trip system during testing in the case of high model dynamic response or in case the first DCS fails. The second DCS uses National Instruments LabVIEW Software and Hardware within a Macintosh environment. Author

N93-13807 Missouri Univ., Rolla.
AN INVESTIGATION OF THE DYNAMIC RESPONSE OF LIFTING SURFACES WITH CONCENTRATED STRUCTURAL NONLINEARITIES Ph.D. Thesis
IYAD KHALIL QUMEI 1992 244 p
Avail: Univ. Microfilms Order No. DA9224680

The dynamic response of rigid and flexible lifting surfaces with elastic root restraint is studied both experimentally and analytically. Testing is performed on two straight wings with symmetrical cross sections elastically supported at the root with a rigid structure. The root support motion is constrained by two springs which involve an adjustable freeplay mechanism. The active degrees of freedom considered are the rigid body plunge and pitch and the flexural motion of the lifting surface relative to the root support. Testing is carried out at relatively low speeds in a subsonic wind tunnel. The analytical model is developed using the finite element method for the structural part, and recently-developed transient unsteady aerodynamics to represent the air force in the time domain, instead of the usual representation in the frequency domain. The dynamic responses of the linear and nonlinear system configurations are obtained by directly integrating the equations of motion. Predicting the response of the lifting surface close to the nonlinear flutter speed from a linearized form of the equations of motion which utilizes the harmonic balance method proved to be possible and effective. But modeling the system without resorting to approximate forms for the freeplay nonlinearity has the advantage of predicting all possible responses the nonlinear system may experience at all airspeeds within the sustained oscillation region, such as nonperiodic. A satisfactory correlation between experimentally and analytically-obtained responses on both a qualitative and a quantitative basis has been achieved. Dissert. Abstr.

N93-13815 Texas Univ., Arlington.
OPTIMUM DESIGN OF AIRCRAFT STRUCTURES WITH MANUFACTURING AND BUCKLING CONSTRAINTS Ph.D. Thesis
DANIEL PATRICK COSTIN 1991 172 p
Avail: Univ. Microfilms Order No. DA9217626

Aircraft design incorporates a large number of structural and aerodynamic disciplines. Each discipline must be considered in order to obtain a feasible and optimum design. All too often, however, some constraints are left out of the optimization problem, leading to an 'optimum' design that is not feasible. In practical terms the design looks good on paper, but does not perform well when tested, or can not be built as designed. The constraints developed in this dissertation are two that are commonly left out of aircraft design optimization problems. The first group of constraints ensures that the structure will be manufacturable. The constraints are especially useful for composite wing skins, because the flexibility allowed in the optimization of composites will often lead to unorthodox laminates. Composite laminates designed with optimization programs often have large variations in both the ply orientation percentage and the total laminate thickness across the plane of the laminate. Also, the ply orientation percentage is often outside the range that is recommended. The second constraint type is a panel buckling constraint. The loads from the finite element model are used in a closed-form buckling solution. The constraint prevents the wing skin from local buckling in the unsupported regions bounded by the ribs and spars. These constraints were used in a number of design studies that evaluated the relative impact of the constraints of the design weight. Also, a design and manufacturing case study was done. In this study an optimum design obtained by using the manufacturing constraints of this dissertation was compared with a conventional design of the same structure. The two designs were built and tested to determine the accuracy of the design and modelling techniques. Dissert. Abstr.

N93-13821 Maryland Univ., College Park.
FORMULATION AND VALIDATION OF HIGH-ORDER MATHEMATICAL MODELS OF HELICOPTER FLIGHT DYNAMICS Ph.D. Thesis
FREDERICK DONG KIM 1991 304 p
Avail: Univ. Microfilms Order No. DA9222710

A high-order mathematical model of a helicopter that models the complete dynamics of the aircraft, including the rotor, inflow, and propulsion dynamics is descibed. The model is formulated so that time invariant linear models can be extracted rigorously to include the high-order dynamics of the aircraft in addition to the dynamics associated with the six fuselage degrees of freedom. Such models are essential to examine compliance with new handling qualities specifications, and to design advanced flight control systems capable of high-bandwidth and low cross couplings. A trim procedure is developed to provide an equilibrium position about which the nonlinear model can be linearized. The procedure is capable of providing the steady state periodic response of the rotor blades and the equilibrium states of the propulsion system, in addition to the trim states of the fuselage for both straight and level, and turning flight. A refinement technique that gives the correct periodicity of all the states is also described. The mathematical model is validated by comparing model responses against flight test data measured on an articulated rotor helicopter. Static trim cases compared include pilot controls, fuselage attitudes, and power required curves against flight test data for hover and up to a forward speed of 170 knots. The frequency domain validation for the bare-airframe configuration is conducted for both hover and forward speeds of 80 knots and 120 knots. The accuracy in modeling the cross coupling are examined by validating both the on-axis and off-axis frequency response to control inputs in hover. The importance of high-order dynamics on the dynamic response of the aircraft is examined by comparing frequency

responses of reduced order models against the full-order model. Reduced order models with the main rotor lag, the propulsion system, and inflow degrees of freedom removal are examined. The dynamic response of a helicopter in a maneuvering flight condition, deemed important for modern military applications, is studied by comparing poles and frequency responses from a helicopter in a 2-g turn against those from a helicopter in straight and steady level flight. Dissert. Abstr.

N93-13914 Florida Atlantic Univ., Boca Raton.
TRIM ANALYSIS BY SHOOTING AND FINITE ELEMENTS AND FLOQUET EIGENANALYSIS BY QR AND SUBSPACE ITERATIONS IN HELICOPTER DYNAMICS Ph.D. Thesis
NAGARI SHRIRANGA ACHAR 1992 161 p
Avail: Univ. Microfilms Order No. DA9220990

The trim analysis for the initial state and control inputs that satisfy response periodicity and flight conditions, and the Floquet eigenanalysis for a few largest eigenvalues of the Floquet transition matrix (FTM) are investigated. In the trim analysis, the convergence of Newton iteration is investigated in computing the periodic initial state and control inputs sequentially and in parallel. The trim analysis uses the shooting method and two h-versions of temporal finite element methods, one based on displacement formulation and the other on mixes formulation of displacements and momenta. In each method, both the sequential and in-parallel schemes are used, and the resulting nonlinear equations are solved by damped Newton iteration with an optimally selected damping parameter. The reliability of damped Newton iteration, including earlier-observed divergence problems, is quantified by the maximum condition number of the Jacobian matrices of the iterative scheme. For illustrative purposes, rigid flap-lag and flap-lag-torsion models based on quasisteady aerodynamics are selected. Demanding trim analysis conditions are included by considering advance ratios or dimensionless flight speeds twice as high as those of current helicopters. Concerning the Floquet eigenanalysis, the feasibility of using the Arnoldi-Saad method, one of the emerging subspace iteration methods, is explored as an alternative to the currently used QR method, which is not economical for partial eigenanalysis. The reliability of the Arnoldi-Saad method is quantified by the eigenvalue condition numbers and the residual errors of the eigenpairs. In the three trim analysis methods, while the optimally selected damping parameter provides almost global convergence, the in-parallel scheme requires much less machine time than the conventional sequential scheme; both schemes have comparable reliability of the Newton iteration without and with damping. The Arnoldi-Saad method takes much less machine time than the QR method with comparable reliability. Dissert. Abstr.

N93-14248# Naval Postgraduate School, Monterey, CA.
EXPERIMENTAL AND ANALYTICAL INVESTIGATION OF THE VIBRATION CHARACTERISTICS OF A REMOTELY PILOTED HELICOPTER M.S. Thesis
WILLIAM T. TRAINER Jun. 1992 145 p
(AD-A256131) Avail: CASI HC A07/MF A02

The Department of Aeronautics and Astronautics at the Naval Postgraduate School is involved in an ongoing program of Higher Harmonic Control (HHC) research using Remotely Piloted Helicopters (RPH). To date a host RPH has been acquired and a preliminary HHC design study completed. This thesis reports the results of a free vibration shake test conducted on the host RPH as well as efforts to construct a representative finite element model of the vehicle. Broadband noise was used to excite the structure both laterally and vertically from 10-200 Hz in and attempt to accurately document the airframe and rotor system dynamics. Primary airframe structural modes were identified in the tail boom and at frequencies well below the characteristic 4/rev (78.3 Hz) main rotor induced vibration frequency. These modes should not be of concern at normal operating rpm. Main rotor blade modes were documented under non-rotating conditions then extended to predict the modes at operating rpm. Finally, a finite element model of the structure was constructed. Difficulties in matching finite element predictions with experimental results, however, will require refinements to the computer model before it can become a useful design tool. GRA

N93-14448 Cranfield Inst. of Tech., Bedford (England).
DESAID (THE DEVELOPMENT OF AN EXPERT SYSTEM FOR AIRCRAFT INITIAL DESIGN) Ph.D. Thesis
SEUNG-HYEOG NAH 1991 269 p
Avail: Univ. Microfilms Order No. BRDX96714

The tasks involved in designing an aircraft configuration show complex characteristics, considering the fact that aircraft configuration design means the integration of components such as lifting surfaces (wing), fuselage, power-plant, control surfaces (tail or canard), and undercarriage. The discrepancies and mismatches among the aircraft components make the configuration design iterative, repetitive, and thus time-consuming. The current research project is directed at the development of an expert system for aircraft design. This involves the use of Artificial Intelligence and its programming language called PROLOG (PROgramming in LOGic). The research started from a thorough analysis of the major component design areas and has constructed an EXPERT SYSTEM to find out the efficient Control Mechanism which can search intensively for the solutions to design problems for all types of aircraft: civil and military, subsonic and supersonic, conventional and unconventional, etc. In addition, users can have access to the explanations of important items such as a design process, terminology, equations, and results. The explanation facility is one of the most important functions of Expert Systems. Partly due to the limit of computer capacity and partly due to the magnitude of laborious program execution at this stage, the system implementation has focused on the high-subsonic, conventional and jet transport aircraft categories. The approach taken was to find an efficient and effective control mechanism (i.e. an Inference Engine), which integrated the PARAMETRIC STUDY, WING DESIGN, FUSELAGE DESIGN, ENGINE DESIGN, TAIL DESIGN, UNDERCARRIAGE DESIGN, WEIGHT ANALYSIS AND COST ANALYSIS into a whole configuration system. The comparison between Expert System results and existing aircraft such as Boeing 747, Airbus 300 series, BAe 146 series, McDonnell Douglas MD series, etc., showed the permissible ranges of error to be within about 10 percent. Such results enable the Expert System to claim that it can act as a useful design tool for the aircraft designer in the initial stage of aircraft configuration design. The author believes that the control mechanism devised for this Expert System can be used as a sound basis for extending the Expert System to include other types of aircraft and further to encompass spacecraft design, as the designer wishes. Dissert. Abstr.

N93-14462 Pennsylvania State Univ., University Park.
MULTI-POINT INVERSE DESIGN OF ISOLATED AIRFOILS AND AIRFOILS IN CASCADE IN INCOMPRESSIBLE FLOW Ph.D. Thesis
MICHAEL SCOTT SELIG 1992 239 p
Avail: Univ. Microfilms Order No. DA9226776

This thesis describes a multi-point inverse design method for airfoils and one for cascades. In the present sense, inverse design is taken to mean the problem of finding the shape which corresponds to the desired set of aerodynamic and geometric characteristics. These include the pitching moment, maximum thickness ratio, part of the velocity distribution or boundary-layer flow physics, for example, the shape-factor, skin-friction or linear stability amplification factor distribution. Specifically, the airfoil or cascade blade to be determined is divided into a desired number of segments along each of which either the desired velocity distribution or boundary-layer development is prescribed together with, if desired, the maximum thickness ratio, etc. The solution is formulated through the use of conformal mapping and a direct integral boundary-layer technique resulting in a system of nonlinear equations which are solved through multi-dimensional Newton iteration. It is shown that certain integral constraints, continuity constraints and stagnation point velocity distribution relations must be satisfied in order for the inverse problem to be well-posed. The satisfaction of these conditions may be handled conveniently. This makes the practical application of the method feasible. Several

example airfoils and cascades are presented to illustrate the two inverse methods. A solution to the direct analysis problem for the velocity distributions about airfoils and cascades is also discussed. The current approach to both analysis problems differs significantly from the standard approaches such as those based on Theodorsen's method. The airfoil or cascade is mapped to the circle by one transformation that is expressed in derivative form so that the velocity distribution follows directly. Also, an exact solution to the flow through an infinite cascade is presented based on a mapping which has close ties to the Joukowski transformation. As compared with Gostelow's method, exact solutions can be obtained in a straightforward way. Finally, extensions of the theory to the inverse design of radial cascades, semi-infinite bodies and channels are discussed briefly. Dissert. Abstr.

N93-14541 ESDU International Ltd., London (England).
ESTIMATION OF RATE OF CLIMB
Jun. 1992 14 p Supersedes ESDU Perf-EG3/1
(ISSN 0141-4054)
(ESDU-92019; ISBN-0-85679-824-X) Avail: ESDU

ESDU 92019 presents the equations with various degrees of simplification for the calculation of rate of climb of jet-powered or propeller-driven aeroplanes. It is primarily concerned with 'steady-state climbs', that is with instantaneous climb rate, and does not treat the effect of acceleration introduced by a climb schedule. The general calculation procedure is illustrated by a worked example based on a jet-powered combat aircraft. For propeller-driven aeroplanes, approximate guidance is given graphically on maximum climb rate as a function of power/weight ratio. It is based on comparisons of computed data for a wide range of aircraft configurations, using typical propellers having a given variation of efficiency with speed, with published data for a large number of aircraft types with fixed- or variable-pitch propellers driven by piston or turbo-prop engines. Approximate guidance on the speed for best climb rate is also given, based on the computed results. A worked example shows how the data might be used at the preliminary project stage to assess maximum climb rate or, alternatively, installed power to achieve a given rate of climb.
Author

N93-14571# Dayton Univ. Research Inst., OH.
DETERMINATION OF STRESSES ON LAMINATED AIRCRAFT TRANSPARENCIES BY THE STRAIN GAGE-HOLE DRILLING AND SECTIONING METHOD Final Report, Jan. 1989 - Sep. 1990
THOMAS J. WHITNEY and GREGORY J. STENGER Apr. 1992 205 p
(Contract F33615-84-C-3404)
(AD-A255548; UDR-TR-90-106; WL-TR-92-3025) Avail: CASI HC A10/MF A03

Reducing the incidence of transparency changeouts due to craze of the outer acrylic ply requires knowledge of stress levels in in-service aircraft transparencies. Laboratory and field craze data may then be correlated to predict craze onset. Experiments conducted during the first phase of this study verified that the strain gage-hole drilling method, with calibration modification, can measure biaxial stress states in laminated transparencies with an error of less than 10 percent for stresses over 500 psi. A device to apply this method to full-scale transparencies was then designed and fabricated. In the second phase, stresses due to three mechanisms (residual stress, installation, and cabin pressurizing) in full-scale transparencies were measured. For comparison purposes and to identify the contribution of particular mechanisms to the total stress state, the sectioning method was also used. The measurements made on full-scale transparencies removed from service due to craze indicate residual stresses are too low to cause crazing in a 'uniform' environment (one free from wide temperature variation and extended contact with crazing agents). Stresses due to transparency installation and cabin pressurizing were also low relative to the maximum principal stress criteria used in this study. Recommendations include examination of other craze criteria, examination of other stress inducing mechanisms such as moisture desorption from the surface, and examination of cyclic loading and chemical exposure on craze. GRA

N93-14601# Naval Postgraduate School, Monterey, CA.
THE V-22 OSPREY: A CASE ANALYSIS M.S. Thesis
MARK A. OBRIEN 1 Jun. 1992 93 p
(AD-A256445) Avail: CASI HC A05/MF A01

This thesis is a case analysis of the V-22 Osprey program. It examines the history of tilt-rotor technology, as well as the history of the program management. Congressional, OSD, and USMC/USN interplay is detailed chronologically from 1980 through to 1991 with particular reference to congressional action during this period. Various studies and simulations are analyzed with the objective of establishing the V-22 as an aircraft which is capable of fulfilling wide-ranging mission criteria established by the services much more effectively and efficiently than current or planned aircraft. The commercial and foreign military sales markets for the V-22 are also examined. This thesis concludes that the tilt-rotor concept has considerable worldwide potential for both military and civil applications. GRA

N93-14615# *Technische Univ., Delft (Netherlands). Faculty of* Aerospace Engineering.
FLIGHT TESTING: PAST, PRESENT, AND FUTURE
J. A. MULDER *In* NAL, Symposium on the Occasion of the Farewell of Prof. Dr. Ir. O. H. Gerlach as Chairman of the Board of the Foundation National Aerospace Laboratory NLR, The Netherlands p 31-57 1991
Avail: CASI HC A03/MF A01

Ideas behind 'aircraft parameter identification' are presented in an historical context and an attempt is made to project their effect on future developments in the theory and practice of dynamic flight test techniques. In particular, the work of O.H. Gerlach in the analysis of a method for the measurement of performance and stability and control characteristics in unsteady symmetrical *flight is discussed. Flight test maneuvers and instrumentation are* described. ESA

N93-14828 Georgia Inst. of Tech., Atlanta.
STABILITY OF ELASTICALLY TAILORED ROTOR BLADES Ph.D. Thesis
MARK VERNER FULTON 1992 212 p
Avail: Univ. Microfilms Order No. DA9231728

A stability analysis has been developed for a hingeless, composite, isolated rotor in hover. The analysis is a finite element based solution of mixed, weak, intrinsic dynamic equations for a rotating beam. The aerodynamic forces were modeled with two-dimensional, quasi-steady strip theory, with inflow taken from momentum/blade element theory. The completely nonlinear analysis includes shear deformation, a mechanism for the inclusion of a complete 6 x 6 stiffness matrix (relating six generalized forces and moments to six generalized strains and elastic curvatures), and the effects of rotary inertia. In other words, the analysis can handle nonclassical couplings as well as shear deformation. In addition, no explicit restrictions on the magnitudes of the displacement and rotation components were made; the only implicit restriction was that the magnitudes of the strain components remain small compared to unity. The blade's equilibrium position was obtained by an iterative solution of the complete nonlinear equations using the Newton-Raphson method. The dynamic equations were linearized about this position and a small motion solution to the resulting eigen-problem was obtained. The eigenvalues give the damping and frequency of each eigenvector. The resultant FORTRAN program was thoroughly validated against analytical and existing experimental results for equilibrium, dynamic, and stability calculations. The validations encompassed both small and large equilibrium deflections. In addition, extensive correlations were performed against experimental composite results, including both static and dynamic cases. These studies indicate that the current approach accurately represents large deflections and linearized dynamics and is capable of predicting composite behavior quite well. The accuracy of the composite predictions was found to depend on the quality of the cross-sectional stiffnesses. The

two-dimensional analyses used, however, gave nearly identical results for many cases because of their high quality. The performance of the 'classical' stiffnesses (which ignore shear deformation effects), however, was poor for several cases. The stability cases studied were not typically very sensitive to the nonclassical couplings. There was one stability case, however, for which a significant error appeared (especially at high thrust levels) when bending-shear coupling was neglected. Dissert. Abstr.

N93-15004# Naval Air Warfare Center, Warminster, PA. Air Vehicle and Crew Systems Technology, Dept.
A NEURAL NETWORK PROTOTYPE FOR PREDICTING F-14B STRAINS AT THE B.L. 10 LONGERON Final Report, Mar. - May 1992
MARGERY E. HOFFMAN May 1992 48 p
(AD-A255272; NAWCADWAR-92042-60) Avail: CASI HC A03/MF A01

A neural network prototype was developed to predict strain from data obtained from an F-14 flight test program. Data from two flights were available: Flight 400 consisted of standard structural maneuvers, and Flight 401 consisted of maneuvers performed during typical fleet operations. Several variables were monitored during flight, including Nz, Mach number, altitude, wingsweep angle, roll rate, angle of attack, a weight-on-wheels indicator and the strain at B.L. 10 of the F-14B. The neural network was trained on Flight 400, and tested on Flight 401. A forward-stepwise-regression was also performed on Flight 400 and the selected model was tested on Flight 401, for comparison. Results were evaluated by comparing the correlation coefficients between the predicted and measured strains. The correlation coefficient obtained by the neural network was 0.93 and by the regression equation was 0.94. Based on these preliminary results, the conclusion is made that the neural network approach offers a viable alternative to standard regression analysis for predicting strains on airframes. GRA

N93-15126# Institut de Mecanique des Fluides de Lille (France).
AEROPLANE CRASHES ON THE RUNWAY: VALIDATION AND FINAL EVALUATION OF THE METHOD OF MODELING AN AIRFRAME STRUCTURE [CRASH DES AVIONS SUR PISTE: VALIDATION ET EVALUATION FINALE DE LA METHODOLOGIE DE MODELISATION D'UNE STRUCTURE DE CADRE AVION]
E. DELETOMBE and P. GEOFFROY 30 Sep. 1991 58 p In FRENCH
(Contract DRET-88-003-01)
(IMFL-91-32; ETN-92-92721) Avail: CASI HC A04/MF A01

The validation and evaluation of a method of modeling an airframe structure subjected to a linear crushing is presented. The validation is based on the adjustment capacity of the model with respect to a criterion. The criterion, in this analysis, corresponds to the minimization of the difference, (in terms of absorbed energy, critical charge and post buckling rigidity), between the experimental force/displacement curve at the top of the cylindrical structure and the curve calculated with this macroelement method of modeling. During the evaluation the precision and cost of the model is compared to a classical model, of type 476 regular elements. The global benefit of this method in the complete modeling of the cylindrical structure of a commercial plane is assessed. ESA

N93-15227# Scientific-Atlantic, Inc., San Diego, CA. Signal Processing Systems.
ONBOARD SYSTEM EVALUATION OF ROTORS VIBRATION, ENGINES (OBSERVE) MONITORING SYSTEM Final Test Report, Aug. 1991 - Apr. 1992
J. A. GOODRICH and K. M. KLEPIN Jul. 1992 22 p
(Contract DAAJ02-91-C-0030)
(AD-A255366) Avail: CASI HC A03/MF A01

The On Board System for the Evaluation of Rotors Engine and Vibration (OBSERVE) research and development (R and D) program was designed to investigate and demonstrate the benefits of onboard data recording/processing and rotor tuning equipment for monitoring and diagnosis of mechanical subsystems on the CH-47. The payoffs for such a concept include reduced aircraft vibration levels (with extended MTBF of electronics and mechanical system as well as reduced crew fatigue), reduced maintenance flights, and early warning of component failures. This program demonstrates an approach to a practical, automated system which monitors certain mechanical subsystems, provides inflight vibration and control system status, and prescribes corrective actions to the maintainer. Various monitoring components were developed and integrated to demonstrate this concept. GRA

N93-15238# Naval Postgraduate School, Monterey, CA.
ANALYSIS OF IN-FLIGHT STRUCTURAL FAILURES OF P-3C WING LEADING EDGE SEGMENTS M.S. Thesis
DENNIS A. LOTT Jun. 1992 118 p
(AD-A256212) Avail: CASI HC A06/MF A02

A quantitative analysis was carried out to determine the stresses present in the leading-edge segment of a P-3C aircraft operating within and outside the normal operating envelope of the aircraft. The purpose of the analysis was to ascertain whether a specific weakness may exist in the leading-edge structure which might endanger future operating flight crews. A three-step process consisting of a static aeroelastic span-load analysis, an inviscid two-dimensional panel-method analysis, and finite-element analysis was employed in the course of the evaluation. Lift coefficient distributions from the wing span-load analyses were used in the two-dimensional panel method to determine the pressure distribution around the leading edge, which was then used as input to the finite-element analysis. Additionally, static aeroelastic-derived wing-twist effects were included in the structural model. The results of the analysis suggest that the leading edge segment studied may experience stress levels sufficient to cause failure within the normal operating envelope. GRA

N93-15361# Naval Air Warfare Center, Patuxent River, MD. Aircraft Div.
STANDARDIZATION OF PRECIPITATION STATIC TEST METHODS AND EQUIPMENT FOR THE NAVY
MATTHEW R. MAIER 1992 25 p
(AD-A257025) Avail: CASI HC A03/MF A01

The Naval Air Warfare Center Aircraft Division, Patuxent River, is currently the Navy's lead facility for Precipitation Static testing of aircraft. It was involved extensively with the design and production of standard Precipitation Static test methods and equipment. As part of tasking given by the Naval Air Systems Command, these methods are to be presented to other Navy facilities to provide additional test capability and overall fleet awareness of Precipitation Static. Further, this will provide standard procedures and equipment for Precipitation Static testing of aircraft Navy-wide. This paper presents an overview of the Precipitation Static test methods and equipment to be standardized, as well as the current plans to distribute these to Navy facilities. Particular attention will be paid to test methodology, design of standard test equipment, and plans for distribution and training. GRA

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A93-14158
TCAS II TESTING CONFLICTS AND RESOLUTIONS
KEVIN M. CALDWELL (Boeing Commercial Airplane Group, Seattle, WA) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 9-17. refs
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The airborne collision-avoidance concept for commercial aircraft

called the Traffic Alert and Collision Avoidance System II (TCAS II) is described in terms of its experimental evaluation and development. TCAS II ground and flight tests are described on four commercial transport aircraft for assessing: (1) the arrangement of controls; (2) self-test and failure-mode functions; (3) directional antenna bearing accuracy; and (4) proper operation of the traffic and resolution displays. Problems are identified in the areas of data reduction and analysis for identifying the ground-station target. By relocating the ground station to a remote area, this problem is resolved. Postflight data for analysis of the TCAS II system are collected by means of cameras mounted in the flight deck, and the need for effective transponders is found to be a critical issue for the use of the system. C.C.S.

A93-14200
SOLID STATE FLIGHT DATA RECORDERS AND THEIR APPLICATION IN THE FLIGHT OPERATION ANALYSIS
P. GIESE (Aviatronic - Aviation Engineering Development, Ltd., Budapest, Hungary), J. ROHACS (Budapest Technical Univ., Hungary), T. FARKAS (Aviatronic - Aviation Engineering Development, Ltd., Budapest, Hungary), and J. APATHY (Hungarian Academy of Sciences, Central Research Inst. for Physics, Budapest, Hungary) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 361-366.
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The paper describes a family of solid state flight data recorders (SSFDRs). These SSFDRs replace the optomechanical recorders used aboard civil and military aircraft. A data recorder consists of three components: the interface unit, the digital flight data acquisition unit, and the memory. Different computer-based ground station systems for the processing of the collected airborne data are presented. The SIROM evaluation program enables fast automatic data processing and the display of graphics for detailed analysis. Following the requirements of modern diagnostic programs, the TEMES analysis program was developed. TEMES has three display and analysis features, including the aircraft, instrument panel, the reconstructed flight trajectory, and graphics of selected parameters, which can be shown in parallel on two high resolution monitors. Author

A93-14295
APPLICATION OF FLIGHT DATA FOR DIAGNOSTIC PURPOSES
J. ROHACS (Budapest Technical Univ., Hungary), J. APATHY (Hungarian Academy of Sciences, Central Research Inst. for Physics, Budapest, Hungary), T. FARKAS (AVIATRONICS - Aviation Engineering Development, Ltd., Budapest, Hungary), and S. SZENDRO (Hungarian Academy of Sciences, Central Research Inst. for Physics, Budapest, Hungary) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1122-1132. refs
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The use of data from flight recorders for the diagnosis of flight operational states is considered based on mathematical models proposed for aircraft systems and engines. A candidate data-acquisition system is used for sample experimental results of digital and analog inputs that are compared to predicted parameters. Analytical expressions are developed for the dynamic and static models of generic aircraft engines with attention given to a combined linearized diagnostic model. The use of the diagnostic models for fault detection is hindered by problems of model formation, data processing, and evaluation. Solutions proposed to address the diagnostic limitations of the models include identification procedures, preliminary wide-sphere data processing, and the detection of relationships between the variation of identified factors and the actual system state. This review of flight diagnostic identifies the critical limitations of the mathematical models used to interpret aircraft data. C.C.S.

A93-14326* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
IN-FLIGHT DETECTION OF FLOW SEPARATION, STAGNATION, AND TRANSITION
S. M. MANGALAM and S. KUPPA (Analytical Services and Materials, Inc., Hampton, VA) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1382-1391. refs
(Contract NAS2-13252)
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Flight tests were conducted to demonstrate the feasibility of simultaneous determination of: (1) boundary-layer instability and transition characteristics; (2) flow separation region; and (3) the location of the leading-edge stagnation point. Surface mounted, multi-element, micro-thin, hot-film sensors were used in conjunction with a bank of constant-temperature anemometers and a PC-based 8-channel simultaneous data acquisition system. Conventional techniques were used to determine the boundary-layer instability and transition characteristics while the flow separation and the stagnation points were determined through the presence of phase reversal signatures. Author

A93-14327* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
IN-FLIGHT SURFACE-FLOW MEASUREMENTS ON A SUBSONIC TRANSPORT HIGH-LIFT FLAP SYSTEM
LONG P. YIP (NASA, Langley Research Center, Hampton, VA), PAUL M. H. W. VIJGEN (High Technology Corp., Hampton, VA), and JAY D. HARDIN (North Carolina State Univ., Raleigh) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1392-1406. refs
(Contract NAS1-18240; NAS1-19299)
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As part of a multiphased program for subsonic transport high-lift flight research, flight tests were conducted on the Transport Systems Research Vehicle (B737-100 aircraft) at the NASA Langley Research Center, to obtain detailed flow characteristics of the high-lift flap system for correlation with computational and wind-tunnel investigations. Pressure distributions, skin friction, and flow-visualization measurements were made on a triple-slotted flap system for a range of flap deflections, chord Reynolds numbers (10 to 21 million), and Mach numbers (0.16 to 0.36). Experimental test results are given for representative flap settings indicating flow separation on the fore-flap element for the largest flap deflection. Comparisons of the in-flight flow measurements were made with predictions from available viscous multielement computational methods modified with simple-sweep theory. Computational results overpredicted the experimentally measured pressures, particularly in the case involving separation of the fore lap, indicating the need for better modeling of confluent boundary layers and three-dimensional sweep effects. Author

A93-15040
CONTROL OF THE PILOT-SYSTEM INTERFACE [LA MAITRISE DE L'INTERFACE PILOTE-SYSTEME]
DANIEL LEROUGE (Dassault Aviation, Saint-Cloud, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 144 1990 p. 4, 5, 8-12. In French.
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A review is presented of advanced working techniques using relevant methods in the fields of testing and simulation to enhance pilot-system optimization coupled with cost control. Attention is given to collimated displays, flat screens, helmet mounted displays, voice processing, and large onboard data bases. The goal is to optimize the pilot's role in the entire system with a better efficiency/cost ratio. R.E.P.

A93-15043
METHODOLOGY IN THE DEVELOPMENT OF AVIONICS [METHODOLOGIE DANS LE DEVELOPPEMENT DE L'AVIONIQUE]

ALAIN COUPIER (Toulouse, Centre d'Essais Aeronautique; Ecole Nationale Superieure d'Ingenieurs de Constructions Aeronautiques, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 144 1990 p. 25-29. In French.
Copyright

This paper reviews the principal standards used throughout the French avionics industry. A product-oriented approach is utilized which aims at estimating quality by measuring inductive well-chosen values. Also a process-oriented approach is employed which aims at obtaining a commitment toward using suitable techniques and tools to obtain the right product at the first attempt. R.E.P.

A93-15047
ONBOARD MAINTENANCE MONITORING SYSTEMS IN MODERN AIRCRAFT [LES SYSTEMES D'AIDE A LA MAINTENANCE, EMBARQUES SUR LES AVIONS MODERNES]
CLAUDE JOUVENOT (Societe de Fabrication d'Instruments de Mesure, Massy, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 144 1990 p. 47-49. In French.
Copyright

A review is presented of airplane condition monitoring systems (ACMS) that acquire the mandatory data sent to the onboard flight data recorder and the processing of the data to provide the ground crew with maintenance data before or after the aircraft has landed. Flight phases are determined automatically by the ACMS and data are processed according to each flight phase.
R.E.P.

A93-15048
THE STATIC-MEMORY CRASH RECORDERS [LES ENREGISTREURS D'ACCIDENT A MEMOIRE STATIQUE]
JACQUES-ETIENNE PREVOST (Dassault Electronique, Saint-Cloud, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 144 1990 p. 50, 51. In French.
Copyright

The advanced development of semiconductor memory technology has allowed current production of reliable, completely static recorders with an enhanced availability factor, and ease of operation. The principal characteristics of static-memory recorders are presented. R.E.P.

A93-17095
FAST-RESPONSE AIRCRAFT TEMPERATURE SENSORS
CARL A. FRIEHE and DJAMAL KHELIF (California Univ., Irvine) Journal of Atmospheric and Oceanic Technology (ISSN 0739-0572) vol. 9, no. 6 Dec. 1992 p. 784-795. Research supported by U.S. Navy and NSF refs
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Three aircraft temperature sensors were compared in clear-air conditions on the NCAR King Air: a standard Rosemount nondeiced, fast-response flight test probe, the NCAR K probe, and a modified Rosemount probe with the platinum wire element replaced with a small thermistor bead. Responses to transient temperature changes were compared from soundings through sharp inversions. High-frequency spectral comparisons were obtained from level runs in the marine boundary layer. All three probes followed a two-time-constant response. The response of the thermistor-modified Rosemount probe was, however, much closer to a one-time-constant model than the two others. Following previous results and analyses, it appears that the longer time constant in the Rosemount probe is largely due to the contact of the platinum wire element, which is wound around mica supports. The long unsupported wire elements in the NCAR K probe do produce a superior high-frequency response, but low-frequency response is anomalous, perhaps due to the large plastic body placed upstream of the wires to separate out particles. The two-time-constant temperature response was compared for the three probes by developing expressions for the time derivative and time integral of the normalized temperature that separated the relative contributions of the sensor element and its support.
Author

N93-15152# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Inst. fuer Flugfuehrung.
PROCEEDINGS OF THE 16TH SYMPOSIUM ON AIRCRAFT INTEGRATED MONITORING SYSTEMS [BEITRAEGE ZUM 16TH SYMPOSIUM BORDINTEGRIERTE UEBERWACHUNGSSYSTEME]
Jan. 1992 644 p Symposium held in Munich, Germany, 17-19 Sep. 1991
(ISSN 0176-7739)
(DLR-MITT-92-01; ETN-92-92162) Avail: CASI HC A99/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

Reports on latest results achieved worldwide in Aircraft Integrated Monitoring Systems (AIMS) are presented. AIMS are utilized for many applications, such as aircaft performance monitoring, flight recording, pilot aircraft interaction, early fault detection in engine, airframe, and avionics, maintenance, improvement of aircraft operation, accident investigation, development of future requirements for design and operation of aircraft. Reports are presented under the following headings: AIMS developments, developments in recorders and read out, propulsion system monitoring techniques, helicopter health and usage monitoring, advanced monitoring tools, related systems, and techniques.
ESA

N93-15153# Japan Air Lines Co. Ltd., Tokyo.
DISCUSSION FOR THE IDEAL AIMS [BETRACHTUNGEN ZUM THEMA EINES IDEALEN AIMS]
F. NAGAMATSU *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 19-36 Jan. 1992 Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

Past experience with Aircraft Integrated Monitoring System (AIMS) is considered and its uses discussed: flight operations, aircraft maintenance, performance monitoring, ground proximity warning analysis, and engineering analysis. The present and future role of AIMS is discussed. More than 10 years ago, the AIMS was the only data system onboard the aircraft. But because of system integration and emergence of the other data systems on the newest aircraft models, the situation has changed. The question of whether AIMS can stay in the same position as it has been is considered. The need to review what is being done in the project of AIMS, and to find out what is involved in an ideal AIMS is discussed.
ESA

N93-15154# Deutsche Airbus G.m.b.H., Munich (Germany).
SOFTWARE FLEXIBILITY AND CONFIGURATION CONTROL FOR THE A340/A330 AIRCRAFT CONDITION MONITORING SYSTEM (ACMS) [FLEXIBLE SOFTWARE UND DEREN KONFIGURATIONSKONTROLLE FUER DAS ZUSTANDSUEBERWACHUNGSSYSTEM (ACMS) FUER DIE FLUGZEUGTYPEN A340/A330]
HELMUT KALBE *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 37-56 Jan. 1992 Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

The necessity of ACMS software changes onboard the aircraft are demonstrated. Problems with a flexible software and configuration control are discussed and a solution is presented. It is concluded that since the software is on the aircraft and the compatibility check includes the complete aircraft and airline ident, it is possible to have partially different functions in each aircraft of a fleet with always the same hardware. It is also possible to exchange data management units between customers with different ACMS functions as long as the same hardware configuration is used. This could be a way to reduce the effort for spare parts if appropriate cooperation between customers is established. All together it can be stated that the A340/A330 ACMS is a very flexible system which is open for customer modifications without moving around expensive hardware units. All programming work can be done in the personal computer based Ground Support Equipment (GSE) outside the aircraft. This means no hold up for

aircraft in service for programming new monitoring tasks. The GSE enables also a comprehensive documentation of all modifications. Although the ACMS provides a high flexibility for reconfiguration the configuration control in and outside the aircraft will not be lost if the software part numbers are treated carefully. ESA

N93-15155# Teledyne Controls, Los Angeles, CA.
THE TELEDYNE CONTROLS AIRCRAFT CONDITION MONITORING SYSTEM [DAS ACMS-SYSTEM DER TELEDYNE CONTROLS]
A. UYTHOVEN *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 57-68 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

An Aircraft Condition Monitoring System (ACMS) that is fully reprogrammable by airlines is considered. Salient features of the avionics and its associated ground support equipment are described. The system, which is now in operation with several airlines, provides airlines with a flexibility, which up until now was thought impossible. A number of benefits, which airlines using this system have realized, include improved operation, promotion of flight safety, extended warranties on engines, and more effective trouble shooting. ESA

N93-15156# Scandinavian Airlines System, Stockholm (Sweden).
FLIGHT DATA AND FLIGHT SAFETY IN SAS [FLUGDATEN UND FLUGSICHERHEIT BEI SAS]
MADS H. BRANDT *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 69-85 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

The use of flight data as a tool for enhancement of flight safety and for internal audit, as well as for effective and timely maintenance is becoming part of our daily lives. It is no longer a question of whether to invest in airborne aircraft condition monitoring systems hardware or not. The question is rather how to make best use of the enormous amount of data collected during flight every second. The use of flight data has already proven itself as being cost effective for maintenance and flight operation. The SAS (Scandinavian Airline System) flight analysis and monitoring system, FLIDRAS, is considered and the following questions addressed: how should raw data be retrieved?; how should reports triggered by data management units software be retrieved?; and where and when should this be done? ESA

N93-15157# Sundstrand Data Control, Inc., Redmond, WA.
FDAMS: AN EXTENDABLE AND RECONFIGURABLE SOLUTION FOR AVIONICS DATA MANAGEMENT SYSTEMS [FDAMS: EINE ERWEITERBARE LOESUNG FUER AVIONIKDATEN-VERARBEITUNGSSYSTEME]
STEPHEN B. WILMOT *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 87-114 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

The evolution of Aircraft Integrated Monitoring Systems (AIMS) has resulted in continued growth of monitoring and collecting aircraft information. It has become apparent that the users of AIMS require that the system be easily reconfigurable and extendable. A Flight Data Acquisition and Management System (FDAMS) is described. This was designed to satisfy the needs for information monitoring and storage requirements onboard modern aircraft, using a system which is both extendable and reconfigurable. ESA

N93-15159# Technical Univ. of Budapest (Hungary).
DETECTION OF TECHNICAL STATES WITH AIRCRAFT [ERMITTLUNG DES BETRIEBSZUSTANDES VON FLUGZEUGEN]
J. ROHACS *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 129-147 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

Experience gained in connection with the development of the onboard state monitoring and diagnostic systems for the technical systems with nonconstant parameters in aircraft is outlined. It is concluded that the technical conditions of aircraft can be detected through the deviations in their system parameters. The onboard integrated condition and failure detection systems can be designed for the detection of five states representing the real technical conditions (changing from the normal operation conditions to the operation with failure producing the accidents) and giving the more effective information for pilots. The information of technical state to the pilot is given if the system has identified a definite deviation from normal condition. ESA

N93-15161# National Aeronautical Lab., Bangalore (India).
INDIAN EXPERIENCE IN FLIGHT DATA READOUT AND ANALYSIS [INDISCHE ERFAHRUNGEN BEI DER FLUGDATEN-WWIEDERGABE UND -ANALYSE]
B. S. ADIGA, S. J. MURALIDHAR, and S. NAGABHUSHANA *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 169-183 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

The Digital Flight Data Recorder (DFDR) readout facility developed to read and analyze the raw digital from Lockheed Model 209F DFDR and other recorders is described. Three system configurations are considered: the first makes use of, as front end, the Lockheed FRIAR unit and a PDP-11 computer; the second uses direct memory access mode to directly transfer the raw data from the DFDR to the PDP-11; and the third unit is a stand-alone IBM compatible personal computer based DFDR readout system. Software was developed for channel selection, conversion to engineering units, time search, and graphic presentation. ESA

N93-15162# *Ceskoslovenska Akademie Ved, Prague.* Aeronautical Research and Test Inst.
CZECHOSLOVAK DEVELOPMENT AND EXPERIENCE IN FLIGHT DATA RECORDER READOUT AND ANALYSIS [ENTWICKLUNG UND ERFAHRUNGEN BEI DER FLUGSCHREIBERDATENAUS-LESUNG UND -AUSWERTUNG IN DER TSCHECHOSLOWAKEI]
J. KOZAK *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 185-200 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

The development of an Automatic Test Mobile Equipment (AIME) intended for ground based performance testing of the jet trainer L 39 is addressed. The first step in development and production of ATE in Czechoslovakia was followed by a test and diagnostic system which is now being used for the L 39 MS jet trainer and for L 610 commuter aircraft. The onboard part of the system, the Digital Flight Data Recorder (DFDR) for combined accident and operational use, electronic unit and data entry panel, is intended for permanent record of maximum 200 parameters with the sampling rate 0.125 to 8 Hz. The ground evaluation equipment is personal computer based and equipped with programs for analysis from different points of view. Results of these developments together with other application examples and the future introduction of solid state memory are described. ESA

N93-15165# Aviatronic Ltd., Budapest (Hungary).
THE SIROM FLIGHT DATA RECORDER AND EVALUATION SYSTEM [DAS SYSTEM SIROM ZUR FLUGDATENERFASSUNG UND -AUSWERTUNG]
P. GIESE *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 237-249 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wessenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

The SIROM solid state onboard data recorder for the acquisition of flight data and engine parameters is described. The SIROM replaces the optomechanical recorder of the type SARP12 used on MIG fighters and MI helicopters. The data memory unit has

crash recorder quality. The ground based IBM personal computer compatible system performs automatic evaluation and has high resolution graphic and instrument panel displaying facilities. A modified variant of SIROM for the recording of the pilot's physiological parameters is discussed. ESA

N93-15166# Central Research Inst. for Physics, Budapest (Hungary).
DAR-2: ON-BOARD DATA ACQUISITION SYSTEM FOR AIRCRAFT ENGINES [DAR-2 - EIN BORDGESTUETZTES DATERNERFASSUNGSSYSTEM FUER FLUGTRIEBWERKE]
ISTVAN APATHY, ISTVAN SZEMEREY, SANDOR SZENDRO, and JANOS FARKAS (Hungarian Airlines, Budapest.) *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 251-266 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

Details of the DAR-2 onboard data acquisition system for aircraft engines developed on Tupolyev TU-154 airliners are given. DAR-2, a reduced activity computer installed onboard the aircraft, collects and stores parameters describing the state of aircraft engines and ensures their processing by the airline ground processing center. As DAR-2 is based on the present service system, there is no need to invent new signal detectors. With only minor modifications it can be used on other aircraft types. ESA

N93-15169*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
REAL-TIME IN-FLIGHT ENGINE PERFORMANCE AND HEALTH MONITORING TECHNIQUES FOR FLIGHT RESEARCH APPLICATION [IN ECHTZEIT ARBEITENDE, BORDGESTUETZTE TRIEBWERKSLEISTUNGS- UND -ZUSTANDSUEBERWACHUNGSTECHNIKEN FUER ANWENDUNGEN IN DER FLUGFORSCHUNG]
RONALD J. RAY, JOHN W. HICKS, and KEITH D. WICHMAN *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 311-340 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

Various engine related performance and health monitoring techniques developed in support of flight research are described. Techniques used during flight to enhance safety and to increase flight test productivity are summarized. A description of the NASA range facility is given along with a discussion of the flight data processing. Examples of data processed and the flight data displays are shown. A discussion of current trends and future capabilities is also included. ESA

N93-15177# Motoren- und Turbinen-Union Muenchen G.m.b.H. (Germany).
MODELLING THE ENGINE TEMPERATURE DISTRIBUTION BETWEEN SHUT DOWN AND RESTART FOR LIFE USAGE MONITORING [MODELLIERUNG DER TEMPERATURVERTEILUNG IM TRIEBWERK ZWISCHEN ABSCHALTEN UND NEUSTART FUER DIE LEBENSDAUERUEBERWACHUNG]
G. DHONDT and W. MOEHRES *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 493-498 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

The total life consumption during a flight depends on the initial temperature distribution in the engine. This definitely applies to helicopter systems, which often restart after a very short cooling time. An algorithm was developed to model these temperatures as a function of the temperature distribution at shutdown of the previous flight and the time elapsed. It is based on the same mathematical equations as the inflight temperature calculation and satisfies the severe constraints due to processor speed and storage size. Furthermore parts of the algorithm can be used to calculate the temperature at shutdown peaks. Examples show that the damage assessment can be significantly improved by using the modeled temperature distribution instead of ambient temperature, and by incorporating shutdown peaks. ESA

N93-15178# Teledyne Controls, Los Angeles, CA.
HELICOPTER FLIGHT DATA RECORDER AND HEALTH AND USAGE MONITORING SYSTEM [FLUGDATENAUFZEICHNUNGS- SOWIE ZUSTANDS- UND NUTZUNGSUEBERWACHUNGSSYTEM (FDR/HUMS) FUER HUBSCHRAUBER]
JAMES E. LAND and GRAHAME DANIELS (British International Helicopters Ltd., Oxford, England) *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 499-518 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

In response to evolving user and regulatory requirements for improved helicopter monitoring, FDR/HUMS (Flight Data Recorder/Health and Usage Monitoring Systems) are now being installed on medium and large helicopters, starting with those which operate in the North Sea from bases in the United Kingdom and Europe. A summary of the technical requirements of these systems and the details of a particular implementation are presented. An overview of the regulatory and user requirements, the technical features of the avionics kit and ground systems as well as the operational features of the system is given. A summary of the system functions is presented. The details of the onboard processing approach in multiple, high speed digital processors are given. ESA

N93-15179# Stewart Hughes Ltd., Eastleigh (England).
HELICOPTER HEALTH MONITORING: CURRENT PRACTICE AND FUTURE TRENDS [ZUSTANDSUEBERWACHUNG BEI HUBSCHRAUBERN - DERZEITIGER EINSATZ UND ZUKUENFTIGE ENTWICKLUNGEN]
R. M. STEWART *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 519-538 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

The safety record of large passenger carrying helicopters and the way in which the United Kingdom Civil Aviation Authority is pressing owners of aircraft on its register to improve this, both in the medium and long term, are reviewed. Some of the theoretical weight penalties involved in achieving the new safety targets through both safe life and fail safe design practices are considered. Some of the design methodologies used to design the health and usage monitoring systems now being fitted to North Sea operating aircraft to improve safety through better monitoring of the aircraft's dynamic parts are reviewed. ESA

N93-15180# Vibro-Meter S.A., Fribourg (Switzerland).
NEW ROTOR TRIM AND BALANCE SYSTEM FOR HELICOPTER USAGE MONITORING [NEUARTIGES TRIMM- UND AUSWUCHTSYSTEM FUER DIE BETRIEBSUEBERWACHUNG VON HUBSCHRAUBERN]
T. A. STAUB and C. S. VENTRES (Technology International Corp., Bedford, MA.) *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 539-556 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

Conventional rotor trim and balance methods rely to some extent on the optical alignment of the blade tips. ROTABS (trademark for Rotor Trim and Balance System), a unique system that tackles the problem at its source by making a multiplane analysis of the airframe vibration characteristics using accelerometers, is described. The system is based on the philosophy that the rotor set up that produces the least vibration will be the best possible combination for performance, comfort and reduced structural fatigue. Vibration levels were significantly reduced from the levels previously achieved by helicopter operators and manufacturers in U.S. and Europe using conventional systems. Future developments are considered. ESA

N93-15182# Technische Univ., Brunswick (Germany). Inst. fuer Flugfuehrung.
SENSOR FAULT DETECTION USING NONLINEAR OBSERVER AND POLYNOMIAL CLASSIFIER [SENSORFEHLERERKENNUNG MIT NICHTLINEAREM BEOBACHTER UND POLYNOMKLASSIFIKATOR]
R. BROCKHAUS and J. J. BUCHHOLZ (Deutsche *Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany*) *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 567-584 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

A sensor fault detection algorithm for the supervision of the aerodynamic states of an aircraft (airspeed, angle of attack and angle of sideslip) is presented. It consists of a Luenberger observer containing a three degree of freedom, nonlinear model of aircraft motion, and the implementation of a polynomial classifier on a transputer network. Results of state estimation and fault detection from flight measurements with a Dornier 128 research aircraft are presented, that prove the applicability of these methods as well as their limitations. ESA

N93-15235# Charles River Analytics, Inc., Cambridge, MA.
DESIGN FOR TACTICAL SITUATION AWARENESS DISPLAY Final Report
GREG L. ZACHARIAS and PAUL G. GONSALVES 15 Jun. 1992 93 p
(Contract DAAA15-90-C-0019)
(AD-A256194; R89351) Avail: CASI HC A05/MF A01

Because of continuing advances in on-board sensors, computers, and displays, we can expect to see significant growth in the amount of information presented to rotorcraft crews by next-generation tactical situation displays. If unchecked, this growth will easily exceed the crew's capability for dealing with the available on-board information base in a timely and effective fashion. A range of technologies are now being proposed to provide appropriate levels of information management and situation awareness, ranging from hardware upgrades like touch screen displays, to advanced computing horsepower to support multi-sensor data fusion, to new AI technologies including expert systems like Pilot's Associate. The problem, however, is not that there is a dearth of candidate technologies; rather it is that we have no reliable means for evaluating them in terms of the fundamental situation awareness they afford the crew. What is called for is an objective metric for evaluating the awareness level provided a crew by a new cockpit technology, and a rational means for using this metric in a structured methodology involving: (1) identification of mission-specific tactical informational requirements; (2) generation of candidate display formats and symbologies; and (3) metric-based evaluation of afforded situation awareness. GRA

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.

A93-14077* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NUMERICAL SIMULATION OF A LOW-EMISSION GAS TURBINE COMBUSTOR USING KIVA-II
S. L. YANG, R. CHEN (Michigan Technological Univ., Houghton), M. C. CLINE (Los Alamos National Lab., NM), H. L. NGUYEN (NASA, Lewis Research Center, Cleveland, OH), and G. J. MICKLOW (Florida Univ., Gainesville) International Journal for Numerical Methods in Fluids (ISSN 0271-2091) vol. 15, no. 8 Oct. 30, 1992 p. 865-881. refs
(Contract NAG3-1109; NAG3-1113; NASA ORDER C-30050-R)
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A modified version of the KIVA-II code was used to obtain a multidimensional numerical solution for the turbulent two-phase chemically reacting flows inside a staged turbine combustor (STC). The STC under consideration is equipped with an advanced airblast fuel nozzle and encompasses a fuel nozzle (FN), a rich-burn (RB) zone, a converging connecting pipe, a quick-quench (QQ) zone, a diverging connecting pipe, and a lean-combustion (LC) zone. The STC was divided into two subsystems, namely, FN/RB zone and QQ/LC zones, and the numerical solutions were obtained separately for each subsystem. Preliminary data characterize the major features of the flow and temperature fields inside the STC. Information on velocity, temperature, and some critical species in the FN/RB zone is presented. In the QQ/LC zones, formation of the co- and counter-rotating bulk flow and the sandwiched-ring-shaped temperature field can be clearly seen. The calculations of the mass-weighted standard deviation and the pattern factor of temperature indicated that the mixing performance of the STC is very promising. O.G.

A93-14153
ADVANCEMENTS IN AIRCRAFT GAS TURBINE ENGINES - PAST AND FUTURE
W. L. WEBB (Pratt & Whitney Group, East Hartford, CT) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. XLII-LIII.
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An overview is presented of gas-turbine engines for commercial applications with attention given to key technological advances. From descriptions of the first commercial engine and the emergence of the high-bypass-ratio engines of the 1960s, the paper chronicles the evolution of gas-turbine engine cycles. Improvements in the core engine are detailed that led to improved aerodynamic configurations, thrust, and efficiency. Progress in emissions reductions including NO(x) emissions and noise reductions are shown to be significant. Engine cycle, fan bypass ratio, turbine temperature, and aerodynamics are argued to be the key areas that led to the seat mile efficiency caused by reductions in fuel consumption. Also reviewed are developments in engine systems and engine technologies that lead to reduced weight, cost, and noise while enhancing performance in terms of thrust, safety, and reliability. C.C.S.

A93-14176
VIBRATION MONITORING AND FAULT DIAGNOSIS OF INFLIGHT AIRCRAFT ENGINES
J. YI (Beijing Aeronautical Technology Research Center, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 147-150. refs
Copyright

A revised version of the Airborne Vibration Monitoring (AVM) system is presented including results of analyses of the vibration signals from fifteen healthy or faulty aircraft engines. The AVM system and diagnostics are based on a data-acquisition unit that collects vibrations from three channels, and sampled data are monitored and collected in partitioned RAM by means of quasi-DMA. Vibration monitoring and fault diagnosis are described, and the techniques are shown to be applicable to the detection of rotor imbalance and misalignment. The data show that broadband vibration signals can be collected and stored in flight and that an airborne microcomputer can process the signals for ground-based analysis. Frequency-spectrum analysis permits the monitoring of mechanical faults in the engine and structural elements from the collected data. C.C.S.

A93-14242
SUPERSONIC COMBUSTION AND GASDYNAMIC OF SCRAMJET
O. V. VOLOSHCHENKO, O. M. KOLESNIKOV, E. A.

MESHCHERIAKOV, V. N. OSTRAS', V. A. SABEL'NIKOV, and V. N. SERMANOV (TsAGI, Zhukovski, Russia) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 693-702. refs
Copyright

The paper investigates the mechanisms of the supersonic combustion in the following types of scramjet combustors: axisymmetric combustor with preliminary gasification of liquid kerosene in a gas generator; 2D hydrogen-fuelled combustor; and 2D stepwise combustor using liquid kerosene. The gas generator parameters at which the maximum combustion efficiency takes place are determined. The liquid kerosene ignition and combustion stabilization system with naturally disappearing obstacles at the exit of the chamber is investigated. Results of the numerical modeling of a set of supersonic hydrogen combustion problems are presented. The combustion of coflowing and tangential near-wall jets of hydrogen is considered via boundary layer equations and parabolized Navier-Stokes equations. The causes of the reduction of the heat release in the diverging channels are identified, and the dependence of the combustion efficiency and the flame length on the flight Mach number and the oxidizer-to-fuel equivalence ratio in the scramjet combustor is established. P.D.

A93-14243* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SCRAMJET COMBUSTOR AND NOZZLE COMPUTATIONS
PRADEEP S. KAMATH (Analytical Services and Materials, Inc., Hampton, VA) and CHARLES R. MCCLINTON (NASA, Langley Research Center, Hampton, VA) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 703-711. Sponsorship: . refs

The SHIP3D PNS code is used to conduct a 3D parametric study of a scramjet combustor and nozzle configuration at flight Mach numbers of 8, 10, 12, 16, and 20. The study demonstrated the powerful computational strategy of using a highly efficient, modified PNS code and a nonkinetic chemistry model to analyze test data and conduct parametric studies of scramjet combustors and nozzles. The mixing efficiency was found to decrease by 0.2 when the flight Mach number increased from 8 to 12 and showed little change at higher Mach numbers. The protruding ramp injector generated an oblique shock that impinged on the cowl. Ramp-slot injection produced better mixing, both because of the interaction of this shock with the slot fuel, and because of better fuel distribution in the duct. The former effect was enhanced when the ramp angle was increased. Mixing was also enhanced when the ramp fuel injection angle and sweep angle were increased. P.D.

A93-14244
COMBINED ENGINES FOR HYPERSONIC FLIGHT
M. M. TSKHOVREBOV and V. A. PALKIN (TsIAM, Moscow, Russia) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 712-721. refs
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Some types of combined (turboramjet and air-turborocket) engines are considered. Engine performance in different flight conditions are compared, and their features and parameters in different flight conditions are defined. Results are presented of investigations into the real operation and performance of the turboramjet engines conducted within the development program and test bench studies of several versions of full-scale turboramjet demonstrators. The performance at switching for various operation modes, at ramjet mode with cooling of the heat-stressed components, and the operation conditions of rotor supports are examined. P.D.

A93-14247
EXPERIMENTAL INVESTIGATION OF HYDROGEN BURNING AND HEAT TRANSFER IN ANNULAR DUCT AT SUPERSONIC VELOCITY
V. A. VINOGRADOV, R. V. ALBEGOV, and M. D. PETROV (TsIAM, Moscow, Russia) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 737-743. refs
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An experimental study of a model axisymmetric scramjet with an annular chamber is reported. Conditions of engine operation organization with supersonic velocity in the chamber are analyzed. When H2 is injected both through I and II and I and V rows of injectors the combustion efficiency varies from 0.7 at beta sub Sigma = 1 to 0.95-1 at beta sub Sigma of not greater than 0.5. When H2 is injected only through row V over the whole range of beta sub v = 0.33-0.9, there is no ignition of the fuel, as the dimensions of the flameholders are not sufficient for self-ignition under the conditions studied. The relative heat flux ratio into the walls at beta sub Sigma = 1 is 20-25 percent from the heat emitted as a result of combustion. P.D.

A93-14271
NUMERICAL SIMULATION OF TURBULENT REACTING FLOWS IN COMBUSTION CHAMBERS
X. S. BAI and L. FUCHS (Royal Inst. of Technology, Stockholm, Sweden) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 935-941. Research supported by STU refs
Copyright

The numerical computation of turbulent reacting flows in combustion chambers of a gas turbine engine are carried out. The Reynolds averaged Navier-Stokes equations and the two-equation k-epsilon model, together with either premixed flame or diffusion flame reaction models, are used. The numerical scheme employed here is finite-difference based, together with the multigrid method and local grid refinement technique. The mathematical models and numerical method are applied to simulating the main burners and afterburners of a gas turbine engine. Author

A93-14272
RECENT PROGRESS IN THE IMPLEMENTATION OF ACTIVE COMBUSTION CONTROL
KLAUS C. SCHADOW (U.S. Navy, Naval Air Warfare Center, China Lake, CA), ERIC W. HENDRICKS (U.S. Navy, Naval Command, Control and Ocean Surveillance Center, San Diego, CA), and ROBERT J. HANSEN (U.S. Navy, Office of Naval Research, Arlington, VA) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 942-952. refs
Copyright

Active combustion control has received increasing attention for the suppression of pressure oscillations and the extension of flammability limits in dump combustors and premixed combustors with flameholders. In order to accelerate progress in this emerging area, a research program was initiated to improve the physical understanding of combustion dynamics, develop new actuators, and explore new control strategies. This paper describes progress made in the program. The role of shear-flow dynamics in combustion control through experiments and numerical large-eddy simulation has been clarified. New actuators to manipulate the shear layer and increase acoustic level by utilizing periodic chemical energy release have been demonstrated. New control strategies based on neural network, adaptive filter, and modern control synthesis procedures have been implemented. Author

A93-14273
A NUMERICAL STUDY OF SLIT V-GUTTER FLOWS
Y. M. TSUEI (Chung-Shan Inst. of Science and Technology, Longtan, Taiwan) and D. LEE (National Cheng Kung Univ., Tainan, Taiwan) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 953-960. refs
Copyright

A numerical investigation is conducted for both reacting and nonreacting flowfields of a slit V-gutter, whose flow pattern is

noted to differ substantially from that of the conventional V-gutter. Of the two recirculation bubbles formed for a small slit height, the smaller is anchored behind the inner gutter, and a larger one follows. As slit height increases, the smaller bubble grows and the larger one shrinks; eventually, the bubbles merge to form a single recirculation zone whose length is a function of the magnitude and the angle of the slit velocity. Higher recirculation zone energy content is obtained than with conventional V gutters. O.C.

A93-14481
ELIMINATION OF OVERTEMPERATURE IN TURBOJET
YI SHANG, BAOAN ZHANG, and XIAOXING CHEN (Nanjing Aeronautical Inst., China) Journal of Aerospace Power (ISSN 1000-8055) vol. 7, no. 4 Oct. 1992 p. 317, 318. In Chinese.

This paper analyzes the reasons of overheating in a turbojet and provides the available measures to eliminate it, such as the strict requirements for the engine overhaul at the repair factory and the reasonable engine adjustment in the field maintenance. It is essential for the field maintenance to adjust properly the relationship between the turbine pressure ratio and the exhaust nozzle area, so that the turbine gas temperature comes down without afterburning temperature drop. In this way, the influence of the above problem on the operational performance of the engine can be minimized on condition that the engine reliability is guaranteed. Author

A93-14494
PREDICTION OF THE RADIATION CHARACTERISTIC OF A HELICOPTER EXHAUST JET
JIANXING ZHAO and LIGUO LI (Air Force College of Engineering, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 7, no. 4 Oct. 1992 p. 371-374. In Chinese. refs

A numerical analysis has been completed for 3D turbulent free flame jet from an elliptical jet pipe of a helicopter. A six-flux model was applied to the calculation of radiation fluxes and temperature distributions. The k-epsilon turbulence model was also employed due to its simplicity and computational economy. The SIMPLE algorithm and the formulation of the CTDMA on the assumption of cyclically repeating boundary conditions were used to solve the finite-difference equations. Since the partial differential equations feature parabolic-type, solutions may be obtained by means of marching integration. Predictions of the exhaust gas temperature, velocity, composition, and radiation of marching integration. Predictions of the exhaust gas temperature, velocity, composition, and radiation flux are presented, and show a good agreement of numerical solution with experimental data. Author

A93-14496
ESTIMATION OF MAXIMAL LOCAL TEMPERATURE AT EXIT OF ANNULAR COMBUSTOR
SHIYI PENG (Nanhua Power Plant Research Inst., China) Journal of Aerospace Power (ISSN 1000-8055) vol. 7, no. 4 Oct. 1992 p. 378-380. In Chinese. refs

Four kinds of annular reverse-flow combustors have been investigated experimentally, which differ in construction, techniques of air inlet, the type and number of fuel injecters swirler, the blending orifices in the burner liner, and small orificies in the burner head. The temperature profiles and the maximal local temperature at the exit of the combusters have been measured, and the accumulative distributions curves of the exit temperature profiles have been obtained. Comparing the accumulative distribution curves with the curves of the Rosin-Rammler equation, it is found that the maximal exit temperature can be estimated proportional to the averaged exit temperature multiplied by a factor with exponent N. The value of the exponent N can be obtained from the accumulative distribution curves. Author

A93-14497
HYBRID REAL-TIME SIMULATION OF A TWO-ROTOR ENGINE
WEIDOU NI and SHAUYIN LIU (Tsinghua Univ., Beijing, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 7, no. 4 Oct. 1992 p. 381-384. In Chinese. refs

A new simulation method is proposed for the simulation of a two-rotor aircraft engine on small hybrid simulation system IBMPC-DJM310A. The real-time simulation is described. The key to the real-time simulation is the pretreatment of the mathematical model. The mathematical model of the engine is divided into three parts, A, B, and C. Part A includes the characteristics of the components and equations of parameters linkage and is independent from the time; part B is the integration of high-pressure rotor speed differential equation; and part C is the integration of the low-pressure rotor speed differential equation. According to local similarity theory, the five-dimensional data group, which determines the performance of the engine, is decomposed into three-, two-, and one-dimensional data groups. Thus, the calculation process is greatly simplified and the real-time simulation is realized. The simulation results agree with the experimental data satisfactorily. Author

A93-14498
APPLICATION OF MODEL REFERENCE ADAPTIVE CONTROL TO SPEED CONTROL SYSTEM IN AN AEROENGINE
WANNONG CHEN, LINGQUING XUN, and CHIHUA WU (Northwestern Polytechnical Univ., Xian, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 7, no. 4 Oct. 1992 p. 385-388. In Chinese.

The model reference adaptive control is researched for the speed control system in an aeroengine. Popov's superstability theory is chosen as the design method, and the adjustable parameters of the adaptive rule for this system are determined. The reference model of this system is given according to the requirements of the aeroengine performance. Then, the control calculation and the structure of the model reference adaptive control system are obtained. We carried out the digital and semiphysical simulations for this control system. The results of these simulations show that this control system has great adaptability. It can control the process of narrow operation and various accelerations of the aeroengine satisfactorily. Author

A93-14499
A MINIMUM-TIME ACCELERATION CONTROL STRATEGY FOR A TWO-ROTOR AEROENGINE
WEIDOU NI and SHAUYIN LIU (Tsinghua Univ., Beijing, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 7, no. 4 Oct. 1992 p. 389, 390. In Chinese.

A new acceleration control strategy for a two-rotor aeroengine is proposed, which is feedforward-PID control. The fuel flow rate during acceleration is determined by a three-dimensional data table stored in the computer. The simulation results have shown that this control strategy can ensure smooth and fast transients which are much better than the transients obtained from ordinary mechanical-hydraulic control system. Author

A93-14516
CONFINED JET THRUST VECTOR CONTROL NOZZLE STUDIES
J. H. FRIDDELL and M. E. FRANKE (USAF, Inst. of Technology, Wright-Patterson AFB, OH) Journal of Propulsion and Power (ISSN 0748-4658) vol. 8, no. 6 Nov.-Dec. 1992 p. 1239-1244. Previously cited in issue 17, p. 2651, Accession no. A90-40598 refs

A93-14519
GENERIC DEVELOPMENTAL TURBOJET FUEL CONTROL
J. S. LILLEY (U.S. Army, Missile Command, Redstone Arsenal, AL), S. L. PENGELLY, and P. FISHER (Boeing Defense & Space Group, Huntsville, AL) Journal of Propulsion and Power (ISSN 0748-4658) vol. 8, no. 6 Nov.-Dec. 1992 p. 1258-1265. Previously cited in issue 18, p. 3069, Accession no. A91-44329 refs

A93-14525
COMMENT ON 'EXPERIMENTAL STUDY ON AUTOIGNITION IN A SCRAMJET COMBUSTOR'
F. SUTTROP (Aachen, Fachhochschule, Germany) Journal of

Propulsion and Power (ISSN 0748-4658) vol. 8, no. 6 Nov.-Dec. 1992 p. 1300-1302. refs

If as Sato et al. (1991) stated, test air is preheated by internal combustion to 2500 K and rapidly expanded in the supersonic test section of a scramjet, measured autoignition characteristics may be wrong by 1-2 orders of magnitude. In a flying scramjet, however, conditions are of dry air at low static pressure that is captured by an engine inlet diffuser and compressed to burner entry conditions. Calculation results are presented which show that safe autoignition of hydrogen under ramjet conditions may be expected above Mach 5, especially in burner-inlet Mach-number conditions of 1.8-2.2. O.C.

A93-14608
ROBUST FAULT DETECTION OF JET ENGINE SENSOR SYSTEMS USING EIGENSTRUCTURE ASSIGNMENT

R. J. PATTON and J. CHEN (York Univ., United Kingdom) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090) vol. 15, no. 6 Nov.-Dec. 1992 p. 1491-1497. Previously cited in issue 21, p. 3596, Accession no. A91-49742 Research supported by Lucas Aerospace, PLC and Royal Aerospace Establishment refs (Contract SERC-GR/G/2586/3)

A93-14624* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CONCURRENT PROCESSING ADAPTATION OF AEROELASTIC ANALYSIS OF PROPFANS

D. V. MURTHY and D. C. JANETZKE (NASA, Lewis Research Center, Cleveland, OH) Computers & Structures (ISSN 0045-7949) vol. 45, no. 2 Oct. 3, 1992 p. 397-404. Previously announced in STAR as N90-14656 refs

Discussed here is a study involving the adaptation of an advanced aeroelastic analysis program to run concurrently on a shared memory multiple processor computer. The program uses a three-dimensional compressible unsteady aerodynamic model and blade normal modes to calculate aeroelastic stability and response of propfan blades. The identification of the computational parallelism within the sequential code and the scheduling of the concurrent subtasks to minimize processor idle time are discussed. Processor idle time in the calculation of the unsteady aerodynamic coefficients was reduced by the simple strategy of appropriately ordering the computations. Speedup and efficiency results are presented for the calculation of the matched flutter point of an experimental propfan model. The results show that efficiencies above 70 percent can be obtained using the present implementation with 7 processors. The parallel computational strategy described here is also applicable to other aeroelastic analysis procedures based on panel methods. Author

A93-14626
PHILOSOPHICAL APPROACH TO THE BASIC UNDERSTANDING OF THE MECHANICS OF JET PROPULSION

SHRIPAD P. MAHULIKAR (Indian Inst. of Technology, India) Apr. 1992 9 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992
(SAE PAPER 920960)

Consideration is given to the philosophy which lies behind the practical application of airbreathing and rocket engines. An attempt is made to understand the various practical manifestations of the philosophy of jet propulsion by viewing the engine as the frame of interest and not the fluid. Thrust and propulsive efficiency are defined and the practical manifestations of the philosophy are discussed. R.E.P.

A93-14629
THE INTEGRAL STARTER/GENERATOR DEVELOPMENT PROGRESS

ELKE RICHTER, R. E. ANDERSON (GE Aircraft Engines, Cincinnati, OH), and CLARENCE SEVERT (USAF, Wright Lab., Wright-Patterson AFB, OH) Apr. 1992 8 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992 refs (Contract F33615-90-C-2052)
(SAE PAPER 920967)

The work reported in this paper has been conducted by GE-Aircraft Engines as part of a contract sponsored by the USAF, Wright Laboratories, WPAFB, under Contract No. F33615-90-C-2052. The objective of this contract is to prove the feasibility of an Integral Starter-Generator (IS/G) through the preliminary design stage and demonstrate the starter/generator technology in the externally mounted version utilizing switched reluctance machine technology. This paper will report on the progress for the IS/G through the preliminary design stage. The key points of the electrical machine design, integration design, and impact on the engine dynamics will be discussed. The key message of the results obtained is, that the integration of such a machine into an existing engine is practical and that no new center-line engine design is necessary to bring this technology to flight demonstration. Author

A93-15042
THE CONTROL OF AIRCRAFT ENGINES IN THE 1990'S [LA REGULATION DES MOTEURS D'AVIONS DANS LES ANNEES 1990]

JOHN C. RICHARDS (GE Aircraft Engines, Cincinnati, OH) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 144 1990 p. 19, 21-24. In French.

An overview is presented of the evolution of aircraft engine controls to the present and the developments foreseen over the next decade. Engine controls have progressed from simple control loops to more sophisticated control additions with automatic control of turbomachinery clearances, starting and thrust reversing. Mechanization of engine controls by hydromechanical computation and control means has been superseded in new engines by digital electronic controls. R.E.P.

A93-15343
FEWEST-FAULT INTEGRAL OPTIMIZATION ALGORITHM FOR ENGINE FAULT DIAGNOSIS

ZUO-MIN FAN and ZHAO-FU LIN (Civil Aviation Inst. of China, Tianjin) Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 5, no. 3 Aug. 1992 p. 182-189. refs

An important method for jet engine fault diagnosis is based on solving the engine fault equation, which represents the linearized relationship between a limited set of measurements and a large set of possible but improbable malfunctions. The fault equation is usually underdetermined and some supplemental conditions are required for resolving it. The fewest-fault principle may be employed to solve the underdetermined equation. Two algorithms of constrained integral optimization based on the fewest-fault principle are presented. The introduction of the fewest-fault principle and constraints of physical reasonableness can improve both the definition and the reasonableness of the solution to the fault equation. A practical test of JT9D engine fault diagnosis was made. The proposed algorithm is very satisfactory. Author

A93-16234
EFFECTS OF VITIATED AIR ON THE RESULTS OF GROUND TESTS OF SCRAMJET COMBUSTOR

LING LIU, MING TANG, ZHENG ZHANG (Northwestern Polytechnic Univ., Xian, China), JINHUA LIU, YURENG WANG, and LIXING YANG (31st Research Inst., China) Journal of Propulsion Technology (ISSN 1001-4055) no. 5 Oct. 1992 p. 11-17, 33. In Chinese. refs

An investigation is conducted for the effects of both vitiated inlet air and moisture on the automatic ignition and combustion performance of a ground test rig-operated scramjet combustor. The test apparatus employed arc-heated inlet air in conjunction with the injection of water into the air stream, thereby simulating a hydrogen heater. It is established that model-test simulations must consider both the presence of moisture and the quantity of vitiated species. O.C.

A93-16235
AN EXPERIMENTAL INVESTIGATION ON THE COMBUSTOR WITH BYPASS FLOW IN INTEGRAL LIQUID FUEL RAMJET
XINYU QIU and BENQUAN GONG (31st Research Inst., China) Journal of Propulsion Technology (ISSN 1001-4055) no. 5 Oct. 1992 p. 18-24. In Chinese.

This paper presents a dump combustor which was designed based on research accomplishment. The velocity in the main dump section is reduced in the combustor while the main dump area ratio is not changed. A series of tests were conducted on a direct connected test bench with RP-1 common kerosene. The preliminary test result shows that the combustor can be reliably ignited under the condition of large nozzle throat, the combustion process is stable and combustion efficiency is high. Author

A93-16236
A NUMERICAL STUDY ON THE RADIATION CHARACTERISTIC OF AN ELLIPTICAL EXHAUST JET
JIANXING ZHAO and LIGUO LI (Nanjing Aeronautical Inst., China) Journal of Propulsion Technology (ISSN 1001-4055) no. 5 Oct. 1992 p. 25-33. In Chinese. refs

The radiation characteristics of an IR suppressor are presently studied numerically by means of a 3D turbulent free flame jet's elliptical exhaust model, with a view to exhaust temperature, velocity, and composition concentration distributions. A six-flux radiation model is employed whose radiative transfer equations are differential in form and thereby easily incorporated into existing computation schemes. The k-epsilon twin-equation turbulence model used is based on the Boussinesq effective viscosity hypothesis. O.C.

A93-16239
THE NUMERICAL CALCULATION OF AIRCRAFT PROPELLER NOISE
WEIYANG QIAO and WENLAN LI (Northwestern Polytechnical Univ., Xian, China) Journal of Propulsion Technology (ISSN 1001-4055) no. 5 Oct. 1992 p. 44-49. In Chinese. refs

A method for calculating the acoustic pressure of a propeller due to blade thickness and steady surface pressure loading (including the effect of forward motion) is presented in this paper. The blade tip speed is limited to subsonic. The formulation is based on the FW-H equation. The blade parameters and observer position are described in three coordinates. The retarded time equation is solved numerically by Newton's method. The surface integration is calculated by a cubic spline program. Noise frequency spectrum is analyzed by using a FFT program. Good agreement is found between theoretical and experimental results within both the time and frequency domains. Author

A93-16844
AN INVESTIGATION OF REAL-TIME DIAGNOSTIC TECHNIQUE ON AEROENGINE
ZIYUAN ZHAO, JIANGUO MAO, HUA YAO, and WEIYE LI Nanjing Aeronautical Institute, Journal (English Edition) vol. 9, no. 1 June 1992 p. 31-39. refs

The real-time diagnostic technique to estimate turbine engine performance and control system operation is presented. Three essential parts are considered: (1) establishing a hardware system, (2) a simplified engine mathematical model and real-time digital and physical simulation, and (3) the techniques of diagnosis and dynamic display. The hardware system is a full-authority two-channel digital electronic control with selected redundancy. R.E.P.

A93-16846
EFFECT OF BIRD IMPACT LOAD TYPES ON BLADE RESPONSE
JING YIN and DEPING GAO (Nanjing Aeronautical Inst., China) Nanjing Aeronautical Institute, Journal (English Edition) vol. 9, no. 1 June 1992 p. 48-53. Research supported by Aeronautical Scientific Foundation of China refs

The process of bird impacting on a blade is a complicated loading process. In order to simplify the process, so as to establish the bird impact load model simply and reasonably, it is necessary to analyze the effects of various factors for bird impact load on blade response. The effect of point load and evenly distributed load on the blade response is studied, and the response analyses are performed in both elastic and plastic states in this paper. The FEM is used to compute the nonlinear transient response of blades by simulating a real blade with a rectangular cantilever plate and simulating bird impact loads with shock loads. The conclusions obtained in this paper may provide a reference for selecting the bird impact load type. Author

A93-16852
PROPULSION OF A SUPERSONIC TRANSPORT: WHAT ARE THE CHALLENGES? II - ACHIEVEMENTS [LA PROPULSION D'UN AVION DE TRANSPORT SUPERSONIQUE: QUELS DEFIS? II - LA REALISATION]
JEAN CALMON L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 151 1991 p. 55-61. In French. refs
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This paper discusses the appropriate conditions for a successful design and development of the second generation supersonic transport engine. Various powerplant configurations evaluated by engine manufacturers verify that the variable cycle engine will materialize when the SST operations are more clearly defined and the optimal cruise Mach number is selected. R.E.P.

A93-16853
THE RAMJET ENGINE IN HIGH SPEED PROPULSION [LA PLACE DU STATOREACTEUR DANS LA PROPULSION A GRANDE VITESSE]
ROGER MARGUET and PHILIPPE POISSON-QUINTON (ONERA, Chatillon, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 153 1992 p. 8-12. In French.
Copyright

An overview is presented of various ramjets studied in France and their integration in propulsion systems as a function of the speed considered, ranging from Mach 2 to about Mach 12. Attention is given to different experimental and operational ramjets researched in combination with other propulsive engine types. Promising results for ramjets to be used in tactical missiles, HSTs, and transatmospheric vehicles for spacecraft are discussed. R.E.P.

N93-12695*# General Motors Corp., Indianapolis, IN. Gas Turbine Div.
INVESTIGATION OF ADVANCED COUNTERROTATION BLADE CONFIGURATION CONCEPTS FOR HIGH SPEED TURBOPROP SYSTEMS. TASK 4: ADVANCED FAN SECTION AERODYNAMIC ANALYSIS Final Report, Jul. 1991 - Jul. 1992
ANDREW J. CROOK and ROBERT A. DELANEY Nov. 1992 74 p Original contains color illustrations
(Contract NAS3-25270; RTOP 535-03-10)
(NASA-CR-187128; NAS 1.26:187128) Avail: CASI HC A04/MF A01; 3 functional color pages

The purpose of this study is the development of a three-dimensional Euler/Navier-Stokes flow analysis for fan section/engine geometries containing multiple blade rows and multiple spanwise flow splitters. An existing procedure developed by Dr. J. J. Adamczyk and associates and the NASA Lewis Research Center was modified to accept multiple spanwise splitter geometries and simulate engine core conditions. The procedure was also modified to allow coarse parallelization of the solution algorithm. This document is a final report outlining the development and techniques used in the procedure. The numerical solution is based upon a finite volume technique with a four stage Runge-Kutta time marching procedure. Numerical dissipation is used to gain solution stability but is reduced in viscous dominated flow regions. Local time stepping and implicit residual smoothing are used to increase the rate of convergence. Multiple blade row solutions are based upon the average-passage system of equations. The numerical solutions are performed on an H-type grid system, with meshes being generated by the system (TIGG3D) developed earlier under this contract. The grid generation scheme meets the

average-passage requirement of maintaining a common axisymmetric mesh for each blade row grid. The analysis was run on several geometry configurations ranging from one to five blade rows and from one to four radial flow splitters. Pure internal flow solutions were obtained as well as solutions with flow about the cowl/nacelle and various engine core flow conditions. The efficiency of the solution procedure was shown to be the same as the original analysis. Author

N93-13155*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
SUBSONIC FLIGHT TEST EVALUATION OF A PROPULSION SYSTEM PARAMETER ESTIMATION PROCESS FOR THE F100 ENGINE
JOHN S. ORME and GLENN B. GILYARD Nov. 1992 27 p Presented at the 28th AIAA/SAE/ASME/ASEE Joint Propulsion Conference, Nashville, TN, 6-8 Jul. 1992
(Contract RTOP 533-02-36)
(NASA-TM-4426; H-1809; NAS 1.15:4426; AIAA PAPER 92-3745)
Copyright Avail: CASI HC A03/MF A01

Integrated engine-airframe optimal control technology may significantly improve aircraft performance. This technology requires a reliable and accurate parameter estimator to predict unmeasured variables. To develop this technology base, NASA Dryden Flight Research Facility (Edwards, CA), McDonnell Aircraft Company (St. Louis, MO), and Pratt & Whitney (West Palm Beach, FL) have developed and flight-tested an adaptive performance seeking control system which optimizes the quasi-steady-state performance of the F-15 propulsion system. This paper presents flight and ground test evaluations of the propulsion system parameter estimation process used by the performance seeking control system. The estimator consists of a compact propulsion system model and an extended Kalman filter. The extended Laman filter estimates five engine component deviation parameters from measured inputs. The compact model uses measurements and Kalman-filter estimates as inputs to predict unmeasured propulsion parameters such as net propulsive force and fan stall margin. The ability to track trends and estimate absolute values of propulsion system parameters was demonstrated. For example, thrust stand results show a good correlation, especially in trends, between the performance seeking control estimated and measured thrust. Author

N93-13218# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Inst. fuer Entwurfsaerodynamik.
THE JET BEHAVIOUR OF AN ACTUAL HIGH-BYPASS ENGINE AS DETERMINED BY LDA-MEASUREMENTS IN GROUND TESTS
H. HOHEISEL, K. A. BUETEFISCH (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen, Germany), B. LEHMANN (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Berlin, Germany), R. HENKE (Deutsche Airbus G.m.b.H., Bremen, Germany), H. J. ROSCHER, and U. SEELHORST (Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen, Germany) *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 14 p Sep. 1992
Copyright Avail: CASI HC A03/MF A04

The present contribution describes the measurements of a three-component laser Doppler anenometer (LDA) within the jet of a bypass engine CFM56-5 installed on an A320, in the form of ground tests. The aerodynamic data obtained at the fan exit and *in two sections at the turbine nozzle exit near cruise condition* allow an insight into the complete jet behavior. The velocity components in the specified position for all three coordinate directions are discussed allowing the evaluation of the radial velocity distribution and the swirl components. In addition, the important parameters of the turbulence intensity and the direction of the thrust vector are considered. Author

N93-13229# Wright Lab., Wright-Patterson AFB, OH.
HYPERSONIC PROPULSION SYSTEM FORCE ACCOUNTING
K. NUMBERS *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles p 15 Sep. 1992
Copyright Avail: CASI HC A03/MF A04

A generic matrix of propulsion force accounting procedures was developed from a survey of the U.S. aerospace community. The matrix includes definitions for propulsion system and control volume boundary specification. Aerodynamic reference conditions are also discussed relative to off-design performance. The advantages and disadvantages of each of the force accounting procedures are discussed as they apply to some typical hypersonic force accounting problems. Author

N93-13230# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany).
INTEGRATION OF TURBO-RAMJET ENGINES FOR HYPERSONIC AIRCRAFT
O. HERRMANN *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 7 p Sep. 1992
Copyright Avail: CASI HC A02/MF A04

The integration of turbo-ramjet engines for hypersonic transport vehicles operating in the Mach 0 to 6+ regime represents one of the most important development tasks. A survey over the variety of interacting problem areas and faculties, which have to be integrated to lead to an optimized propulsion/airframe system, is presented Author

N93-13697*# Illinois Univ., Urbana. Coordinated Science Lab.
SUMMARY: EXPERIMENTAL VALIDATION OF REAL-TIME FAULT-TOLERANT SYSTEMS Final Report
R. K. IYER and G. S. CHOI Oct. 1992 5 p
(Contract NAG1-602)
(NASA-CR-190985; NAS 1.26:190985) Avail: CASI HC A01/MF A01

Testing and validation of real-time systems is always difficult to perform since neither the error generation process nor the fault propagation problem is easy to comprehend. There is no better substitute to results based on actual measurements and experimentation. Such results are essential for developing a rational basis for evaluation and validation of real-time systems. However, with physical experimentation, controllability and observability are limited to external instrumentation that can be hooked-up to the system under test. And this process is quite a difficult, if not impossible, task for a complex system. Also, to set up such experiments for measurements, physical hardware must exist. On the other hand, a simulation approach allows flexibility that is unequaled by any other existing method for system evaluation. A simulation methodology for system evaluation was successfully developed and implemented and the environment was demonstrated using existing real-time avionic systems. The research was oriented toward evaluating the impact of permanent and transient faults in aircraft control computers. Results were obtained for the Bendix BDX 930 system and Hamilton Standard EEC131 jet engine controller. The studies showed that simulated fault injection is valuable, in the design stage, to evaluate the susceptibility of computing sytems to different types of failures. L.R.R.

N93-14111# Quest Integrated, Inc., Kent, WA.
ACTIVE CONTROL OF COMBUSTION INSTABILITY IN A RAMJET USING LARGE-EDDY SIMULATIONS
S. MENON Sep. 1992 103 p LIMITED REPRODUCIBILITY; *Availability; Document partially illegible*
(Contract N00014-90-C-0089)
(AD-A255226; QUEST-TR-575) Avail: CASI HC A06/MF A02

Combustion instability in a ramjet engine is an extremely complex phenomenon involving nonlinear interactions among acoustic waves, vortex motion and unsteady heat release. Typically, the instability manifests itself as a large-amplitude pressure oscillation in the low-frequency range (100-800 Hz) and is very difficult to control. When the amplitude of the pressure oscillation reaches some critical limit, it can cause structural damage due to

fatigue or can cause an engine 'unstart', which occurs when the shock in the inlet duct is expelled to form a bow shock ahead of the inlet. This phenomenon of engine unstart is one of the most serious technical problems encountered in developing an operational ramjet engine. Both experimental and numerical investigations have been conducted to determine the mechanism of the combustion instability. Attempts to control combustion instability using both passive and active control techniques have also been carried out in the past. Passive control methods that typically involve structural modifications have proven insufficient for controlling the low-frequency instability. Recent experimental studies suggest that active control techniques may be more effective in controlling the combustion instability in a ramjet. In parallel to the experimental studies, a numerical study of active control methods was carried out in the project. Earlier, the result of numerical studies of active control using acoustic feedback techniques was reported and it was shown that combustion instability can be successfully controlled using such techniques provided certain feedback criteria are satisfied. Although the results are in good agreement with experimental observations, it is well known that in realistic ramjet combustors, acoustic feedback control using loudspeakers as the controller may not be practical due to the prevailant hostile (hot) environment in the combustor. A numerical study of another type of active control technique which uses secondary injection of the premixed fuel as the controller was also carried out. Such a technique has been shown experimentally to be a more practical and effective control system. The results of the simulation carried out over the two year period from May 1990 to May 1992 are summarized. Papers that were written using the results of the study are included in Appendix A.
L.R.R.

N93-14890# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Propulsion and Energetics Panel.
PROPULSION AND ENERGETICS PANEL WORKING GROUP 20 ON TEST CASES FOR ENGINE LIFE ASSESSMENT TECHNOLOGY [CAS D'ESSAI POUR LA GESTION DE LA DUREE DE VIE DES MOTEURS]
Sep. 1992 232 p
(AGARD-AR-308; ISBN-92-835-0686-3) Copyright Avail: CASI HC A11/MF A03

This report presents a set of six test cases intended to provide support for the development and validation of structural analysis and life prediction codes applicable to gas turbine components. The test cases are based on actual engine simulation tests. The data bases comprising the test cases include geometric design information describing the component, rig interface information, material data, and test condition data including steady, dynamic, and thermal loading. Crack initiation and propagation data are also included. Hence, these test cases, for the first time, make available all of the component and loading information required to verify that existing codes or codes in development yield meaningful and consistent predictions. This Advisory Report was prepared at the request of the Propulsion and Energetics Panel of AGARD.

N93-14891# Army Aviation Systems Command, Cleveland, OH. Engine and Transmission Div.
INTRODUCTION TO TEST CASES FOR ENGINE LIFE ASSESSMENT TECHNOLOGY
ROBERT C. BILL *In* AGARD, Propulsion and Energetics Panel Working Group 20 on Test Cases for Engine Life Assessment Technology 6 p Sep. 1992
Copyright Avail: CASI HC A02/MF A03

The cost of maintaining fleet readiness and the trend toward higher power to weight ratio gas turbine engines has put increased importance on component structural analysis and life prediction. Over the past decade there has been considerable progress in the development of advanced structural analysis and life prediction codes for gas turbine engine components. The six test cases comprising this document include a collection of problems that consider crack initiation and crack propagation in hot section and cold section engine components. A broad range of component configurations and loading conditions are included as well as a detailed listing of test case attributes. Author

N93-14892# Societe Nationale d'Etudes et de Construction de Moteurs Aeronautiques, Moissy-Cramayel (France). Service YLEC.
LARZAC HP TURBINE DISK CRACK INITIATION AND PROPAGATION SPIN PIT TEST
ROLAND KRAFFT *In* AGARD, Propulsion and Energetics Panel Working Group 20 on Test Cases for Engine Life Assessment Technology 13 p Sep. 1992
Copyright Avail: CASI HC A03/MF A03

The component test of the LARZAC HP turbine disk proposed in this document provides the opportunity for validation of life prediction methodologies concerning crack initiation and propagation behavior on an area of a nickel-based refractory alloy turbine disk subjected to multi-axial loading. It should be noted, in particular, that this test, carried out under a partial vacuum at high temperature, proposes study of the natural initiation and propagation of a low-cycle fatigue crack. This test case offers the advantages of test analysis of a real turbine part, well defined test conditions, natural initiation of a crack in an area subjected to multi-axial loading leading to moderate plasticity, a well-known nickel-based material (INCONEL 718), and only two-dimensional test analysis, but requiring fine elastic-plastic modeling. The limitations of the test are that it is a component test carried out under isothermic conditions, with a simple load cycle (non-mission); and it involves a complex disk environment (recreating that of an engine) requiring modelling, of the adjacent parts to simulate realistic boundary conditions. From this study conducted by GE and RAE, it was concluded that the test case includes sufficient information to make analytic predictions of fatigue crack propagation behavior, and correlate life predictions with spin pit test results. Author

N93-14893# Motoren- und Turbinen-Union Muenchen G.m.b.H. (Germany).
RB 199 HIGH PRESSURE COMPRESSOR STAGE 3 SPIN PIT TESTS
JURGEN BROEDE *In* AGARD, Propulsion and Energetics Panel Working Group 20 on Test Cases for Engine Life Assessment Technology 20 p Sep. 1992
Copyright Avail: CASI HC A03/MF A03

The RB 199 test case presented here addresses areas with stress concentration to a stress level of local elastic-plastic material behavior. The material used is a corrosion resistant steel X8CrCoNiMo11. Information about component geometry, part processing, operating conditions and history, recommendations about stress analysis and relevant boundary and thermal conditions as well as materials data are presented. This test case deals with cyclic spin pit testing conducted on the 3rd stage HP compressor disk of the TURBO UNION RB 199 engine. The tests were performed to verify disk design and life prediction under a safe life LCF lifting concept. Addressed critical areas are Bolt Holes and Rim Slots. For Bolt Hole testing the original component geometry was modified slightly, for Rim testing significantly to ensure component failure to occur in the area under investigation and local stress distribution as under engine operating conditions. Following an independent analysis, it was concluded that the test case includes sufficient information to generate a viable stress analysis model, generate concentrated stress factors, and correlate life predictions with the spin pit test results. Analyses and the materials data provided in the test cases were used to predict the disk lives for the spin pit testing within 10 percent of the observed lives. Author

N93-14894# General Electric Co., Cincinnati, OH. Aircraft Engines.
CF6-6 HIGH PRESSURE COMPRESSOR STAGE 5 LOCKING SLOT CRACK PROPAGATION SPIN PIT TEST
PAUL A. DOMAS *In* AGARD, Propulsion and Energetics Panel

Working Group 20 on Test Cases for Engine Life Assessment Technology 26 p Sep. 1992
Copyright Avail: CASI HC A03/MF A03

The CF6-6 High Pressure Compressor Stage 5 Locking Slot Crack Propagation Spin Pit test case provides the opportunity for validation of stress analysis and crack propagation life prediction methodologies for a complex geometry, titanium material, gas turbine aircraft engine component. The case addresses crack growth from an artificial crack starter notch under isothermal, constant amplitude, continuous (no dwell period), cyclic testing in a partially evacuated spin pit test facility. The most outstanding attribute of the case in the comprehensive crack growth measurement data available in 200 cycle increments throughout the 7355 cycle test duration. The test case included use of actual hardware (field returned, titanium material, engine part); complex local part geometry involving a decaying stress gradient; an elastic-plastic stress level (local area yielding); realistic surface conditions (milled and shot peened surface), and assessment of a significant failure mode. To evaluate this test case, a two-dimensional axisymmetric finite element stress analysis of the compressor spool was completed followed by a two-dimensional finite element analysis of the concentration effect of the loading slot. These results were used to calculate the crack propagation behavior from the crack starter notches introduced at the loading slots. Factors to account for the effect of shot peening were derived empirically from the results given for the notched bend specimen. These factors were used in the component life calculation which resulted in a prediction within 13 percent of the observed life. The assessment confirmed the suitability of this test case. Author

N93-14895# Rolls-Royce Ltd., Bristol (England).
RB211-524B DISC AND DRIVE CONES HOT CYCLIC SPINNING TEST
LAWRENCE M. JENKINS and S. E. CROW *In* AGARD, Propulsion and Energetics Panel Working Group 20 on Test Cases for Engine Life Assessment Technology 28 p Sep. 1992
Copyright Avail: CASI HC A03/MF A03

The details of component dimensions, loading, material properties, and general arrangements required to perform a stress analysis on the RB211-524 HPT Disc and Drive Cones are presented. The experimental assembly was modelled using finite element stressing techniques at a temperature of 500 C, with the radial load being applied for the dummy blade weights. The test was halted after 3734 rig cycles due to LCF cracking at the runout of the bolt hole boss blend radius to the rear face diaphragm of the disc. Author

N93-14896# General Motors Corp., Indianapolis, IN. Allison Gas Turbine Div.
ENGINE LIFE ASSESSMENT TEST CASE TF41 LP COMPRESSOR SHAFT TORSIONAL FATIGUE
WILLIAM H. PARKER *In* AGARD, Propulsion and Energetics Panel Working Group 20 on Test Cases for Engine Life Assessment Technology 63 p Sep. 1992
Copyright Avail: CASI HC A04/MF A03

The test case presented here provides an example for crack initiation and crack growth of a shaft loaded with major, zero to maximum, torsional cycles with steady axial load and high cycle minor torsional cycles superimposed. The TF41 LP compressor drive shaft was tested as part of a U.S. Air Force Life Extension Program in the early to mid 1980s. This test program provided a controlled set of fatigue testing information and material characterization data which form the basis of the test case. Details of the engine shaft are presented along with pertinent processing information. The test setup and program are described in sufficient detail to permit users to model the component and predict the state of stress. Material data are presented with enough detail so that fatigue life models can be used to predict the shafting life and comparisons with test results can be made. Author

N93-14897# Pratt and Whitney Aircraft, West Palm Beach, FL. Government Engine Business.
F100 SECOND STAGE FAN DISK BOLTHOLE CRACK PROPAGATION FERRIS WHEEL TEST
THOMAS E. FARMER *In* AGARD, Propulsion and Energetics Panel Working Group 20 on Test Cases for Engine Life Assessment Technology 48 p Sep. 1992
Copyright Avail: CASI HC A03/MF A03

This test case provides the opportunity for the evaluation of the overall stress state in a typical 'fracture critical' gas turbine engine rotor component and residual crack propagation life assessment at the bolthole for a simulated low cycle fatigue engine operation mission cycle. Ferris wheel testing provides the crack propagation data to which the prediction is correlated. In addition, an overload hot pre-spin treatment of the disk is evaluated as a means of establishing an induced beneficial near surface compressive residual stress at the bolthole to enhance the crack propagation life. The F100 2nd stage fan disk was tested as part of the U.S. Air Force Damage Tolerant Design for Cold-section Turbine Engine Disks Program AFWAL-TR-81-2045 in the late 70s. The component geometry, part processing, test rig set-up, operating conditions and environment, and materials data are presented in sufficient detail to allow users to model the component and predict the state of stress throughout the body of the disk with particular attention to the bolthole outer diameter location of interest. Solution of the stress state at the bolthole O.D. for the simulated mission cycle and use of crack propagation rate models allow prediction of the residual life from pre-cracks and make comparisons to actual test data. Author

N93-14898# Hawker Siddeley Canada Ltd., Toronto (Ontario). Orenda Div.
IN-SERVICE CONSIDERATIONS AFFECTING COMPONENT LIFE
RAJ THAMBURAJ *In* AGARD, Propulsion and Energetics Panel Working Group 20 on Test Cases for Engine Life Assessment Technology 16 p Sep. 1992
Copyright Avail: CASI HC A03/MF A03

It is believed that the cases reported will be the forerunner of a number of future studies dealing with more complex combinations of factors that need to be considered to assess the life of a gas turbine component in actual service. Some of these considerations are discussed here, in relation to the test cases detailed in earlier chapters. While the focus is upon discs and spacers, to maintain a close relationship with the test cases presented earlier for other engines, blade life prediction is also discussed. Where appropriate, examples were drawn from experience in J85 and F404 engines operated in Canada. This paper considers various practical aspects of life prediction which merit further investigation. These are as follows: small crack behavior; the effect of loading conditions, multiaxial loading, HCF-LCF interactions, creep-fatigue and creep-fatigue-environment interactions; microstructural effects, long term service exposure effects, grain size, and grain shape effects, anisotropic behavior and single crystal turbine blades; coating effects; defects and damage tolerance; inspection sensitivity and reliability effects; residual stress effects; effects of repair; and usage monitoring. Author

N93-15143# Motoren- und Turbinen-Union Muenchen G.m.b.H. (Germany).
ENGINE TECHNOLOGIES FOR FUTURE SPACEPLANES
P. KRAMMER and R. R. SCHWAB 1991 10 p Presented at 10th ISABE, Nottingham, England, 1-6 Sep. 1991 Sponsored by BMFT and ESA
(ETN-92-92732) Avail: CASI HC A02/MF A01

The importance of propulsion generic technologies, in the successful design of an airbreathing hybrid propulsion system for hypersonic applications, is discussed. These technologies are put into perspective with regard to system performance and safety aspects. These technological requirements are discussed, and they include the following: aerothermodynamics of inlets and nozzles; hydrogen combustion and environmental effects; thermal

management; and high temperature and hydrogen resistant materials and structures. ESA

N93-15168# Dornier System G.m.b.H., Friedrichshafen (Germany).
INTEGRATED ENGINE CONTROL AND MONITORING WITH EXPERIENCES DERIVED FROM OLMOS [INTEGRIERTE TRIEBWERKSREGELUNG UND -UEBERWACHUNG MIT ERFAHRUNGEN AUS OLMOS]
UWE SCHULZ and JULIAN BOTT *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 287-310 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

A description of the Onboard Life Monitoring System (OLMOS) for a fighter aircraft is given. The experiences with the system in service and the modifications derived from this are presented. Based on these experiences and the technical requirements for engine control and monitoring, the advantages and disadvantages of an integrated concept are presented. Different requirements with respect to reliability and flight safety are considered. ESA

N93-15171# Airbus Industrie, Blagnac (France).
MONITORING OF POWERPLANTS IN ADVANCED COMMERCIAL AIRCRAFT [TRIEBWERKSUEBERWACHUNG IN MODERNEN VERKEHRSFLUGZEUGEN]
ANTOINE VIEILLARD *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 361-372 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

Over the last decade, commercial aircraft design has evolved with a strong emphasis on the implementation of onboard computers. Solutions which have been taken for monitoring the powerplants in the current Airbus family (particularly A320) as well as those to be certified in the near future (A330, A340) are described. The powerplant control and monitoring have changed by the introduction of digital engine control computers integrated with the aircraft system. The reliability requirements, highlighted by ETOPS, and the environmental conditions, such as vibration, reinforce the need for sophisticated monitoring and the definition of associated maintenance tasks. ESA

N93-15172# Motoren- und Turbinen-Union Muenchen G.m.b.H. (Germany).
EJ 200 ENGINE MONITORING SYSTEM: ON- AND OFF-BOARD DATA CAPTURE, ANALYSIS, AND MANAGEMENT SYSTEM [EJ 200 TRIEBWERKS-UEBERWACHUNGS-SYSTEM ON- UND OFF-BOARD DATENERFASSUNG, ANALSE, UND MANAGEMENT SYSTEM]
P. STADLMEIER *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 373-389 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

The EJ 200 engine monitoring system is part of the Integrated Monitoring and Recording System (IMRS) for the European Fighter Aircraft (EFA). The engine related part of the virtual system is considered. This includes the onboard data acquisition of engine data and subsequent onboard data analysis, the data transfer to the ground support system, and the remaining data analysis (not performed by the onboard system) and management of the ground support system. ESA

N93-15173# Motoren- und Turbinen-Union Muenchen G.m.b.H. (Germany).
RB199 ENGINE OIL SYSTEM FAILURE DIAGNOSTICS BY COMPARISON OF MEASURED AND CALCULATED OIL CONSUMPTION USING THE OLMOS ON-BOARD MONITORING SYSTEM [STOERUNGSDIAGNOSE FUER DAS RB199-OELSYSTEM DURCH VERGLEICH ZWISCHEN GEMESSENEN UND MIT DEM OLMOS ON-BOARD UEBERWACHUNGSSYSTEM GERECHNETEN OELVERBRAEUCHEN]
H. PFOERTNER and H. STREIFINGER *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 391-414 Jan. 1992 Sponsored by Bundesministerium der Verteidigung
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

The oil consumption of military aircraft engines varies, depending on the mission to be undertaken, throughout a flight. In order to detect oil system related failures and to reduce the number of engine ground runs required to check the oil consumption, a mathematical model was developed to calculate the expected oil consumption from available flight data. It was implemented in the engine monitoring function of OLMOS (Onboard Life Monitoring System). First flight test results and possible directions for the development of future systems are described. ESA

N93-15174# General Electric Co., Cincinnati, OH. Aircraft Engines.
A PHILOSOPHY FOR INTEGRATED MONITORING SYSTEM DESIGN [GRUNDSAEZLICHE UEBERLEGUNGEN ZUR ENTWICKLUNG INTEGRIERTER UEBERWACHUNGSSYSTEME]
DAVID L. DOEL *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 415-432 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

The use of a different philosophy for engine monitoring system design where diagnostic requirements are derived from goals for the aircraft is suggested and discussed. As an example jet engine gas path analysis is discussed. A better example, the Ground-based Engine Monitoring (GEM) software system to support the CF6-8OA3 engines is disucssed. The software advances include automatic recognition of trends or step changes in the engine behavior, better integration of the system into the airline day to day activities, and earlier availability of results so problems are detected in near real time. Aims to build a better gas path algorithm are given. It is concluded that any fundamental improvement to engine monitoring systems will be preceded by a change in emphasis on the part of the designer. These changes are outlined. ESA

N93-15175# Universitaet der Bundeswehr, Hamburg (Germany).
SOME EXPERIMENTS AND IDEAS ON GPA BEFORE REACHING STEADY STATE OF ENGINE [EINIGE EXPERIMENTE UND UEBERLEGUNGEN UEBER GPA VOR ERREICHEN DES STATIONAEREN ZUSTANDES DES TRIEBWERKS]
K. FIEDLER, R. LUNDERSTAEDT, and K.-J. SCHMIDT *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 433-454 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

During normal operating conditions, often the steady state of jet engines and gas turbines is not reached. Nevertheless it is desirable to perform a Gas Path Analysis (GPA) even under these conditions. Therefore experimental and theoretical investigations were made concerning the time dependent reaction of a shaft power engine after changing the operating point. The time constants deduced from experimental results show good agreement with the theoretical values if somewhat sophisticated theories are applied. Concerning the GPA, it was found that the values for the capacity can be used after less than 10 s, but only after several minutes does the efficiency reach its steady state value, which is necessary for the existing GPA procedures. ESA

N93-15176# Technische Univ., Munich (Germany).
EXPERIMENTAL ANALYSIS OF STEADY-STATE AND DYNAMIC MONITORING OF POWER SHAFT TURBINES [ZUR EXPERIMENTELLEN ANALYSE DER STATIONAEREN UND DYNAMISCHEN ZUSTANDSUEBERWACHUNG VON WELLENLEISTUNGSTRIEBWERKEN]
S. BOGNER, G. KAPPLER, and H. RICK *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems

p 455-482 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

The increasing demand for safety and reliability of aircraft turbines, as well as the reduction of their life cycle costs, have led to intensive research of turbine monitoring systems. High accuracy engine models, which must be adapted to the present engine state by means of experimental modeling, are required for steady state and dynamic engine monitoring. Compressor disturbances are simulated in the steady and dynamic state and are calculated using engine monitoring models in order to identify engine failures. The tests are carried out on a helicopter engine situated on a computer controlled test stand which provides, among other things, extensive dynamic measuring techniques. ESA

N93-15337# Exotech, Inc., Fremont, CA.
AN EXPERIMENTAL AND ANALYTICAL STUDY OF TIP CLEARANCE EFFECTS IN AXIAL FLOW COMPRESSORS
Ph.D. Thesis
IAN N. MOYLE Dec. 1991 252 p
(AD-A256434; NPS-AA-92-001CR) Avail: CASI HC A12/MF A03

An analytical and experimental study of the performance changes and flow effects of rotor tip clearance variation in axial flow compressors is presented. The analyses demonstrate that previously unrecognized loss characteristics and flow behavior trends can be identified in a wide range of published tests of clearance effects. The performance and flow data are correlated at constant power conditions or nondimensionally in terms of the test compressor's geometry and wall flow conditions to observe the trends. Flow field changes caused by increasing the tip seal clearance of a low speed, large scale axial compressor having a symmetric velocity diagram were examined experimentally. The measurements were made at several clearances for one rotational speed. Synchronized blade-to-blade measurements of case wall static pressure and skin friction under the rotor tip of the second stage were collected. GRA

N93-15342*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SUPERSONIC INVESTIGATION OF TWO DIMENSIONAL HYPERSONIC EXHAUST NOZZLES
JEANNE D. CARBONI, RICKEY J. SHYNE, LAURENCE D. LEAVITT (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.), JOHN G. TAYLOR (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.), and MILTON LAMB (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.) Oct. 1992 46 p
(Contract RTOP 763-01-21)
(NASA-TM-105687; E-7067; NAS 1.15:105687) Avail: CASI HC A03/MF A01

An experimental investigation was conducted in the NASA Lewis 10 x 10 ft supersonic Wind Tunnel to determine the performance characteristics of 2D hypersonic exhaust nozzles/afterbodies at low supersonic conditions. Generally, this type of application requires a single expansion ramp nozzle (SERN) that is highly integrated with the airframe of the hypersonic vehicle. At design conditions (hypersonic speeds), the nozzle generally exhibits acceptable performance. At off-design conditions (transonic to mid-supersonic speeds), nozzle performance of a fixed geometry configuration is generally poor. Various 2-D nozzle configurations were tested at off-design conditions from Mach 2.0 to 3.5. Performance data is presented at nozzle pressure ratios from 1 to 35. Jet exhaust was simulated with high-pressure air. To study performance of different geometries, nozzle configurations were varied by interchanging the following model parts: internal upstream contour, expansion ramp, sidewalls, and cowl. Author

N93-15359*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
OPTIMIZATION OF CIRCULAR ORIFICE JETS MIXING INTO A HEATED CROSS FLOW IN A CYLINDRICAL DUCT
J. T. KROLL (California Univ., Irvine.), W. A. SOWA (California Univ., Irvine.), G. S. SAMUELSEN (California Univ., Irvine.), and J. D. HOLDEMAN Dec. 1992 19 p Presented at the 31st Aerospace Sciences Meeting and Exhibit, Reno, NV, 11-14 Jan. 1993; sponsored by AIAA
(Contract NAG3-1110; RTOP 537-02-20)
(NASA-TM-105984; E-7508; NAS 1.15:105984; AIAA PAPER 93-0249) Avail: CASI HC A03/MF A01; 2 functional color pages

To examine the mixing characteristics of circular jets in an axisymmetric can geometry, temperature measurements were obtained downstream of a row of cold jet injected into a heated cross stream. The objective was to obtain uniform mixing within one duct radius downstream of the leading edge of the jet orifices. An area weighted standard deviation of the mixture fraction was used to help quantify the degree of mixedness at a given plane. Non-reacting experiments were conducted to determine the influence of the number of jets on the mixedness in a cylindrical configuration. Results show that the number of orifices significantly impacts the mixing characteristics of jets injected from round hole orifices in a can geometry. Optimum mixing occurs when the mean jet trajectory aligns with the radius which divides the cross sectional area of the can into two equal parts at one mixer radius downstream of the leading edge of the orifice. The optimum number of holes at momentum-flux ratios of 25 and 52 is 10 and 15 respectively. Author

N93-15403*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ACOUSTIC MODE MEASUREMENTS IN THE INLET OF A MODEL TURBOFAN USING A CONTINUOUSLY ROTATING RAKE: DATA COLLECTION/ANALYSIS TECHNIQUES
DAVID G. HALL (Sverdrup Technology, Inc., Brook Park, OH.), LAURENCE HEIDELBERG, and KEVIN KONNO Jan. 1993 14 p Presented at the 31st Aerospace Sciences Meeting, Reno, NV, 11-14 Jan. 1993; Sponsored by AIAA
(Contract RTOP 535-03-10)
(NASA-TM-105936; E-7452; NAS 1.15:105936; AIAA PAPER 93-0599) Avail: CASI HC A03/MF A01

The rotating microphone measurement technique and data analysis procedures are documented which are used to determine circumferential and radial acoustic mode content in the inlet of the Advanced Ducted Propeller (ADP) model. Circumferential acoustic mode levels were measured at a series of radial locations using the Doppler frequency shift produced by a rotating inlet microphone probe. Radial mode content was then computed using a least squares curve fit with the measured radial distribution for each circumferential mode. The rotating microphone technique is superior to fixed-probe techniques because it results in minimal interference with the acoustic modes generated by rotor-stator interaction. This effort represents the first experimental implementation of a measuring technique developed by T. G. Sofrin. Testing was performed in the NASA Lewis Low Speed Anechoic Wind Tunnel at a simulated takeoff condition of Mach 0.2. The design is included of the data analysis software and the performance of the rotating rake apparatus. The effect of experiment errors is also discussed. Author

N93-15521*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AN INTEGRAL EQUATION SOLUTION FOR MULTISTAGE TURBOMACHINERY DESIGN CALCULATIONS
ERIC R. MCFARLAND 1993 12 p Proposed for presentation at the 38th International Gas Turbine and Aeroengine Congress and Exposition, Cincinnati, OH, 24-27 May 1993; sponsored by ASME
(Contract RTOP 505-62-52)
(NASA-TM-105970; E-7493; NAS 1.15:105970) Avail: CASI HC A03/MF A01

A method was developed to calculate flows in multistage turbomachinery. The method is an extension of quasi-three-dimensional blade-to-blade solution methods. Governing equations for steady compressible inviscid flow are linearized by introducing approximations. The linearized flow equations are solved using integral equation techniques. The flows

through both stationary and rotating blade rows are determined in a single calculation. Multiple bodies can be modelled for each blade row, so that arbitrary blade counts can be analyzed. The method's benefits are its speed and versatility. Author

N93-15525*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PROPULSION SYSTEM PERFORMANCE RESULTING FROM AN INTEGRATED FLIGHT/PROPULSION CONTROL DESIGN
DUANE MATTERN (Sverdrup Technology, Inc., Brook Park, OH.) and SANJAY GARG Oct. 1992 22 p Presented at the AIAA Guidance, Navigation, and Control Conference, Hilton Head, SC, 10-12 Aug. 1992; sponsored by AIAA Previously announced in IAA as A92-55281
(Contract RTOP 505-62-50)
(NASA-TM-105874; E-7339; NAS 1.15:105874) Avail: CASI HC A03/MF A01

Propulsion-system-specific results are presented from the application of the integrated methodology for propulsion and airframe control (IMPAC) design approach to integrated flight/propulsion control design for a 'short takeoff and vertical landing' (STOVL) aircraft in transition flight. The IMPAC method is briefly discussed and the propulsion system specifications for the integrated control design are examined. The structure of a linear engine controller that results from partitioning a linear centralized controller is discussed. The details of a nonlinear propulsion control system are presented, including a scheme to protect the engine operational limits: the fan surge margin and the acceleration/deceleration schedule that limits the fuel flow. Also, a simple but effective multivariable integrator windup protection scheme is examined. Nonlinear closed-loop simulation results are presented for two typical pilot commands for transition flight: acceleration while maintaining flightpath angle and a change in flightpath angle while maintaining airspeed. The simulation nonlinearities include the airframe/engine coupling, the actuator and sensor dynamics and limits, the protection scheme for the engine operational limits, and the integrator windup protection. Satisfactory performance of the total airframe plus engine system for transition flight, as defined by the specifications, was maintained during the limit operation of the closed-loop engine subsystem. Author

08

AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

A93-14159
INVESTIGATION OF PRECISE APPROACH AND LANDING OF CIVIL AIRCRAFT USING INTEGRATED SYSTEM BASED ON GPS
J. P. WANG, E. ZHENG, J. P. YUAN, and X. F. DENG (Northwestern Polytechnical Univ., Xian, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 18-23. refs
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The possibility of using integrated system based on GPS to guide the civil aircraft precision approach and landing is investigated. Using eigenstructure assignment method, the longitudinal and lateral-directional autopilot of a feeder aircraft are designed. Using the state output of the aircraft-autopilot system as filtering object and the output of the integrated system based on GPS as the filtering measurement, a Kalman filter is designed. To guess the guidance accuracy of the whole system, covariance analysis and Monte Carlo simulation method are used. The results showed that the integrated system of GPS with the aid of altimeter is possible to meet the guidance accuracy requirement of ILS, if the accuracy of the altimeter is high enough. Author

A93-14160
FLIGHT PATH OPTIMIZATION AND SUBOPTIMAL CONTROL LAWS SYNTHESIS FOR TRANSPORT MISSION OF MANEUVERABLE AIRCRAFT
N. M. GREVTSOV, O. E. EFIMOV, and I. O. MELTTS (TsAGI, Zhukovski, Russia) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 24-31. refs
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The flight-path optimization for transport missions of maneuverable aircraft as well as suboptimal control synthesis for optimal flight-path implementation are considered. The calculation of the extremal fields for some examples are carried out by the second order method, which presents the extension of previously known one, and by the maximum principle. The approximations of optimum solutions are proposed for the schedule design. The synthesis for a normal load factor is performed through tracking the approximations. The adaptive extremal law for the engine thrust control is proposed and numerical results are presented. Author

A93-14161
OPTIMALITY-BASED CONTROL LAWS FOR REAL-TIME AIRCRAFT CONTROL VIA PARAMETER OPTIMIZATION
SHAW Y. ONG and BION L. PIERSON (Iowa State Univ. of Science and Technology, Ames) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 32-39. refs
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The potential for real-time aircraft control via the control law obtained by the application of the 'optimality-condition' is investigated. This optimality-based control law possesses simplicity and yet preserves the original structure of the highly complex, nonlinear, optimal control. The technique is applied to aircraft trajectory optimization, in particular, the minimum-time-to-climb and the minimum-time-to-turn problems. Robustness is also studied via simulations with respect to various initial state disturbances and plant/aerodynamic modelling uncertainties. The results indicate that the optimality-based control law exhibits excellent natural robustness in terms of meeting the final flight conditions when a certain 'correction' term is included. The open-loop solutions are also given for comparison purposes. Author

A93-14186
THE DEVELOPMENT OF AN EFFICIENT TAKE-OFF PERFORMANCE MONITOR (TOPM)
R. KHATWA (National Aerospace Lab., Amsterdam, Netherlands) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 219-241. Research supported by SERC, British Aerospace, PLC, and Netherlands Agency for Aerospace Programs refs
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A take-off performance monitor (TOPM) could assist the pilot in keeping the progress of the take-off constantly in view, so as to make it easier to decide if a take-off can safely be continued, or to support the decision to abondon it. This paper considers the development of a TOPM with a predictive capacity. A pretake-off module calculates and displays the critical take-off lengths using nominally correct data. These lengths are evaluated on the basis of measured data and 'forward computations' during ground roll. Techniques to deal with anomalies such as sensor failures, incorrect data inputs, improper aircraft configuration and changes in take-off conditions during ground roll are proposed. The possibility of enhancing situation awareness by monitoring of the engine health and acceleration performance is investigated. Consideration is also given to the nature and cockpit position of the display. Author

A93-14187
INTEGRATION OF FLIGHT CONTROL AND CARRIER LANDING AID SYSTEM
T. LE MOING (ONERA, Chatillon, France) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 242-251. refs
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The state-of-the-art carrier landing-aid systems developed in France are reviewed, and a landing procedure that allows recovery in adverse sea conditions is proposed. This procedure is based on a deck-motion stabilization system, a deck-motion predictor system, and an all-weather localization sytem. A numerical simulation code is described which is aimed at evaluating the improvement of deck landing performance, and in particular, the predictive accuracy of the system for the carrier's motion. O.G.

A93-14188
AUTOMATIC GUIDANCE AND CONTROL FOR RECOVERY OF REMOTELY PILOTED VEHICLES
J. K. M. MACCORMAC, A. ROSE (Bath Univ., United Kingdom), and A. DEDDEN (Flight Refuelling, Ltd., Wimborne, United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 252-255. refs
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Modern remotely piloted vehicles are used extensively for aerial surveillance operations. Many recovery methods have been employed with varying degrees of success. However, manual flying requires significant operator skill. This research is aimed at producing a closed loop automatic landing system for remotely piloted vehicles. The system under investigation utilizes a ground based video camera to track the RPV and produce guidance commands to fly the aeroplane down the axis of the video image to a height suitable to initiate the flare for landing. The system is based on signal processing micro computers, and video data is processed at field rate to locate and track the aircraft and subsequently generate error signals from the center line which are fed to a telemetry interface to guide and control the aircraft on the approach. The paper details the system hardware of a prototype system and outlines the image processing algorithm for target recognition and tracking. Author

A93-14197
A PROPOSAL CONCERNING THE DYNAMIC ANALYSIS METHOD OF CONTINUOUS GUST DESIGN RULES
HANHUI LIU (Civil Aviation Inst. of China, Tianjin) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 340-348. refs
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This paper proposes that the worst deterministic input (WDI) analysis can be used as the dynamic basis of continuous gust design rules to replace the current power spectral density (PSD) analysis. The WDI analysis studies the stochastic response of a system by searching the worst deterministic input from an equiprobable family. For linear time invariant system, the WDI method can give results agreeing exactly with that of PSD method, but the new method can also (1) give the worst case with time informations, and (2) it can deal with linear time variant and nonlinear problems. Adopting WDI analysis instead of PSD analysis can greatly expand the application extent of design rules without changing criteria. Author

A93-14209
DIGITAL FLY-BY-WIRE SYSTEM FOR BK117 FBW RESEARCH HELICOPTER
TAKESHI TOMIO, MUNENORI ISHIKAWA, SHUJI NAKAMURA, and NAOKI SUDO (Kawasaki Heavy Industries, Ltd., Gifu, Japan) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 436-444. refs
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The BK117 fly-by-wire (FBW) research helicopter is being assessed in flight tests to determine FBW technology applicable to the helicopter. Emphasis is placed on the design concept, its system architecture, redundancy management, and the system assessment conducted prior to the flight test. The research helicopter is based on a 4-axis full-authority digital FBW which is basically a triplex redundant system. The core control functions have double-failure operational capability and are clearly separated from the other functions of lower criticality. The system features a side-stick controller, Ada software, a direct drive valve, and digital servo loop. O.G.

A93-14224
FEASIBILITY STUDY OF AN ACTIVE AEROELASTIC CONTROL SYSTEM FOR THE F-16 AIRCRAFT
M. MEDINA, R. A. NAMAN, and E. KAGAN (Israeli Air Force, Tel Aviv, Israel) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 571-577.
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A feasibility study to develop an AOCS for the F-16 A/C as a means of suppressing flutter and limit cycle oscillation (LCO) is described. The study covered the entire span of subjects necessary for implementing such a system in the A/C. The user's point of view in handling flutter and LCO as an obstacle in improving flight quality and expanding the operational flight envelope is presented. Ways to deal with the need to engage/disengage the AOCS according to the loading/downloading flow are discussed. A rough estimate of the flight tests to advance the program is provided. It is concluded that the A/C flight control system (FCS) can be modified to suppress LCO by using the existing FCS sensors and the existing control surfaces and actuators. P.D.

A93-14229
VARIABLE STRUCTURE CONTROLLER DESIGN AND ITS REAL-TIME ANALYSIS FOR MICROPROCESSOR-BASED FLIGHT CONTROL SYSTEMS
HUAIXUN LIU, C. Q. LU, and J. S. CHEN (Luoyang Dynamics Inst., China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 614-619. Research supported by Luoyang Dynamics Inst refs
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This paper presents a new controller design for flight control systems using variable structure system theory. A new variable structure control algorithm combined with a conventional controller applied to missile control systems is derived. Digital and digital-analog hybrid simulations are carried out and both dynamic and static system performance are significantly improved with an exponential convergence law and a satuation function introduced. Some of practical problems encountered in real-time control are discussed for engineering implementation of the design. Author

A93-14232
AN ADAPTIVE ALGORITHM FOR ESTIMATION OF A STATE VECTOR IN THE SYSTEM OF REMOTELY-PILOTED AIRCRAFT CONTROL USING KALMAN FILTER
A. D. TRIFONOV (Moscow Aviation Inst., Russia) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 627-631. refs
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This paper describe the use of the Kalman filter in the system of remotely piloted vehicle control to provide a simultaneous flight of several vehicles using one ground remote control center. The filter uses the kinematic equations of motion of a point mass moving in a 2D surface and the wind model load as a main disturbing factor. Measurements are made in polar coordinates, while target dynamics are estimated in rectangular coordinates, resulting in coupled linear filter equations. An adaptive procedure is used to provide the convergence properties of the algorithm. A computer simulation example, implementing the tracking algorithm, is presented as well. It is concluded that using of the developed

algorithm could increase the time interval between corrections of motion for a separate vehicle and increase the number of controlled vehicles to operate with one ground center. Author

A93-14259
STUDY OF AEROSERVOELASTIC STABILITY OF AN AIRCRAFT
CHANGHONG TANG (Xian Aircraft Co., Development Dept., China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 844-850. refs

An assessment is made of experience gained during systematic analyses and test programs on the servoelastic and aeroservoelastic stabilities of aircraft due to the interaction between aerodynamics, structural dynamics, and flight control systems; these interactions become critical considerations in the design of high-authority flight control systems. Attention is given to effective approaches in the construction and validation of mathematical models based on ground-test data. Consequent control system-related aeroelastic and aeroservoelastic improvements are documented. O.C.

A93-14281
INTEGRATED CONTROL LAW SYNTHESIS OF GUST LOAD ALLEVIATION AND FLUTTER MARGIN AUGMENTATION FOR A TRANSPORT AIRCRAFT
H. MATSUSHITA, K. FUJII, and Y. MIYAZAWA (National Aerospace Lab., Tokyo, Japan) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1033-1037. refs

The present integrated synthesis method for flexible aircraft gust load alleviation control laws as well as flutter margin augmentation is applied to a wind tunnel test model having both aeroelastic and dynamic similarity. A FEM structural analysis and a boundary element unsteady aerodynamic analysis are used to derive a mathematical model in a state-space time domain; on the basis of this mathematical model, control laws are synthesized which apply the linear quadratic Gaussian optimal control law synthesis method with an order-reduction procedure at design speeds for both a sub- and a supercritical flutter state. O.C.

A93-14282
DYNAMIC STABILITY, COUPLING AND ACTIVE CONTROL OF ELASTIC VEHICLES WITH UNSTEADY AERODYNAMIC FORCES MODELING
SHILU CHEN, SHUO TANG, FUMING HUAN, and XIAOPING ZHU (Northwestern Polytechnical Univ., Xian, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1038-1042. Research supported by China National Educational Committee refs

In this paper, longitudinal equations of disturbance motions acting with unsteady aerodynamic forces are derived. A method of analysis of the effect of aeroelasticity on the dynamic stability of elastic vehicles by using a simplified mathematical model of unsteady aerodynamic forces is proposed. Synthesis of optimal design of the active control system is studied from the point of view of coordinations for a design of active feedback control, choice of positions of control surfaces and sensors (gyros), and locations (from the standpoint of the efficient suppression of elastic vibration of the vehible). Moreover, a method of quantitative analysis of the coupling characteristics of elastic vehicles is developed. Author

A93-14288
AN INVESTIGATION OF MODE SHIFT FLUTTER SUPPRESSION SCHEME FOR EMPENNAGES
ZHI-CHUN YANG and JI-KE LIU (Northwestern Polytechnical Univ., Xian, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1079-1083. refs

A theoretical and experimental investigation is conducted for the scheme of mode-shift flutter suppression in empennages, which provides a tip-balancing weight, in the form of an overhang flexible bar having an impact-damping element. Calculation results that the effectiveness of flutter suppression is a function of the shifting of critical flutter mode by the impact damper. Wind tunnel test results also indicate the presence of mode shift. The flutter speed of an empennage model was increased by 29.4 percent. O.C.

A93-14293
HETERO-REDUNDANT ARCHITECTURE WITH KALMAN FILTER FOR INPUT PROCESSING IN FLIGHT CONTROL SYSTEM
C. SUBRAMANIAN and D. K. SUBRAMANIAN (Indian Inst. of Science, Bangalore, India) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1103-1112. refs

A flight-control system (FCS) architecture is proposed that combines both conventional and Kalman filtering techniques for fault-tolerant operation in extended flight regimes. A heteroredundant architecture is described with a Kalman filter in one channel, and the formulation of the Kalman filter is discussed. A model of the Kalman filter is used to estimate the states of the aircraft in four simulation scenarios, and plots of the states' time histories show that filter reduces noise and smooths estimated and measured values of the flight states. A Kalman filter for real-time processing is proposed for development from VLSI circuits, and the proposed design is shown to provide optimal control commands for a range of flight/pilot inputs. The FCS heteroredundant architecture is shown to be less prone to instantaneous sensor failure than homogeneous redundant systems, and common-mode failures are not anticipated for the heterogeneous architecture. C.C.S.

A93-14306
COBRA MANEUVER CONSIDERATIONS
LARS E. ERICSSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1215-1224. refs
(Contract F33615-87-C-3607)

The unsteady aerodynamics associated with a rapid pitch-up/pitch-down motion of an advanced aircraft, the so called 'Cobra' maneuver, have been analyzed. It is found that the maneuver could probably not be performed in laminar flow because of the expected nose-slice tendency based upon experimental results. The likely reason for the absence of nose-slice tendencies in full-scale flight is the existing coupling between boundary layer transition and vehicle motion. These results support the conclusion reached in earlier high-alpha analyses, i.e., dynamic simulation in subscale tests is only possible if the full-scale Reynolds number is simlated. Author

A93-14331* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PREDICTION AND CONTROL OF SLENDER-WING ROCK
OSAMA A. KANDIL and AHMED A. SALMAN (Old Dominion Univ., Norfolk, VA) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1430-1441. refs
(Contract NAG1-648)

The unsteady Euler equations and the Euler equations of rigid-body dynamics, both written in the moving frame of reference,

are sequentially solved to simulate the limit-cycle rock motion of slender delta wings. The governing equations of the fluid flow and the dynamics of the present multidisciplinary problem are solved using an implicit, approximately-factored, central-difference-like, finite-volume scheme and a four-stage Runge-Kutta scheme, respectively. For the control of wing-rock motion, leading-edge flaps are forced to oscillate anti-symmetrically at prescribed frequency and amplitude, which are tuned in order to suppress the rock motion. Since the computational grid deforms due to the leading-edge flaps motion, the grid is dynamically deformed using the Navier-displacement equations. Computational applications cover locally-conical and three-dimensional solutions for the wing-rock simulation and its control. Author

A93-14349
ANALYSIS AND FEEDBACK CONTROL OF AIRCRAFT FLIGHT IN WIND SHEAR
CHAO HAN (Beijing Univ. of Aeronautics and Astronautics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1581-1586. refs
Copyright

The approximate transfer function of aircraft altitude and total energy response to windshear are derived using the modal aggregation method. The formulas agree well with the exact transfer function. The formulas can be used to estimate the performance of aircraft in windshear. C.D.

A93-14350
OPTIMAL LATERAL MANEUVERING FOR MICROBURST ENCOUNTERS DURING FINAL APPROACH
H. G. VISSER (Delft Univ. of Technology, Netherlands) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1587-1597. refs
Copyright

This paper is concerned with the control and optimization of lateral escape trajectories in a microburst wind field for an aircraft on final approach. The performance index being minimized is the peak value of altitude drop. An extensive numerical effort has been undertaken to investigate the characteristics of open-loop extremal solutions for different locations of the microburst. The results bear out that if lateral maneuvering is applied to turn the aircraft away from the microburst center, a significant improvement in the escape capability of the aircraft can be achieved in comparison to a straight flight. In contrast to non-turning escape maneuvers, optimal energy management often calls for an initial climb, rather than descent, in a lateral escape maneuver. Finally, a feedback guidance scheme is proposed that closely approximates the open-loop trajectories. Author

A93-14351
EQUIVALENT DETERMINISTIC INPUTS FOR ATMOSPHERIC TURBULENCE
Y. SHI (Missouri-Columbia Univ., Columbia) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1598-1602. refs
Copyright

Conditions and properties for easily and reasonably realizing the equivalent deterministic input for a physical random process with physical equipment are proposed. As an example, the equivalent deterministic inputs for atmospheric turbulence are obtained using this new method. C.D.

A93-14370* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
FLIGHT-DETERMINED BENEFITS OF INTEGRATED FLIGHT-PROPULSION CONTROL SYSTEMS
JAMES F. STEWART, FRANK W. BURCHAM, JR., and DONALD H. GATLIN (NASA, Flight Research Center, Edwards, CA) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1756-1777. refs

The fundamentals of control integration for propulsion are reviewed giving practical illustrations of its use to demonstrate the advantages of integration. Attention is given to the first integration propulsion-control systems (IPCSs) which was developed for the F-111E, and the integrated controller design is described that NASA developed for the YF-12C aircraft. The integrated control systems incorporate a range of aircraft components including the engine, inlet controls, autopilot, autothrottle, airdata, navigation, and/or stability-augmentation systems. Also described are emergency-control systems, onboard engine optimization, and thrust-vectoring control technologies developed for the F-18A and the F-15. Integrated flight-propulsion control systems are shown to enhance the thrust, range, and survivability of the aircraft while reducing fuel consumption and maintenance. C.C.S.

A93-14371
DESIGN OF DIGITAL MULTIPLE MODEL-FOLLOWING INTEGRATED FLIGHT/PROPULSION CONTROL SYSTEMS
B. PORTER (Salford Univ., United Kingdom) and X.-G. ZHANG (Chinese Aeronautical Establishment, Flight Automatic Control Research Inst., Xian, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1778-1786. refs
Copyright

The design of digital model-following control systems incorporating fast-sampling PID controllers is described. This methodology is applied to the design of integrated flight-propulsion control systems in which multiple model-following characteristics are achieved explicitly. In this way, it is shown that desired closed-loop airframe responses are achievable simultaneously with desired closed-loop engine responses. These general results are illustrated by designing a digital model-following integrated flight/propulsion control system for a high-performance aircraft with thrust-vectoring and thrust-reversing capabilities. Author

A93-14372
ANALYSIS AND DEVELOPMENT OF A TOTAL ENERGY CONTROL SYSTEM FOR A LARGE TRANSPORT AIRCRAFT
SUOFENG GUO, SHUFAN WU, and YONGZHANG SHEN (Nanjing Aeronautical Inst., China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1787-1796. Research supported by Aeronautical Science Foundation of China refs
Copyright

A total energy control system (TECS) based on energy-management theory is developed analytically for transport aircraft with comparisons to conventional automatic flight-control systems. A two-input/two-output P-canonical system representation is developed based on aircraft point-mass energy movement dynamics for pitch-attitude and engine controls. Output-feedback control and decoupling structures are utilized to yield coordinated thrust/elevator control laws for decoupled flight-path/speed maneuvering dynamics. The analysis is used to develop control laws for optimum trajectory guidance, vertical path-segment transition, flight-path angle, and altitude/speed relations. Simulation results based on digital implementations of the TECS for different flight segments are presented. The results show that the TECS meets the requirements of the traditional autopilot and autothrottle, and the system is highly generic and can be used for a range of large transport aircraft. C.C.S.

A93-14373
THE INFLUENCE OF ROTOR AND FUSELAGE WAKES ON ROTORCRAFT STABILITY AND CONTROL
F.-W. MEYER and G. REICHERT (Braunschweig Technical Univ., Germany) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of

Aeronautics and Astronautics, Inc. 1992 p. 1797-1805. refs
Copyright

The aerodynamic interference between the wakes of the main rotor and fuselage passing the tail surfaces are to be discussed. A vortex-lattice method is employed to calculate the inviscid flow of the rotor and the development of the separated vortex sheets leaving the rear part of the fuselage. A 3D boundary-layer method based on similarity in flow and cross-flow direction is used, to calculate the line of separation. Both rotor-wake and fuselage-wake calculations are embedded within a quasi-steady simulation model of the rotorcraft dynamics. Therefore the flow field at the location of the empennage is taken accurately forced by the dynamics of the rotorcraft. The contributions of the aerodynamics are analyzed at significant flight conditions of helicopters. Time histories of angular velocity rates and a stability chart of the characteristic poles give an overview about the influence of main parameter input. Author

A93-14379
NUMERICAL STUDY OF JET INTERACTION AT SUPER- AND HYPERSONIC SPEEDS FOR FLIGHT VEHICLE CONTROL
J. BRANDEIS (Rafael Armament Development Authority, Haifa, Israel) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1847-1857. refs
Copyright

A numerical, two-dimensional study of the jet interaction is presented. Emphasis is placed on optimization of the aerodynamic control force by examining in detail the force amplification parameters. The investigation first covers flat plates with slot-injection of sonic jet. For this configuration much experimental data exists and it is used to validate the present numerical simulations. The parameters investigated are the jet injection pressure, the free stream Mach number, and the angle of injection. The initial transient solution during which the interaction flow field is formed, is also presented. The effect of the ogival an elliptic nose shapes having attached and detached shock waves, on the jet interaction is studied. The shock significantly affects the jet induced flow field, but the force amplification factors were surprisingly similar to the flat plate results. Author

A93-14397
STABILITY CONSIDERATIONS FOR ENHANCED MANOEUVRABILITY - AN OVERVIEW
S. C. GUPTA (Defence Research and Development Organisation, Bangalore, India) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1998-2005a. refs
Copyright

The aircraft characteristics relevant to enhanced maneuverability are discussed. Particular attention is given to questions of static stability, dynamic stability, cross derivatives, and inertia coupling. It is concluded that enhanced maneuverability and controllability in pitch is possible through canard and LEF. I.S.

A93-14398
THE INFLUENCE OF FIGHTER AGILITY ON AIR COMBAT EFFECTIVENESS
HAO GAO, XIAO-GUANG GAO, and SHU-GUANG ZHANG (Northwestern Polytechnical Univ., Xian, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 2006-2009. refs
Copyright

The relationship between the fighter's agility and its effectiveness in air combat is examined, using a one-to-one air combat computer simulation model to qualitatively and quantitatively compare the effects of various parameters on the survival probability of fighters engaged in air combat. The results demonstrate that improving a fighter's agility can greatly increase its combat capability at a reasonable cost, although other factors may be important. It is shown that roll ability seems to relate to pitch ability to a reasonable extent. I.S.

A93-14399
ESTIMATION OF THE PROBABILITY OF LARGE FLIGHT PARAMETERS DEVIATIONS
V. P. KUZMIN and V. A. IAROSHEVSKII (TsAGI, Zhukovski, Russia) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 2010-2015. refs
Copyright

A methodology is proposed for estimating the probability of flight-trajectory parameter deviations at a given point or throughout the whole flight time. For problems of the first type, when the trajectory parameters are defined at a fixed moment in time, the proposed method is confined to calculations of several hundred realizations regardless of the value of the probability. For problems in which the parameters are defined at a certain interval of time, the proposed method can be used only in cases in which the 'aircraft-control system' is similar to a dynamic system of the first or the second order. Results obtained with these methods are compared with other analytical and numerical estimates for several model examples. I.S.

A93-14400
A SENSITIVITY ANALYSIS OF THE STABILITY OF A TUG-ROPE-SAILPLANE SYSTEM
GUIDO DE MATTEIS and LUCIANO M. DE SOCIO (Rome I Univ., Italy) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 2016-2023. Research supported by MURST refs
Copyright

An analysis is carried out of the stability of a tug-rope-glider system, with particular attention given to the sensitivity of the characteristic modes to changes of the system parameters for motions in and out of the vertical longitudinal plane. The results identify parameters which affect the dynamics of the system as well as parameters which have no such effect. The effect of the cable characteristics on the motion of the whole system is also discussed. I.S.

A93-14401
A NEW METHOD FOR CALCULATION OF HELICOPTER MANEUVERING FLIGHT
Y. H. CAO and Z. GAO (Nanjing Aeronautical Inst., China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 2024-2029. Research supported by National Education Committee refs
Copyright

A set of nonlinear equations governing the helicopter in maneuvering flight is developed and solved based on finite difference methods for evaluating the extreme value of function. The inverse solution technique is improved, from which a good result of the sample calculation of the level turn maneuver is obtained. Beginning with a set of prescribed flight conditions, this method calculates the flight path, the velocity, and other kinematic parameters first; then, the control displacement, the flight attitude, and the load factor for a helicopter during the maneuvering are calculated. Author

A93-14587
DESIGN OF REDUCED-ORDER OBSERVERS WITH PRECISE LOOP TRANSFER RECOVERY
MOGHEN M. MONAHEMI, JEWEL B. BARLOW, and DIANNE P. O'LEARY (Maryland Univ., College Park) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090) vol. 15, no. 6 Nov.-Dec. 1992 p. 1320-1326. Previously cited in issue 21, p. 3600, Accession no. A91-49689 refs
(Contract AF-AFOSR-87-0158)
Copyright

A93-14594
DESIGN AND ROBUSTNESS ISSUES FOR HIGHLY AUGMENTED HELICOPTER CONTROLS
STEPHEN OSDER and DONALD CALDWELL (McDonnell Douglas Helicopter Co., Mesa, AZ) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090) vol. 15, no. 6 Nov.-Dec. 1992 p. 1375-1380. Previously cited in issue 21, p. 3600, Accession no. A91-49708 refs
Copyright

A93-14595* National Aeronautics and Space Administration, Washington, DC.
STOCHASTIC MEASURES OF PERFORMANCE ROBUSTNESS IN AIRCRAFT CONTROL SYSTEMS
LAURA R. RAY (Clemson Univ., SC) and ROBERT F. STENGEL (Princeton Univ., NJ) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090) vol. 15, no. 6 Nov.-Dec. 1992 p. 1381-1387. Previously cited in issue 21, p. 3316, Accession no. A90-47665 Research sponsored by FAA refs
(Contract NGL-31-001-252; DAAL03-89-K-0092)
Copyright

A93-14596* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ANALYSIS OF AIRFRAME AND ENGINE CONTROL INTERACTIONS AND INTEGRATED FLIGHT/PROPULSION CONTROL
JOHN D. SCHIERMAN and DAVID K. SCHMIDT (Arizona State Univ., Tempe) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090) vol. 15, no. 6 Nov.-Dec. 1992 p. 1388-1396. Previously cited in issue 17, p. 2653, Accession no. A90-40557 refs
(Contract NAG3-998)
Copyright

A93-14630
THE INTEGRATED ACTUATION PACKAGE APPROACH TO PRIMARY FLIGHT CONTROL
HAP ACEE (Lucas Aerospace Power Transmission Corp., Utica, NY) Apr. 1992 11 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992 refs
(SAE PAPER 920968) Copyright

The integrated actuation package (IAP) which is based on an electric motor driven servopump to control actuator position is considered with particular attention given to a dual channel IAP produced for flight test evaluation on the Lockheed High Technology Test Bed (HTTB). It is concluded that the use of servopump driven at a constant speed and direction makes the IAP suited for the active role of primary flight control. Servopump systems are capable of converting conventional aircraft ac power to mechanical energy without extensive electronic conditioning coupled with the wide choice of control schemes which makes them flexible enough for retrofit applications. O.G.

A93-14635* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PHASE II SIMULATION EVALUATION OF THE FLYING QUALITIES OF TWO TILT-WING FLAP CONTROL CONCEPTS
LOURDES G. BIRCKELBAW and LLOYD D. CORLISS (NASA, Ames Research Center, Moffett Field, CA) Apr. 1992 14 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992 refs
(SAE PAPER 920988) Copyright

A simulation study was initiated to investigate alternative wing and flap controls for tilt-wing aircraft. The initial phase of the study compared the flying qualities of both a conventional (programmed) flap and an innovative geared flap. The second phase of the study, reported in this paper, introduced an alternate method for pilot control of the geared flap and further studied the flying qualities of the programmed flap, and two geared flap configurations. The results showed little difference among the three flap control configurations except during a longitudinal reposition task where the programmed flap configuration was the best. The addition of pitch attitude stabilization greatly enhanced the aircraft handling qualities. This paper describes the tilt-wing aircraft and the flap control concepts, and presents the results of the second simulation experiment. Author

A93-14645
AGILITY POTENTIAL
THOMAS J. CORD and JEFFREY A. BECK (USAF, Wright Lab., Wright-Patterson AFB, OH) Apr. 1992 16 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992
(SAE PAPER 921016) Copyright

The use of the word agility has represented a search for some undefined property of a system which accounts for the discrepancy between how a rotorcraft or an aircraft is flown and what performance metrics can be achieved. A method is proposed which quantifies the maximum capability of change available to a dynamic system within a set of constraints. Instead of looking at the specific value of agility (delta maneuver state per time or change in maneuver rate per time), this paper focuses on possible magnitudes of dynamic parameters and their derivatives. The intent is to provide a means to examine how current levels of agility are being used, and from that provide a data base which can be used to infer how much agility is needed. Aircraft equations are presented for body-axis pitch rate, stability-axis roll rate, normal load factor and their derivatives. These are constrained by stability, roll-coordination, and flight-control limiters. Author

A93-14660
LIMIT CYCLE IN THE LONGITUDINAL MOTION OF THE USB STOL ASKA - CONTROL SYSTEM FUNCTIONAL MOCKUP AND ACTUAL AIRCRAFT
HIROYUKI YAMATO (Tokyo Univ., Japan), TADAO UCHIDA, NORIAKI OKADA, TOSHIO OGAWA, AKIRA TADA (National Aerospace Lab., Chofu, Japan), ISOROKU UCHIKAWA, YOUICHI TAKESUE, and TAKASHI TSUJIMOTO (Kawasaki Heavy Industries, Ltd., Kakamigahara, Japan) Apr. 1992 13 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992 refs
(SAE PAPER 921040) Copyright

The Japanese Quiet Short Take Off and Landing experimental aircraft named ASKA was developed and flight tested during 1977 till 1989. The control system hard and software were examined by the functional mockup by using the actual hardware. The small longitudinal limit cycle was observed in the closed loop test when the pitch control wheel steering software was on in the mockup testing. In this paper the method to analyze and to expect the limit cycle based on the describing function was shown. The limit cycle was induced due to the nonlinearities in the automatic control mechanism. The nonlinearities in the hardware were examined to make the model simulate the system on the computer. The method was shown to be effective to predict the limit cycle in the mockup. Using the flight measured dynamics, the limit cycle was concluded to be on border line between existing and not, which coincides with the actual flight result. The functional mockup and the describing function method can provide an accurate prediction of the limit cycle in the actual aircraft. Author

A93-14818* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ADAPTIVE AEROELASTIC COMPOSITE WINGS - CONTROL AND OPTIMIZATION ISSUES
TERRENCE A. WEISSHAAR (Purdue Univ., West Lafayette, IN) and STEVEN M. EHLERS (McDonnell Douglas Technologies, Inc., San Diego, CA) Composites Engineering (ISSN 0961-9526) vol. 2, no. 5-7 1992 p. 457-476. refs
(Contract NSG-1157)
Copyright

High-performance aircraft are adaptive machines composed of internal structural skeletons to which are attached control surfaces operated by hydraulic muscles to allow them to maneuver. The flight crew, avionic sensors and systems function as the brain and nervous system to adapt the machine to changing flight conditions, such as take-off, cruise and landing. The development of new materials that can expand or contract on command or

change stiffness on demand will blur the now distinct boundaries between the structure, actuators and the control system. This paper discusses the use of imbedded active piezoelectric materials to change the aeroelastic stiffness of a lifting surface to allow this surface to control the aircraft. Expressions are developed for the piezoelectric material effectiveness when these active materials are combined with advanced composite structural materials for a swept, high-aspect-ratio wing. The interaction between advanced composite material properties and piezoelectric electromechanical properties is examined. The importance of choosing the proper active control laws is also illustrated. Author

A93-15046
A LONGITUDINAL CONTROL LAW INTEGRATING FLIGHT CONTROLS AND ENGINE CONTROLS [UNE LOI DE COMMANDE LONGITUDINALE INTEGRANT COMMANDES DE VOL/CONDUITE MOTEUR]
PANXIKA LARRAMENDY and JACQUES FARINEAU (Aerospatiale, Div. Avions, Toulouse, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 144 1990 p. 40-46. In French.
Copyright
The introduction of electrical flight controls and digital computers has led to a new era of civil aviation piloting. These multidimensional controls combine the effects of different control surfaces so that certain movements can be uncoupled from each other. This study focuses on the joint utilization of elevator controls, adjustable horizontal leveling, and engine thrust to control and uncouple pitch movement and aerodynamic speed. R.E.P.

A93-17310
HELICOPTER AUTOMATIC FLIGHT CONTROL SYSTEMS FOR ALL WEATHER OPERATIONS - EH101 AND BEYOND
KENNETH J. POTTER and BRIAN W. RAWNSLEY (Smiths Industries Aerospace & Defence Systems, Ltd., Cheltenham, United Kingdom) *In* Fixed and rotary wing all weather operations; Proceedings of the Conference, London, United Kingdom, Apr. 23, 24, 1991 London Royal Aeronautical Society 1991 p. 13.1-13.14. refs
Copyright
A development history and capabilities evaluation are presented for the SEP20 all-weather-operations autopilot modes, which have been carefully tailored to the slow approach speeds and final-approach deceleration that are typical of helicopters in the case of the EH101 rotorcraft. Attention is given to MLS steep and curved approaches, the effects of such novel sensor technologies as differentiated GPS and synthetic visual displays, CAT III approaches to helipads, and full-authority fly by wire automatic flight control. O.C.

N93-12578# Catholic Univ. of America, Washington, DC. Cognitive Science Lab.
ADAPTIVE AUTOMATION AND HUMAN PERFORMANCE: MULTI-TASK PERFORMANCE CHARACTERISTICS Final Report
RAJA PARASURAMAN, TOUFIK BAHRI, and ROBERT MOLLOY Mar. 1992 40 p
(AD-A254596; CSL-N91-1; NAWCADWAR-92035-60) Avail: CASI HC A03/MF A01
The present investigation had three major objectives: (1) develop software that provides a robust and sensitive set of flight-relevant tasks; (2) provide operator performance data for each flight task under normal (manual), single-task conditions; and (3) evaluate the sensitivity of operator performance on each task to changes in task difficulty and in the number and type of concurrent tasks performed. The overall goal was to provide an empirical 'baseline' from which the results of future adaptive-automation studies (in which task difficulty and operator workload would vary) could be successfully interpreted. Overall, the three studies were successful in meeting the first major goal of the adaptive automation research program: to establish a baseline of empirical performance data in a multi-task flight-simulation environment. These results will help in the design and interpretation of results of future adaptive-automation studies that will be carried out as part of this research program. GRA

N93-12903*# West Virginia Univ., Morgantown. Dept. of Mechanical and Aerospace Engineering.
DETERMINATION OF THE STABILITY AND CONTROL DERIVATIVES OF THE F/A-18 HARV FROM FLIGHT DATA USING THE MAXIMUM LIKELIHOOD METHOD Semiannual Status Report, May - Nov. 1992
MARCELLO R. NAPOLITANO and JOELLE M. SPAGNUOLO 12 Nov. 1992 12 p
(Contract NCC2-759)
(NASA-CR-191216; NAS 1.26:191216) Avail: CASI HC A03/MF A01
The research being conducted pertains to the determination of the stability and control derivatives of the F/A-18 High Alpha Research Vehicle (HARV) from flight data using the Maximum Likelihood Method. The document outlines the approach used in the parameter estimation (PID) process and briefly describes the mathematical modeling of the F/A-18 HARV and the maneuvers designed to generate a sufficient data base for the PID research. Author

N93-12959# Massachusetts Inst. of Tech., Cambridge. Lab. for Advanced Composites.
NONLINEAR STALL FLUTTER OF WINGS WITH BENDING-TORSION COUPLING Final Technical Report, 1 Feb. - 31 Oct. 1991
PETER E. DUNN and JOHN DUGUNDJI 31 Dec. 1991 277 p
(Contract AF-AFOSR-0159-91)
(AD-A254323; TELAC-91-16A; AFOSR-92-0783TR) Avail: CASI HC A13/MF A03
The nonlinear, stalled, aeroelastic behavior of rectangular, graphite/epoxy, cantilevered plates with varying amounts of bending-torsion stiffness coupling and with NACA 0012 Styrofoam airfoil shapes is investigated for low Reynolds number flow (less than 200,000). A general Rayleigh-Ritz formulation is used to calculate point load static deflections, and nonlinear static vibration frequencies and mode shapes for varying tip deflections. Nonlinear lift and moment aerodynamics are used in the context of the Rayleigh-Ritz formulation to calculate static airload deflections. The nonlinear, stalled ONERA model using non-constant coefficients - initially developed by Tran and Petot - is reformulated into a harmonic balance form and compared against a time-marching Runge-Kutta scheme. Low angle-of-attack, linear flutter calculations are done by applying Fourier analysis to extract the harmonic balance method and a Newton-Raphson solver to the resulting nonlinear. GRA

N93-13367*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ACTIVE FLUTTER SUPPRESSION USING DIPOLE FILTERS
S. SRINATHKUMAR (National Aeronautical Lab., Bangalore, India) and MARTIN R. WASZAK Sep. 1992 40 p
(Contract RTOP 505-64-52-03)
(NASA-TM-107594; NAS 1.15:107594) Avail: CASI HC A03/MF A01
By using traditional control concepts of gain root locus, the active suppression of a flutter mode of a flexible wing is examined. It is shown that the attraction of the unstable mode towards a critical system zero determines the degree to which the flutter mode can be stabilized. For control situations where the critical zero is adversely placed in the complex plane, a novel compensation scheme called a 'Dipole' filter is proposed. This filter ensures that the flutter mode is stabilized with acceptable control energy. The control strategy is illustrated by designing flutter suppression laws for an active flexible wing (AFW) wind-tunnel model, where minimal control effort solutions are mandated by control rate saturation problems caused by wind-tunnel turbulence. Author

N93-13566# National Aeronautical Lab., Bangalore (India). Flight Mechanics and Control Div.
IDEAL AIRCRAFT HANDLING QUALITY MODELS: LONGITUDINAL AXIS
SHAIK ISMAIL and SHYAM CHETTY Jun. 1992 18 p
(Contract NAL PROJ. FC-8-121)
(NAL-PD-FC-9203) Avail: CASI HC A03/MF A01

This document deals with an algorithm for generating Ideal Handling Quality Models for the Longitudinal Axes of modern high performance aircraft when a flight condition is specified. The technique solves a set of non-linear equations which express the performance requirements in terms of the unknown equivalent aircraft stability and control derivatives of the ideal models. The software package is developed using PC-MATLAB and the ideal HQ models are analyzed using the HQ package already developed. The designer can directly incorporate the ideal HQ models as reference models for his feedback synthesis. Author

N93-13735*# McDonnell Aircraft Co., Saint Louis, MO.
MULTIPLEXING ELECTRO-OPTIC ARCHITECTURES FOR ADVANCED AIRCRAFT INTEGRATED FLIGHT CONTROL SYSTEMS Final Report
D. W. SEAL Jun. 1989 90 p
(Contract NAS3-25345)
(NASA-CR-182268; NAS 1.26:182268) Avail: CASI HC A05/MF A01

This report describes the results of a 10 month program sponsored by NASA. The objective of this program was to evaluate various optical sensor modulation technologies and to design an optimal Electro-Optic Architecture (EOA) for servicing remote clusters of sensors and actuators in advanced aircraft flight control systems. The EOA's supply optical power to remote sensors and actuators, process the modulated optical signals returned from the sensors, and produce conditioned electrical signals acceptable for use by a digital flight control computer or Vehicle Management System (VMS) computer. This study was part of a multi-year initiative under the Fiber Optic Control System Integration (FOCSI) program to design, develop, and test a totally integrated fiber optic flight/propulsion control system for application to advanced aircraft. Unlike earlier FOCSI studies, this program concentrated on the design of the EOA interface rather than the optical transducer technology itself. Author

N93-13827 Texas Univ., Austin.
A DOMAIN DECOMPOSITION METHOD FOR PARALLEL TRANSIENT RESPONSE CALCULATIONS Ph.D. Thesis
JIANN-YUARN WU 1992 134 p
Avail: Univ. Microfilms Order No. DA9225768

The objective of this research is to develop parallel algorithms for transient response calculations of large-scale structures. The algorithms are based on a domain decomposition method. The essential idea is to divide a problem domain into a number of smaller subdomains so that the computation can be carried out in parallel. In the algorithms, transient responses of subdomains due to excitation within subdomains are computed independently. Then, these subdomain responses are corrected to give the solution of the global problem by taking into account the interaction between subdomains. In contrast to the approach of most domain decomposition methods, the correction is done directly rather than iteratively. In the first algorithm, piecewise linear interpolation in time is used to approximate the interaction between subdomains and subdomain responses computed independently are corrected at every time step. In the second algorithm, interface responses are sampled less frequently with the use of quintic interpolation functions between samples, which results in less computational effort for the correction of subdomain solutions. Although good accuracy of these methods has been shown on several numerical examples, they are only conditionally stable and their stability behavior is very complicated compared to global time-stepping algorithms. Motivated by this fact, an unconditionally stable parallel algorithm permitting multi-step independent subdomain computation is developed. Numerical experiments and implementation considerations are presented. Speedup factors obtained from benchmark problems are given. Dissert. Abstr.

N93-13872# Wright Lab., Wright-Patterson AFB, OH.
SYMPOSIUM PROCEEDINGS ON QUANTITATIVE FEEDBACK THEORY Final Report
CONSTANTINE H. HOUPIS and PHILLIP R. CHANDLER Aug. 1992 628 p *Symposium held in Fairborn, OH, 2-4 Aug. 1992*
(Contract AF PROJ. 2403)
(AD-A255527; WL-TR-92-3063) Avail: CASI HC A99/MF A06

This document contains the proceedings of Qualitative Feedback Theory (QFT) Symposium at Hope Hotel, WPAFB, OH on 2-4 August 1992. Included are QFT tutorials, and session papers on application to a wide variety of physical systems. The sessions include (1) Theory and Design, (2) Aerospace, and (3) Industrial applications. QFT is a Multiple-Input Multiple Output (MIMO) frequency based synthesis technique that explicitly employs quantitative performance standards and plant uncertainty during controller design. GRA

N93-13915 Notre Dame Univ., IN.
AN EXPERIMENTAL AND COMPUTATIONAL INVESTIGATION OF SLENDER WINGS UNDERGOING WING ROCK Ph.D. Thesis
ANDREW SALVATORE ARENA, JR. 1992 376 p
Avail: Univ. Microfilms Order No. DA9222008

The problem of self-induced roll oscillations of slender delta wings has been studied in order to identify physical mechanisms responsible for the limit cycle oscillations. The investigation is a combination of both experimental and computational methodologies. The experimental and computational investigations focussed on the wing rock characteristics of a slender flat plate delta wing with 80 degree leading edge sweep. Two unique experimental apparatus have been developed for the investigation. A free to roll system was developed using an air bearing spindle which allows the isolation of applied torques due to the flow field. An unsteady pressure acquisition system was also developed in order to measure the unsteady surface pressure distributions acting on the wing during wing rock time histories. The system consists of a motion control system which accurately matches the time dependent boundary conditions of wing rock, and is synchronized with a pressure acquisition system. The computational model is a discrete vortex potential flow method. The time dependent positions and strengths of the leading edge vortices are solved by coupling the flowfield equations to the rigid body equation of motion in roll for the wing. The computational model has captured all the qualitative characteristics of the wing motion and flowfield behavior observed in experiment with the exception of the secondary vortices which are not modelled. Based on the results of the experiment and computational investigations a theory has been developed for the cause of wing rock of slender wings. The theory is broad enough to account for variations in sweep angle and angle of attack. Wing rock is initiated by some initial perturbation or wing imperfection. The motion builds in time due to an instability caused by a time lag in the position of the vortices normal to the wing surface. A steady state is reached when damping contributions from the top and bottom surfaces are in equilibrium with the instability. Damping is provided by conventional roll damping on the bottom surface of the wing, and by the unsteady behavior of vortex strength on the top surface. Dissert. Abstr.

N93-13916 Rensselaer Polytechnic Inst., Troy, NY.
AN INVESTIGATION OF DYNAMIC STRESS REDUCTION OF MULTI-BODY AIRCRAFT USING ACTIVE GUST CONTROL Ph.D. Thesis
JOHN CHANG 1991 125 p
Avail:. Univ. Microfilms Order No. DA9220881

In the future there will be aircraft which are much larger than current aircraft now in service. It is important that their efficiency also be increased. One way to increase their efficiency is to reduce the percentage of gross weight devoted to structural weight. These savings can then be translated into payload weight increases. Structural weight savings can be achieved by reducing those

bending moments and/or torsion moments which design major parts of the structure. One way to attain this is to redistribute the load so as to be closer to where the lift is. A multibody aircraft can provide such advantages. Another means which is becoming increasingly acceptable is through active control alleviation of dynamic loads. Gusts usually define the structural design through fatigue allowables. By active control of control surfaces such as ailerons and elevators, it may be possible to reduce the bending moments resulting from gust encounters. This thesis will compare structural weight among three large aircraft designs: single-body, two-body and three-body on the basis of equal structural margins of safety. In addition it examines how a multibody aircraft with active control can further reduce the moments associated with response to gusts. This will then allow a further assessment of the extent to which structural weight can be reduced.
Dissert. Abstr.

N93-13928 Stanford Univ., CA.
HYPERSONIC PANEL FLUTTER IN A RAREFIED ATMOSPHERE Ph.D. Thesis
HUGO B. RESENDE 1992 118 p
Avail: Univ. Microfilms Order No. DA9221657

Panel flutter is a form of dynamic aeroelastic instability resulting from the interaction between motion of an aircraft structural panel and the aerodynamic loads exerted on that panel by air flowing past one of the faces. It is not usually catastrophic, the panel's motion being limited by nonlinear membrane stresses produced by the transverse displacement. Above some critical airflow condition, the linear instability grows to a limit cycle. The present investigation studies panel flutter in an aerodynamic regime known as 'free molecule flow', wherein intermolecular collisions can be neglected and loads are caused by interactions between individual molecules and the bounding surface. After collision with the panel, molecules may be reflected specularly or reemitted in diffuse fashion. Two parameters characterize this process: the 'momentum accommodation coefficient', which is the fraction of the specularly reflected molecules; and the ratio between the panel temperature and that of the free airstream. This model is relevant to the case of hypersonic flight vehicles traveling at very high altitudes and especially for panels oriented parallel to the airstream or in the vehicle's lee. Under these conditions the aerodynamic shear stress turns out to be considerably larger than the surface pressures, and shear effects must be included in the model. This is accomplished by means of distributed longitudinal and bending loads. The former can cause the panel to buckle. In the example of a simply-supported panel, it turns out that the second mode of free vibration tends to dominate the flutter solution, which is carried out by a Galerkin analysis. Several parametric studies are presented. They include the effects of (1) temperature ratio; (2) momentum accommodation coefficient; (3) spring parameters, which are associated with how the panel is connected to adjacent structures; (4) a parameter which relates compressive end load to its value which would cause classical column buckling; (5) a parameter proportional to the pressure differential between the front and back faces; and (6) initial curvature. The research is completed by an investigation into the possibility of accounting for molecular collisions, which proves to be infeasible given the speeds of current mainframe supercomputers. Dissert. Abstr.

N93-14252# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
AN EXAMINATION OF WING ROCK FOR THE F-15 M.S. Thesis
MICHAEL T. DAVISON Feb. 1992 169 p
(AD-A256613; AFIT/GAE/ENY/92M-01) Avail: CASI HC A08/MF A02

Wing rock in the F-15 was examined both analytically and experimentally. Using a previously developed model for the F-15, bifurcation analysis and continuation techniques were used to map out the periodic wing rock solutions and the equilibrium solutions leading up to wing rock. This was done for four maneuvers: a 1 g stall, rudder sweeps, constant bank turns, and a symmetric pullup. To supplement this research, time history simulations were used to examine the time history of wing rock. A study of stability derivatives was also performed to determine the critical parameters in wing rock. Bifurcation was also used to study candidate feedback architectures used to suppress wing rock. It was found that feeding back roll rate was effective in delaying wing rock onset and suppressing the subsequent motion, but this made the aircraft more departure prone. The results of the 1 g stall, constant bank turns, and the symmetric pullup were experimentally tested through flight test. Wing rock onset differed 4 degrees AOA from that predicted in all maneuvers but the symmetric pullup, where the flight Mach number correlated with the computer model's flight condition/wing rock was found to be highly random and non periodic, directly contradicting computer predictions and prior research. GRA

N93-14608# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
MULTIPLE MODEL ADAPTIVE ESTIMATION APPLIED TO THE VISTA F-16 WITH ACTUATOR AND SENSOR FAILURES M.S. Thesis
TIMOTHY E. MENKE 1 Jun. 1992 222 p
(AD-A256444; AFIT/GA/ENG/92J-01) Avail: CASI HC A10/MF A03

A Multiple Model Adaptive Estimation (MMAE) algorithm is applied to the Variable Stability In-flight Simulator Test Aircraft (VISTA) F-16 at a low dynamic pressure flight condition (0.4 Mach at 20,000 ft). A complete F-16 flight control system is modeled containing the longitudinal and lateral-directional axes. Single and dual actuator and sensor failures are simulated including: complete actuator failures, partial actuator failures, complete sensor failures, increased sensor noise, sensor biases, dual complete actuator failures, dual complete sensor failures, and combinations of actuator and sensor failures. Failure scenarios are examined in both maneuvering and straight and level flight conditions. Single scalar residual monitoring techniques are evaluated with suggestions for improved performance. A hierarchical moving bank structure is utilized for multiple failure scenarios. Simultaneous dual failures are included within the study. White Gaussian noise is included to simulate the effects of atmospheric disturbances, and white Gaussian noise is added to the measurements to simulate the effects of sensor noise. GRA

N93-14830 Georgia Inst. of Tech., Atlanta.
FINITE-STATE INFLOW APPLIED TO AEROELASTIC FLUTTER OF FIXED AND ROTATING WINGS Ph.D. Thesis
BRUCE DAVID NIBBELINK 1992 154 p
Avail: Univ. Microfilms Order No. DA9231746

A new p-type, finite-state, aerodynamic theory is used in the aeroelastic analysis of a fixed wing and a rotating wing in hover. The helicopter inflow theory is modified for application to a fixed-wing, or stopped-rotor configuration. The structural models are linear for both configurations, with elastic bending and torsion degrees of freedom. Results are compared with those using Theodorsen and Loewy theories, respectively, for the fixed and rotating wings. These results include steady and unsteady sectional lift distributions, as well as frequency and damping values as a function of the location of the centroidal axis. For the fixed wing, it is shown that dynamic inflow theory gives good qualitative behavior for the lift and aeroelastic properties of the limiting, stopped-rotor case. For the rotating wing, the results give new insight into the physics of the complex inflow/blade dynamics system. With the identification of both structural and aerodynamic modes, the involved frequency content of the flow is seen in a new, more detailed perspective. Dissert. Abstr.

N93-14831*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ICING EFFECTS ON AIRCRAFT STABILITY AND CONTROL DETERMINED FROM FLIGHT DATA: PRELIMINARY RESULTS
T. P. RATVASKY and R. J. RANAUDO Jan. 1993 28 p
Presented at the 31st Aerospace Sciences Meeting and Exhibit, Reno, NV, 11-14 Jan. 1993

(Contract RTOP 505-68-10)
(NASA-TM-105977; E-7500; NAS 1.15:105977; AIAA PAPER 93-0398) Avail: CASI HC A03/MF A01

The effects of airframe icing on the stability and control characteristics of the NASA DH-6 Twin Otter icing research aircraft were investigated by flight test. The flight program was developed to obtain the stability and control parameters of the DH-6 in a baseline ('uniced') configuration and an 'artificially iced' configuration for specified thrust conditions. Stability and control parameter identification maneuvers were performed over a wide range of angles of attack for wing flaps retracted (0 deg) and wing flaps partially deflected (10 deg). Engine power was adjusted to hold thrust constant at one of three thrust coefficients (C(sub T) = 0.14, C(sub T) = 0.07, C(subT) = 0.00). This paper presents only the pitching- and yawing-moment results from the flight test program. Stability and control parameters were estimated for the uniced and artificially iced configurations using a modified stepwise regression algorithm. Comparisons of the uniced and iced stability and control parameters are presented for the majority of the flight envelope. The artificial ice reduced the elevator and rudder control effectiveness by 12 percent and 8 percent respectively for the 0 deg flap setting. The longitudinal static stability was also decreased substantially (approximately 10 percent) because of the tail ice. Further discussion is provided to explain some of the effects of ice on the stability and control parameters. Author

N93-14835 Princeton Univ., NJ.
ROBUST NONLINEAR FEEDBACK GUIDANCE FOR AN AEROSPACE PLANE: A GEOMETRIC APPROACH Ph.D. Thesis
MARKUS ANTONIUS VANBUREN 1992 250 p
Avail: Univ. Microfilms Order No. DA9230652

Single-stage-to-orbit vehicles using airbreathing propulsion -- referred to as aerospace planes -- hold promise for more economical delivery of payload to low Earth orbit. Feedback guidance logic is developed for efficiently and effectively steering such a vehicle through the atmosphere and into orbit. Accurate and robust regulation of the vehicle translational dynamics is considered first. A nonlinear design approach drawing from singular perturbations, feedback linearization, and variable structure control is employed to synthesize regulators which lead to similar dynamic behavior over the entire flight envelope. The design approach provides for a systematic way to counter disturbance effects as well as modeling uncertainties. Differential geometry provides a common framework for the three nonlinear feedback control methodologies. The two-time-scale behavior present in the vehicle translational dynamics allows the state space to be decomposed into an invariant slow manifold and an invariant foliation of fast manifolds. Feedback guidance logic with robust performance is obtained by synthesizing a composite feedback control from a slow control for the regulation of the nominal slow dynamics along the slow manifold and a fast control for robust tracking of the slow manifold in the presence of atmospheric disturbances and modeling errors. The tracking problem is solved as a family of stabilization problems along the fast foliation, using the feedback linearization methodology. In the presence of boundable disturbances, uniform ultimate boundedness of the exactly linearized fast dynamics can be ensured through application of a smoothed variable structure controller. The two-time-scale decomposition also provides the basis for developing feedback guidance logic for steering and accelerating an aerospace plane along the super- and hypersonic segments of a near-minimum fuel ascent trajectory. Accurate solutions of the minimum-fuel ascent problem show the effects of dynamic pressure, axial load, and heating rate constraints and establish a basis for the development and assessment of the guidance logic. The minimum-fuel ascent trajectories are found to track the ascent corridor constraints. This characterization permits the formulation of the robust near-minimum-fuel ascent guidance problem as a robust tracking problem, which is amenable to the geometric feedback synthesis approach. Dissert. Abstr.

N93-15366*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SIMULATOR EVALUATION OF DISPLAYS FOR A REVISED TAKEOFF PERFORMANCE MONITORING SYSTEM
DAVID B. MIDDLETON, RAGHAVACHARI SRIVATSAN (Vigyan Research Associates, Inc., Hampton, VA.), and LEE H. PERSON, JR Washington Dec. 1992 45 p
(Contract RTOP 505-66-01-02)
(NASA-TP-3270; L-16761; NAS 1.60:3270) Avail: CASI HC A03/MF A01

Cockpit displays for a Takeoff Performance Monitoring System (TOPMS) to provide pilots with graphic and alphanumeric information pertinent to their decision to continue or abort a takeoff are evaluated. Revised head-down and newly developed head-up displays were implemented on electronic screens in the real-time Transport Systems Research Vehicle (TSRV) Simulator for the Boeing 737 airplane at the Langley Research Center and evaluated by 17 NASA, U.S. Air Force, airline, and industry pilots. Both types of displays were in color, but they were not dependent upon it. The TOPMS head-down display is composed of a runway graphic overlaid with symbolic status and advisory information related to both the expected takeoff point and the predicted stop point (in the event an abort becomes necessary). In addition, an overall Situation Advisory Flag indicates a preferred course of action based on analysis of the various elements of airplane performance and system status. A simpler head-up display conveys most of this same information and relates it to the visual scene. The evaluation pilots found the displays to be credible, easy to monitor, and appropriate for the task. In particular, the pilots said the head-up display was monitored with very little effort and did not obstruct or distract them from monitoring the simulated out-the-window runway scene. This report augments NASA TP-2908, 1989. Author

N93-15396# Naval Air Warfare Center, Patuxent River, MD. Aircraft Div.
F/A-18 CONTROLS RELEASED DEPARTURE RECOVERY FLIGHT TEST EVALUATION
DAVID L. PRATER, MARC G. STEVENS, and JAMES B. LACKEY 1991 20 p
(AD-A256522) Avail: CASI HC A03/MF A01

The F/A-18 has had a history of numerous departures from controlled flight during operational fleet use. Several of these departures have resulted in mishaps. The current flight manual procedure requires the pilot to neutralize the control stick for departure recovery, however many F/A-18 departures are characterized by high lateral forces making it difficult to maintain neutral longitudinal and lateral control stick position. Recent mishap investigations have questioned the viability of releasing the control stick as a more effective way of maintaining neutral controls thereby reducing recovery times. The Naval Air Warfare Center--Aircraft Division was tasked by Naval Air Systems Command to determine if releasing the control stick during departure recovery would result in any airplane induced control inputs that would delay recovery. Additionally, from the desire to improve departure awareness of all F/A-18 pilots, an assessment was made of the suitability of the test maneuvers for inclusion into an airborne departure recognition and out-of-control flight training syllabus. Testing was conducted using a fleet representative F/A-18D which did not incorporate any non-production emergency recovery devices (i.e., no spin recovery chute). Test maneuvers included both high and low angle of attack departures up to 0.80 IMN. GRA

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RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

A93-13910* National Aeronautics and Space Administration, Washington, DC.
SYSTEMS INTEGRATION TEST LABORATORY - APPLICATION AND EXPERIENCES
MELVYN RIMER, MICHAEL FALCO, and MICHAEL SOLAN (Grumman Corp., Space Systems Div., Bethpage, NY) *In* Space nuclear power systems; Proceedings of the 8th Symposium, Albuquerque, NM, Jan. 6-10, 1991. Pt. 3 New York American Institute of Physics 1991 p. 1181-1193. Research supported by DARPA, NASA, and USAF refs

The experiences gained from the development of the X-29 aircraft's digital flight control system is discussed. The master test plan, validation testing, verification testing, and flight hardware testing of the system are briefly reviewed, and the test facilities are described. Simulator verification and results are summarized. C.D.

A93-14274
DNW TEST HIGHLIGHTS RELATED TO AIRCRAFT ENVIRONMENT
H. U. MEIER and J. C. A. VAN DITSHUIZEN *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 961-968. refs

A survey is given of environmental problem areas in aerospace. Noise and pollution emission are discussed and related aspects like pollution distribution, propulsion technology improvements, energy saving by drag reduction, and noise reduction of aircraft are analyzed for potential applications of DNW. Typical examples of DNW tests are given in fields like noise reduction of aircraft, helicopters and propulsion units, integration of engines and airframe, and drag reduction by laminarization. Future activities will concentrate in these areas whereby research and technology programs initiated by the aerospace industry sponsored partly from EC BRITE/EURAM funds, will play an important role. Author

A93-14276
THE USE OF A DEEP HONEYCOMB TO ACHIEVE HIGH FLOW QUALITY IN THE ARA 9 FT X 8 FT TRANSONIC WIND TUNNEL
J. E. GREEN, C. A. MCHUGH, A. J. BAXENDALE, and D. R. STANNILAND (Aircraft Research Association, Ltd., Bedford, United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 979-990. refs

Until August 1990, the 9 ft x 8 ft Transonic Wind Tunnel at ARA Bedford relied on a single gauze screen, in combination with a relatively high contraction ratio, to achieve flow uniformity in the test section. This screen has now been replaced by a honeycomb with a high ratio of cell length to diameter. The paper sets out the reasons for the change, outlines the aerodynamic investigations that preceded it, describes the main features of interest in the honeycomb construction, and reports the resulting changes in tunnel flow quality. Detailed surveys of total pressure, flow direction, and turbulence show that a high degree of flow uniformity has been achieved across the whole of the test section, with unsteady velocity components of 0.1 percent longitudinally and 0.2 percent laterally. Mean flow velocity and direction is close to that which would be obtained with completely uniform reservoir conditions, and has remained unchanged since the honeycomb was installed. Author

A93-14299
EXTENDING THE USEFUL FREQUENCY OF 'RIGID' WIND TUNNEL MODELS WITH ACTIVE CONTROL
R. J. MCKINNELL and L. H. VAN ZYL (AEROTEK, Pretoria, South Africa) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1155-1160. refs

The use of active control in suppressing elastic deformation in wind-tunnel models is investigated analytically for a fighter-type wing with a trailing-edge control surface. The carbon-fiber wing is analyzed with modal data from the first three modes, and flutter and response analyses are performed over a range of frequencies. Pressure distributions calculated at 37 percent and 83 percent span are illustrated for 49 Hz and 20 Hz, and the control law is selected that completely suppresses the response of mode 1. The control activity is found to disturb the pressure field in the vicinity of the control surface to a large degree. The control-surface motion is found to impart additional pressure distribution that is of the same order of magnitude as the pressure distribution associated with the elastic deformation the control is intended to suppress. The present analysis is of use in assessing the effects of control laws on pressure distribution in a range of aerospace structures. C.C.S.

A93-14300
THE EFFECT OF WIND TUNNEL CONSTRAINT ON UNSTEADY AERODYNAMICS EXPERIMENTS
R. B. GREEN and R. A. MCD. GALBRAITH (Glasgow Univ., United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1161-1168. Research supported by SERC refs

The effects of wind-tunnel constraint during low-speed unsteady aerodynamics experiments are assessed by comparing the data from two NACA 0015 models, one with a chord length of half the other. To distinguish between the effects of the constraint upon separation and attachment, ramp-up and ramp-down tests are considered. The unsteady separation process measured in terms of the normal force, pitching moment and stall vortex convection speed is virtually unaffected by the difference in constraint between the two models, while the attachment process, assessed in terms of the normal force response and attachment behavior, is sensitive to the size of the model. Author

A93-14352
A LOW SPEED WIND-TUNNEL WITH EXTREME FLOW QUALITY - DESIGN AND TESTS
ARNE V. JOHANSSON (Royal Inst. of Technology, Stockholm, Sweden) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1603-1611. Research supported by Swedish Bank Foundation for Economic and Technical Research, FRN, and Goran Gustafsson Foundation refs

Aerodynamic design aspects and testing methodology for the construction of low-turbulence, low-noise wind tunnels are discussed on the basis of various design studies carried out in conjunction with the construction of a wind-tunnel. The design studies were carried out during a five year period and resulted in a tunnel with a combination of extremely low turbulence and noise levels, along with accurate temperature control. The streamwise turbulence intensity is below 0.02 percent over the total velocity interval investigated (10 - 60 m/s). The total length of the tunnel is approximately 25 m and the cross section of the 7-m test section measures 1.2 m x 0.8 m. The maximum velocity is 69 m/s with empty test section. Author

A93-14365
RAPID WIND TUNNEL PROTOTYPE USING STEREOLITHOGRAPHY AND EQUIVALENT TECHNOLOGIES
R. JAMIESON (Cranfield Inst. of Technology, United Kingdom) and J. HAMMOND (British Aerospace, PLC, Airbus Div., Bristol, United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1712-1722. refs
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Stereolithography is examined as a means for development of wind-tunnel aerospace models, and a small wing form is developed by means of four stereolithographic systems. The review discusses the use of stereolithography generally to point out the need for accurate CAD models for reference use. The four systems reviewed include rapid prototyping (RP) from scale models by means of: (1) 3D systems for solidifying a photosensitive liquid polymer with a laser beam; (2) EOS systems for solidification; (3) the Cubital machine using photopolymer solidification; and (4) selective laser sintering for powder fusing. Visual inspections and measuring devices are used to compare the accuracies of three wing components manufactured by the methods. The comparison reveals that the most accurate part is that produced by EOS technologies, and the RP technologies are shown to provide wind-tunnel model components of reasonable quality. C.C.S.

A93-14403
FIVE YEARS OPERATIONAL EXPERIENCES WITH INDONESIAN LOW SPEED TUNNEL (ILST)
A. ADIBROTO, FARIDUZZAMAN, and M. B. NASIRAN (Agency for the Assessment and Application of Technology, Serpong, Indonesia) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 2041-2044. refs
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Results are presented of five years of operational experience with the Indonesian Low Speed Tunnel (ILST), a high-quality closed-circuit return type atmospheric tunnel equipped with computerized measurement systems. The design features of ILST are discussed, and the half-model and full-model tests are described. Also discussed are the research and development activities at the ILST facility. I.S.

A93-14410
FLIGHT SIMULATOR DEVELOPMENT IN CHINA
XING R. WANG, XIAO Y. PENG, and QIN FENG (Beijing Univ. of Aeronautics and Astronautics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 2104-2109.
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The salient features of a recently developed flight simulator are discussed. The flight simulator consists of a digital computer system and interface, a 6-DOF motion system, a digital control loading system, a computer-generated imagery motion system, a flight compartment, and mathematical models and software modules. The Chinese simulator is being widely applied to engineering research and pilot training in China. I.S.

A93-14412
EXPERIMENTAL WORKING POSITION SIMULATOR TO ANALYSE, DEVELOP AND OPTIMIZE CONCEPTS FOR COMPUTER-AIDED AIR TRAFFIC MANAGEMENT
M. FRICKE and A. WATTLER (Berlin Univ. of Technology, Germany) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 2117-2127. refs
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The development and optimization of concepts and procedures for a future, computer-based Air Traffic Management (ATM) requires a very flexible and adaptable testbed which simulates both different air traffic scenarios and the working positions of air traffic controllers with regard to different ATM functions. The designed Experimental ATM Working Position Simulator represents an interactive realtime data processing system for traffic information, planning and coordination, and is supposed to assist the air traffic controller. Different software modules are implemented to simulate air traffic scenarios, to display flight plan data and flight trajectories and to make possible the controller's interaction with these modules. To support the controller in fulfilling its tasks, it was necessary to develop computer-based planning aids, including a (semi-)automated tool for the prediction and resolution of potential conflicts. Author

A93-14414
DESIGN PHILOSOPHIES OF THE BASIC RESEARCH SIMULATOR
S. K. ADVANI and M. BAARSPUL (Delft Univ. of Technology, Netherlands) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 2134-2143a. refs
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Principles applied to the design of the Basic Research Simulator are discussed and the simulator's hardware is described. Particular attention is given to the simulation of the motion system and of the flight-deck platform. The applications of the Basic Research Simulator facility include its use in the design of advanced hydraulic systems, in motion drive research, in studies related to the improvement of vehicle simulation models, in aircraft systems research, and in human factors research. I.S.

A93-14634
A SIMULATOR SOLUTION FOR THE PARACHUTE CANOPY CONTROL AND GUIDANCE TRAINING PROBLEM
JEFFREY R. HOGUE, WALTER A. JOHNSON, and R. W. ALLEN (Systems Technology, Inc., Hawthorne, CA) Apr. 1992 9 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992 refs
(SAE PAPER 920984) Copyright

A low-cost simulator that is specifically designed to teach and permit practice of professional parachuting skills is presented. This simulator allows an instructor to coach and instruct while a student maneuvers on a simulated parachute descent. Trainees are able to learn good parachute handling techniques and also learn the consequences of poor handling in complete safety. R.E.P.

A93-16934
ESTIMATION OF AERODYNAMIC CHARACTERISTICS FROM FLIGHT TEST DATA. II - ANALYSIS METHODS UNDER IN-FLIGHT WIND TUNNEL TEST CONCEPT
OSAMU KOBAYASHI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663) vol. 40, no. 466 1992 p. 617-626. In Japanese. refs

This is the second report of the paper which discusses the physical meaning between flight test data and analyses, by studying the equation error method. As the more inclusive concept in the equation error method, the 'in-flight wind tunnel test' concept is introduced. Under this concept, two methods can be suggested in addition to the equation error method, which respectively correspond to the output error method and the maximum likelihood method. Furthermore, it is shown that the equation error method has the built-in weighting function, which makes smaller the roles of the explanatory variables having noises as these noises increase. The modified use of the multiregression analysis, in the case that the noise variances in the explanatory variables are known, is described. Author

A93-17311
GROUND VISUAL AIDS - RECENT RESEARCH AT RAE BEDFORD
A. J. SMITH (Royal Aerospace Establishment, Bedford, United Kingdom) *In* Fixed and rotary wing all weather operations; Proceedings of the Conference, London, United Kingdom, Apr. 23, 24, 1991 London Royal Aeronautical Society 1991 p.

14.1-14.13.
Copyright

Visual aids are under development in support of helicopter operations in all weather conditions. Representative of these are the Horizontal Approach Path Indicator, an azimuth alignment system, a heliport beacon, and landing cues. Visual aids for airport taxying are also under development, giving attention to the integrity of power supplies and the use of state-of-the-art displays. A Precision Approach Path Indication system is noteworthy among these efforts. O.C.

N93-12552# Calspan Field Services, Inc., Arnold AFS, TN. Engineering Development Center Div.
DESIGN PHILOSOPHY FOR WIND TUNNEL MODEL POSITIONING SYSTEMS
H. D. HAGAR and R. G. BUTLER Apr. 1992 15 p
(Contract F40600-90-C-0002)
(AD-A254958) Avail: CASI HC A03/MF A01

Wind tunnel testing usually requires positioning of the aircraft model in the airstream. This paper presents the design philosophy for a typical generic automatic control system for use in the wind tunnel facilities at Arnold Engineering Development Center in Tullahoma, Tennessee, and is presently used to accurately control the position and/or velocity of an aircraft in one to six degrees of freedom while taking into account the effects of outside influences. Selection of feedback devices, controller design concepts, safeguard implementation, operator status and display capabilities, and mechanism movement simulation are topics that are addressed. GRA

N93-12668# Federal Aviation Administration, Atlantic City, NJ.
ILS MATHEMATICAL MODELING STUDY OF THE EFFECTS OF AN ASR-9 STRUCTURE AT THE LONG ISLAND MACARTHUR AIRPORT, ISLIP, NY Technical Report, Jun. 1992
JAMES D. RAMBONE Sep. 1992 24 p
(Contract FAA-T0603-S)
(DOT/FAA/CT-TN92/25) Avail: CASI HC A03/MF A01

This Technical Note describes the instrument landing system (ILS) math modeling performed by the Federal Aviation Administration (FAA) Technical Center at the request of the Eastern Region. Computed localizer data are presented showing the effects of an ASR-9 antenna structure proposed for construction on the performance of an ILS localizer serving runway 24 at the Long Island MacArthur Airport. The ASR-9 antenna structure was modeled at four proposed sites. The Eastern Region is concerned that radio frequency signal reflections from the ASR-9 structure may degrade the localizer course. Modeled course structure results indicate that category 1 localizer performance should be maintained with the Wilcox 8-element log periodic dipole antenna with the ASR-9 structure constructed at any of the proposed locations. The ASR-9 structure provided minimal signal interference at each site modeled. Computed clearance orbit results indicate satisfactory linearity, course crossover, and signal clearance levels. Author

N93-12899# Federal Aviation Administration, Atlantic City, NJ.
LIMITED PRODUCTION PRECISION RUNWAY MONITOR (PRM) MASTER TEST PLAN
THOMAS BRATTON Nov. 1992 36 p
(DOT/FAA/CT-TN92/23) Avail: CASI HC A03/MF A01

This Master Test Plan (MTP) establishes the basic framework to guide and direct the Limited Production (LP) Precision Runway Monitor (PRM) test program. This MTP explains the relationship between all test phases. It concerns the LP PRM system's readiness to be integrated into the National Airspace System (NAS). Sufficient detail is provided to define and direct the development of the next lower level of documentation. The MTP addresses the responsibilities of the LP PRM contractor and the Federal Aviation Administrator (FAA). Author

N93-12902# Federal Aviation Administration, Atlantic City, NJ.
PROTOTYPE STOP BAR SYSTEM EVALUATION AT JOHN F. KENNEDY INTERNATIONAL AIRPORT Final Report
ERIC S. KATZ and EARL S. STEIN Sep. 1992 47 p Original contains color illustrations
(DOT/FAA/CT-92/24) Avail: CASI HC A03/MF A01

A prototype stop bar system was installed and evaluated at John F. Kennedy International Airport. The purpose of the year-long evaluation was to gain operational experience on the use of a stop bar system and how it could possibly impact the air traffic system. To determine the effectiveness of the stop bar system, data were collected from both user pilots and air traffic controllers. Results of the pilot data indicate that the system is somewhat effective in preventing inadvertent runway incursions, but not as effective as stop bar systems operating at European airports. Results of the air traffic controller data indicate that although the majority of the controllers felt that stop bars are conceptually a good idea, almost all of them agreed that the system was not acceptable, especially when combined with the local control position at moderate to high traffic load. Author

N93-13213# Aircraft Research Association Ltd., Bedford (England).
ASTOVL MODEL ENGINE SIMULATORS FOR WIND TUNNEL RESEARCH
A. E. HARRIS, G. L. WILDE (TKD Ltd., England), V. J. SMITH (TKD Ltd., England), A. R. G. MUNDELL (Defence Research Agency, Farnborough, England), and D. P. DAVIDSON (Rotadata Ltd., Derby, England) *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 10 p Sep. 1992
Copyright Avail: CASI HC A02/MF A04

Feasibility studies have been conducted into the use of military turbine powered simulators (MTPS) for wind tunnel research on typical Harrier/AV8B and ASTOVL aircraft. The MTPS approach has shown significant promise for full simulation of inlet airflow ratio and nozzle thrust representations. The studies were made in two parts. In the first instance, simulation of the basic Pegasus of the Harrier/AV8B was examined. A simulator at 1 to 7.5 model scale using compressed air drive has been shown to be feasible. The design develops 467 SHP and is well adapted for use in available high-speed and low-speed wind tunnels. In the low-speed facility, a strut mounted arrangement coupled to the existing external force balance presents only minor difficulties; for the high-speed tunnel further work is required to develop/refine an internal balance/sting arrangement. Overboard bleed is used in an optimized manner to match cycle requirements to the need for minimum compressed air feed and bleed cross sectional area. In subsequent studies, cycles and layouts appropriate to the evolving ASTOVL powerplants have been examined. It is shown that MTPS designs can be developed to match a representative ASTOVL layout although compromises may be required to the support strut design to suit airfeed and bleed requirements. This paper concludes with a recommendation for a staged evolution of ASTOVL model simulations which is geared to a realistic ASTOVL project timescale in a cost effective manner. Author

N93-13407# National Science Foundation, Washington, DC.
SCIENTIFIC AND ENGINEERING RESEARCH FACILITIES AT UNIVERSITIES AND COLLEGES: 1992
Sep. 1992 138 p
(NSF-92-325) Avail: CASI HC A07/MF A02

The highlights of this survey are outlined in the introduction. Research facility refers to the physical plant in which research activities take place. Research space includes the net assigned square feet (NASF) of space in which organized research activities take place. Research space at universities and colleges contained in early 1992 an estimated 122 million NASF, based on 525 of the largest research-performing U.S. universities and colleges. Suitable research space increase 22 per cent from 1988-1992. Spending for research facility construction and repair renovation increased nearly $1 billion in expected spending between 1986 and 1991 (3.80 billion for 1990+91). Other highlights reported on results for different topics related to research facilities including research facilities at historically black colleges and universities. R.L.B.

N93-13447# Federal Aviation Administration, Atlantic City, NJ.
A NASPAC-BASED ANALYSIS OF THE DELAY AND COST EFFECTS OF THE DALLAS/FORT WORTH METROPLEX PLAN Technical Report, Sep. 1991 - Jul. 1992
JOSEPH M. RICHIE, DOUGLAS BAART, and ARTHUR POMERANTZ Dec. 1992 81 p
(Contract FAA-F2006-E)
(DOT/FAA/CT-TN92/21; DOT/FAA/AOR-100-93/007) Avail: CASI HC A05/MF A01

This technical note contains the findings and analysis of the effects of the Dallas/Fort Worth (DFW) Metroplex Plan on local and system-wide traffic delays. The National Airspace System Performance Analysis Capability (NASPAC) was used to perform this task, and calculates the local (DFW) and system-wide delays with and without the Metroplex Plan. Cost savings were derived using the cost of delay module based on these delays, on passenger cost, and on airline and aircraft specific cost. The results indicate that the plan will reduce delay in the years 1995, 2000, and 2005 at DFW and system-wide for all scenarios modeled. The Southwest Region will be using these results in its planning efforts to execute the Metroplex Plan. Author

N93-13542 Toronto Univ. (Ontario).
THE MODELLING OF TURBULENCE AND DOWNBURSTS FOR FLIGHT SIMULATORS Ph.D. Thesis
PAUL AARON ROBINSON 1990 394 p
Avail. Univ. Microfilms Order No. DANN59945

With their increasing complexity and sophistication, modern flight simulators have formed the core of commercial airline pilot training curricula. The fidelity of the simulation will have an effect on the quality of training provided, and in order to ensure its realism, all elements of a flight simulation must be modelled in such a way as to represent the actual system in as complete a manner as possible, including the presence of external disturbances due to the atmosphere. This study investigates the degree of complexity required in the simulation of turbulence and thunderstorm downburst wind shear for flight simulation. A turbulence model is presented which contains all the correlations found in homogeneous isotropic turbulence. As part of the development of this turbulence model a method is introduced by which a time series may be modulated to alter its statistical properties while not affecting its spectral properties. Several simplifications and alternate models are considered. This report also presents further developments in the simulation of thunderstorm downbursts. A single ring vortex system, a triple ring vortex system, and Joint Airport Weather Studies (JAWS) data are implemented on the UTIAS B-747 Flight Simulator. By means of pilot evaluations on this simulator, it was found that the inclusion of the isotropic turbulence correlations did not seem to affect the pilots' performance on aircraft response. Overall, spectral methods were favored as a means of generating turbulence for flight simulation. Pilot evaluations of the downburst models showed that both single and triple ring vortex systems produced similar pilot reactions to the actual downbursts (JAWS data). It is suggested that the ring vortex models be expanded upon to include more than one downburst cell. Dissert. Abstr.

N93-13712# National Science Foundation, Washington, DC.
NSF SCIENCE AND TECHNOLOGY CENTERS
Aug. 1992 70 p
(NSF-92-104; OMB-3145-0058) Avail: CASI HC A04/MF A01

The National Science Foundation (NSF) established the Science and Technology Centers (STC) Program in 1987 to fund important basic research and education activities and to encourage technology transfer and innovative approaches to interdisciplinary problems. The centers have the opportunity to explore new areas and build bridges among disciplines, institutions, and other sectors. They offer the basic research community a significant mechanism to take a longer term view of science and explore better and more effective ways to educate students. The distribution of these centers by scientific field is six in the biological sciences, three in computer and information science and engineering, one that spans both the behavioral science and computer and information science; five in the geosciences, and ten in the mathematical and physical sciences. A brief summary of administrative, scientific, and educational information on each Center is included. L.R.R.

N93-13882# Federal Aviation Administration, Washington, DC. Office of Airport Planning and Programming.
REPORT TO CONGRESS: STATE BLOCK GRANT PROGRAM
May 1992 189 p
(AD-A254569; DOT/FAA/PP-92-1) Avail: CASI HC A09/MF A02

The State Block Grant Pilot Program was authorized initially for two years by the Airport and Airway Safety and Capacity Expansion Act of 1987, which reauthorized the Airport Improvement Program (AIP). The pilot program was extended an additional year to a total of three years by the Aviation Safety and Capacity Expansion Act of 1990. The purpose of the State Block Grant Pilot Program is to identify administrative functions which might successfully be shifted to or shared with states in carrying out the AIP. The pilot program potentially allows greater state discretion in selecting and managing projects within several categories of AIP funding. The legislation directs the FAA to conduct a review and report to Congress recommendations for further action relating to state administration of the AIP. Detailed information about the pilot program, state-by-state findings, conclusions, as well as recommendations resulting from FAA review and evaluation are reported. L.R.R.

N93-14060 Ohio State Univ., Columbus.
AN INVESTIGATION OF JET ENGINE TEST CELL AERODYNAMICS BY MEANS OF SCALE MODEL TEST STUDIES WITH COMPARISONS TO FULL-SCALE TEST RESULTS Ph.D. Thesis
RICHARD JEFFREY FREULER 1991 180 p
Avail: Univ. Microfilms Order No. DA9211127

Using a methodology developed for modeling of engine test facilities and simulating turbofan engines, an investigation of large turbofan engine test cell aerodynamics was conducted by means of several scale model studies with comparisons to full-scale test results. The results of the scale model studies were used to determine recommended modifications to existing airline owned and operated test cell facilities which would improve the engine test environment and permit stable, reliable, and repeatable testing capability for the GE CF6-80C2 engine. In all cases, the full-scale test cells after modification met or exceeded the aerodynamic performance goals necessary to achieve the required stable and repeatable engine testing environment. Comparisons were made between the results of the model tests and the results obtained from the full-scale facilities after the modifications to each test cell were completed. Test cell performance parameters compared included front cell velocity, cell airflow, cell bypass ratio, inlet system total loss, cell depression, and bellmouth pressure distortion. Particular emphasis was focused on the ability of the model tests to correctly predict the amount of front cell airflow, and subsequently the cell bypass ratio, for the full-scale test cells. The model studies conducted as part of this work have helped bring needed changes to the considerations made in process of test cell design and have provided a solid basis for improved engine test facilities now in use by several airlines. The full-scale results and operational experiences included in this work have served to validate the model test methodology by successfully demonstrating that the implementation in full-scale of recommended modifications based on the model studies resulted in the achievement of specific test cell aerodynamic performance goals and engine parameter variation guidelines. A much improved understanding and heightened awareness of the fundamental importance of the aerodynamics of the large turbofan engine indoor testing environment have resulted in significantly improved engine test facilities now in use world-wide. Dissert. Abstr.

N93-14128# Army Engineer Waterways Experiment Station, Vicksburg, MS. Geotechnical Lab.
IN SITU MATERIAL CHARACTERIZATION FOR PAVEMENT EVALUATION BY THE SPECTRAL-ANALYSIS-OF-SURFACE-WAVES (SASW) METHOD Final Report
DON R. ALEXANDER Jul. 1992 171 p
(AD-A255660; WES/TR/GL-92-10) Avail: CASI HC A08/MF A02

Spectral-analysis-of-surface-waves (SASW) is a method of nondestructive testing for material characterization of pavement systems. SASW is based on the theory of stress waves propagating in elastic media with the key elements being the generation and measurement of Rayleigh waves. From these measurements, shear wave velocity and modulus profiles can be obtained for multilayered elastic systems. SASW tests were conducted on six airfield pavement sites. Young's modulus profiles from SASW were compared with moduli backcalculated using falling weight deflectometer test results and with laboratory values. Results indicate that SASW is a viable method for in situ characterization of pavement materials. Automation of testing and analyses techniques is needed for routine pavement evaluations. Research is needed to evaluate low strain effects on the moduli for surface, base, and subgrade materials and the effect of reflected waves on SASW measurements. GRA

N93-14238# Army Engineer Waterways Experiment Station, Vicksburg, MS. Geotechnical Lab.
REANALYSIS OF MULTIPLE-WHEEL LANDING GEAR TRAFFIC TESTS Final Report
RICHARD G. AHLVIN and JIM W. HALL, JR. Sep. 1992 35 p
(AD-A256593; WES/MP/GL-92-32) Avail: CASI HC A03/MF A01

Growth of aircraft to over a million pounds, with the need for many wheels to support such aircraft, has focused attention on the unduly conservative aspect of present equivalent single wheel load (ESWL) methods when applied to many grouped wheels. The assembly of all multiple-wheel accelerated traffic test data for use in reexamining ESWL methods provided an indication that the earliest multiple-wheel tests likely were treated extremely conservatively during their analysis some 40 years ago. Accordingly, these early tests (reported in TM 3-349) were subjected to a reexamination. The reexamination confirmed that the initial analysis was quite conservatively carried out. With the benefit of the added 40 years of research findings and experience with in-service pavements, a less conservative analysis can now be made and accepted with confidence. This report presents the reanalysis carried out and the revised pavement behavior indicated. GRA

N93-14559# Aerospace Medical Research Labs., Brooks AFB, TX.
ADVANTAGES OF USING A PROJECTED HEAD-UP DISPLAY IN A FLIGHT SIMULATOR Final Report, Jan. 1991 - Jun. 1992
PHILIPP W. PEPPLER Jul. 1992 14 p
(Contract AF PROJ. 1123)
(AD-A255332; AL-TR-1992-0042) Avail: CASI HC A03/MF A01

When viewing a real planar image through an aircraft head-up display (HUD) focused for 'infinity,' diplopia and other related problems render the HUD useless as a training device. Future flight simulator visual displays are being developed with real planar image projections; therefore, this problem must be resolved. Past research into decollimating aircraft HUD's for real planar visual displays presented several solutions, but major side effects limited the tasks that could be trained with a decollimated HUD. Recent advances in projector and graphics technology have made projecting a real planar HUD an attractive solution. Projected HUD technology at Armstrong Laboratory, Aircrew Training Research Division, Williams AFB, Arizona is described. The advantages of using a projected HUD were investigated and are discussed. Advantages of using projected HUDs in simulators with a real planar visual display are numerous. Projected HUD's are undoubtedly a technology for tomorrow. GRA

N93-14616# Mooij and Associates, Oegstgeest (Netherlands).
FLIGHT SIMULATION LEAVES THE GROUND
H. A. MOOIJ *In* NAL, Symposium on the Occasion of the Farewell of Prof. Dr. Ir. O. H. Gerlach as Chairman of the Board of the Foundation National Aerospace Laboratory NLR, The Netherlands p 59-84 1991
Avail: CASI HC A03/MF A01

The technology of flight simulators is reviewed. Four examples demonstrating the 'art' of flight simulation are given. The visual subsystem, which directly impacts the usefulness of flight simulators, is addressed. The need for high fidelity reproduction of vehicle handling, full scenario flight operations, and the possibility of answering a multitude of questions related to crew-vehicle integration as a reason to improve simulation facilities are discussed. ESA

N93-14809*# MCAT Inst., San Jose, CA.
STUDY OF OPTICAL TECHNIQUES FOR THE AMES UNITARY WIND TUNNEL. PART 5: INFRARED IMAGERY Progress Report
GEORGE LEE Nov. 1992 32 p
(Contract NCC2-716)
(NASA-CR-191385; NAS 1.26:191385; MCAT-92-020) Avail: CASI HC A03/MF A01

A survey of infrared thermography for aerodynamics was made. Particular attention was paid to boundary layer transition detection. IR thermography flow visualization of 2-D and 3-D separation was surveyed. Heat transfer measurements and surface temperature measurements were also covered. Comparisons of several commercial IR cameras were made. The use of a recently purchased IR camera in the Ames Unitary Plan Wind Tunnels was studied. Optical access for these facilities and the methods to scan typical models was investigated. Author

N93-15498*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
USER MANUAL FOR NASA LEWIS 10 BY 10 FOOT SUPERSONIC WIND TUNNEL
RONALD H. SOEDER 1992 54 p
(Contract RTOP 505-62-84)
(NASA-TM-105626; E-6967; NAS 1.15:105626) Avail: CASI HC A04/MF A01

This manual describes the 10- by 10-Foot Supersonic Wind Tunnel at the NASA Lewis Research Center and provides information for users who wish to conduct experiments in this facility. Tunnel performance operating envelopes of altitude, dynamic pressure, Reynolds number, total pressure, and total temperature as a function of test section Mach number are presented. Operating envelopes are shown for both the aerodynamic (closed) cycle and the propulsion (open) cycle. The tunnel test section Mach number range is 2.0 to 3.5. General support systems, such as air systems, hydraulic system, hydrogen system, fuel system, and Schlieren system, are described. Instrumentation and data processing and acquisition systems are also described. Pretest meeting formats and schedules are outlined. Tunnel user responsibility and personnel safety are also discussed. Author

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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.

A93-13824 National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
STIRLING ENGINE - AVAILABLE TOOLS FOR LONG-LIFE ASSESSMENT
GARY R. HALFORD and PAUL A. BARTOLOTTA (NASA, Lewis Research Center, Cleveland, OH) *In* Space nuclear power systems; Proceedings of the 8th Symposium, Albuquerque, NM, Jan. 6-10, 1991. Pt. 2 New York American Institute of Physics 1991 p. 581-585. Previously announced in STAR as N91-12980 refs
(Contract RTOP 590-13-11)
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A review is presented for the durability approaches applicable to long-time life assessment of Stirling engine hot-section components. The crucial elements are experimental techniques for generating long-time materials property data (both monotonic and cyclic flow and failure properties); analytic representations of slow strain rate material stress-strain response characteristics (monotonic and cyclic constitutive relations) at high temperatures and low stresses and strains; analytic creep-fatigue-environmental interaction life prediction methods applicable to long lifetimes at high temperatures and small stresses and strains; and experimental verification of life predictions. Long-lifetime design criteria for materials of interest are woefully lacking. Designing against failures due to creep, creep-rupture, fatigue, environmental attack, and creep-failure-environmental interaction will require considerable extrapolation. Viscoplastic constitutive models and time-temperature parameters will have to be calibrated for the hot-section materials of interest. Analysis combined with limited verification testing in a short-time regime will be required to build confidence in long-lifetime durability models. Author

A93-14347
THE HERMES CARRIER AIRCRAFT (HCA)
FRITZ HORMANN (Deutsche Airbus GmbH, Hamburg, Germany) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1565-1570.
Copyright

The general objectives and ground segment of the Hermes program are summarized, and the mission requirements and design solutions of the Hermes Carrier Aircraft (HCA) are examined. Alternative solutions to HCA mission scenarios are considered. Candidate evaluation and selection are addressed. C.D.

A93-14633
INTEGRATED AIR SEPARATION AND PROPULSION SYSTEM FOR AEROSPACE PLANE WITH ATMOSPHERIC OXYGEN COLLECTION
V. V. BALEPIN and E. V. TIURIKOV (TsNII Aviatsionnogo Motorostroeniia, Moscow, Russia) Apr. 1992 10 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992 refs
(SAE PAPER 920974) Copyright

A preliminary design of an integrated air separation and propulsion system for a flight liquid oxygen plant is described. The system can be used for both single-stage and two-stage aerospace planes. Particular attention is given to results of the system's implementation in a two-stage Sanger type aerospace plane. The oxygen extraction is accomplished on a bank of vortex tubes of special configuration. The compressor of a low-speed turbojet engine operates as a pressure generator during the oxygen collection phase for an air separation system. Following oxygen extraction depleted air is supposed to be actively used in one of the power-plant combustion chambers. O.G.

A93-16412
DEVELOPMENT OF A MODEL-BASED MONITORING SYSTEM FOR TURBINE AND ROCKET ENGINES
DAN T. HORAK and BRYAN H. ALLISON (Allied-Signal Aerospace Co., Columbia, MD) *In* Annual Health Monitoring Conference for Space Propulsion Systems, 3rd, Cincinnati, OH, Nov. 13, 14, 1991, Proceedings Cincinnati, OH University of Cincinnati 1991 p. 228-247. refs
Copyright

We describe a project aimed at developing a model-based monitoring system for turbine and rocket engines which is capable of monitoring engines accurately and reliably during all stages of flight, and detecting and isolating sensor, actuator and system failures. Our goal is to demonstrate the feasibility of such a system by including in the laboratory prototype all the functions required in a system that can monitor real engines. Emphasis is placed on accommodating model imperfections which are the main obstacle to reliable model-based monitoring of mechanical and thermofluid systems such as engines. Author

A93-16878
ZVEZDA - THE RUSSIAN PIONEER IN THE FIELD OF LIFE-SUPPORT AND ESCAPE SYSTEMS FOR AERONAUTICS AND SPACE [ZVEZDA - LE PIONNIER RUSSE DES SYSTEMES DE SAUVETAGE ET DE SUPPORT-VIE POUR L'AERONAUTIQUE ET L'ESPACE]
GEORGES GUTMAN (Intertechnique, Plaisir, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 156 1992 p. 32-37. In French.
Copyright

A review is presented of the Russian corporation, Zvezda, which has the design and development capabilities of completely integrated life-support and escape systems ranging from helicopters to high-performance combat aircraft and space vehicles. A comparative table is provided giving the statistical results of actual military aircraft ejection seat injuries reported for the principal fighters/ejection systems of the world. R.E.P.

N93-12575# California Univ., San Diego, La Jolla. Dept. of Applied Mechanics and Engineering Sciences.
AFOSR CONTRACTORS MEETING IN PROPULSION
M. A. BIRKAN and J. M. TISHKOFF 7 Jul. 1992 299 p Meeting held in La Jolla, CA, 15-19 Jun. 1992
(Contract AF PROJ. 2308)
(AD-A254484; AFOSR-92-0740TR) Avail: CASI HC A13/MF A03

Abstracts are given for research in airbreathing combustion, rocket propulsion, and diagnostics in reacting media. The research was supported by the Air Force Office of Scientific Research. GRA

N93-13922 Stanford Univ., CA.
AERONOMY COEXPERIMENTS ON DRAG-FREE SATELLITES WITH PROPORTIONAL THRUSTERS: GP-B AND STEP Ph.D. Thesis
YUSUF R. JAFRY 1992 369 p
Avail: Univ. Microfilms Order No. DA9221629

GP-B and STEP are two proposed experiments in basic physics which will utilize drag-free spacecraft in 600 km polar orbits around the earth. By monitoring the activity of the drag-free compensators, it will be possible to obtain in situ drag measurements from which variations in atmospheric density and winds can be observed with unprecedented resolution. With the inclusion of neutral mass spectrometers, it will be possible to distinguish the effects of the various species; thus significantly enhancing the aeronomic contribution of the drag data. The drag information will be contained in both the motion of the spacecraft about the drag-free proof-mass, and the thruster activity. A new smoother has been developed to deconvolve the net forces from the proof-mass sensor

measurements. The smoother is an adaptation of an existing algorithm, which has been tailored to cater for completely unknown inputs. After the deconvolution process, the thrust force must be subtracted from the net force to yield the estimate of the drag. Hence, the accuracy of the drag measurements will ultimately depend on the accuracy of the thruster calibration. Perhaps the largest source of uncertainty will be associated with impingement of the thruster plumes on the spacecraft surfaces. It is thus desirable to model these effects. Owing to the low thrust levels, the flow through the GP-B nozzles will be highly rarefied, rendering the conventional continuum model invalid. An experimental procedure was thus devised to characterize the plume structure. A mass spectrometer, modified from a helium leak detector, was used to measure the mass flux distribution. The observed plume shapes were found to be essentially unchanged with mass flow. The experimental results were compared with Boyd's DSMC solutions pertaining to the nozzle geometries and flow conditions used in the experiments. For the assumption of diffuse interaction with the nozzle walls, the numerical results were found to be in excellent agreement with the experimental results. From the results of the plume study, it is concluded that the impingement effects will not be significantly detrimental to the aeronomy coexperiments. Dissert. Abstr.

N93-14495*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
FACILITIES AND CAPABILITIES CATALOG FOR LANDING AND ESCAPE SYSTEMS
ROBERT E. MEYERSON, ed. Aug. 1992 232 p Prepared in cooperation with National Parachute Technology Council, Albuquerque, NM
(Contract RTOP 906-11-00)
(NASA-RP-1282; S-682; NAS 1.61:1282) Avail: CASI HC A11/MF A03

This catalog serves as a single source reference for designers of landing and escape systems for spacecraft, aircraft, weapons, and airdrop system. It includes those facilities which may be required by a system designer in planning a development test program for many applications. The primary objective of this catalog is to provide a means for identifying critical facilities with the U.S. which can be used for the development of landing and escape systems. A secondary objective is to provide a useful tool to the system designer for picking and choosing facilities and capabilities. The six chapters in this volume include wind tunnels, drop zones, test aircraft, fabrication facilities, design tools, and other miscellaneous facilities. A different data sheet format is used for each of the chapters which provides information on performance, location, special capabilities, and a local point of contact. All inputs were solicited from the individual facilities and have not been independently verified for accuracy. Author

N93-15528*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AEROTHERMODYNAMIC FLOW PHENOMENA OF THE AIRFRAME-INTEGRATED SUPERSONIC COMBUSTION RAMJET
JAMES T. WALTON Nov. 1992 24 p
(NASA-TM-4376; E-6751; NAS 1.15:4376) Avail: CASI HC A03/MF A01

The unique component flow phenomena is discussed of the airframe-integrated supersonic combustion ramjet (scramjet) in a format geared towards new players in the arena of hypersonic propulsion. After giving an overview of the scramjet aerothermodynamic cycle, the characteristics are then covered individually of the vehicle forebody, inlet, combustor, and vehicle afterbody/nozzle. Attention is given to phenomena such as inlet speeding, inlet starting, inlet spillage, fuel injection, thermal choking, and combustor-inlet interaction. 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.

A93-14101
FUNDAMENTALS OF COMPOSITE REPAIR
J. A. FENBERT and J. C. SEFERIS (Washington Univ., Seattle) Jan. 1992 18 p. Society of Manufacturing Engineers, Conference on Composites in Manufacturing '92, Anaheim, CA, Jan. 7, 8, 1992 Research supported by Toray Industries, Inc., Boeing Commercial Airplane Group, BF Goodrich Co., et al refs
(SME PAPER EM92-100) Copyright

A series of experiments has been designed whereby dissimilar matrices reinforced with the same continuous carbon fibers were fabricated by direct processing or bonding of precured laminates. Thermal analyses including differential scanning calorimetry and dynamic mechanical analysis were coupled with traditional mechanical tests to determine material compatability. R.E.P.

A93-14174
MECHANICAL TESTING ANALYSES OF NEW ALUMINIUM ALLOY SPF TYPICAL-PARTS IN AIRCRAFT
TIEMIN WU and TIECHENG TANG (Chengdu Aircraft Co., Development Div., China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 135-143. refs
Copyright

Mechanical tests are conducted on aluminum-alloy aircraft parts manufactured conventionally or by superplastic forming (SPF) to compare their strengths. Hat-section specimens are produced from the alloys 7475 and Lc4 by means of conventional stamp forming and with superplastic technologies as fine-grain sheets. Mechanical tests are conducted for tension bending, buckling, and fatigue, and the static and fatigue properties of the SPF and normal specimens are found to be approximately the same. SPF hat sections, however, can carry greater loads than the conventional counterparts, and 7475 SPF is shown to be of use in industrial applications for molding complicated configurations due to its high elongation at high temperatures. C.C.S.

A93-14292
USE OF ALTERNATIVE FUELS FOR AVIATION
V. DENISOV, V. MAVRITSKII, V. OVCHINNIKOV (TsAGI, Zhukovski, Russia), and V. ZAITSEV (INTERAVIAGAS, Russia) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1099-1102.
Copyright

The use of alternative fuels is evaluated for aviation purposes with attention given to liquified natural gas (LNG), liquified petroleum (LP), propane, methane, and hydrogen. Specific data are examined regarding the actual and projected availability of the fuels as well as their efficiency in aeronautical engines. Studies conducted for aviation uses of these fuels are reviewed including helicopter flight tests with LP, and the physical and performance characteristics of the alternative fuels are reviewed. The tradeoffs between fuel weight and efficiency are listed, and key costs assumed for the use of alternative fuels are examined including aircraft retrofitting and airport fuel facilities. The primary contention of the paper is that LNG and LP are good candidates for aviation applications and can reduce dependence on conventional fuels. C.C.S.

A93-14307
COMPRESSION AFTER IMPACT (CAI) PROPERTIES OF CF/PEEK (APC-2) AND CONVENTIONAL CF/EPOXY STIFFENED PANELS
TAKASHI ISHIKAWA, YOICHI HAYASHI, and MASAMICHI

MATSUSHIMA (National Aerospace Lab., Mitaka, Japan) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1225-1234a. Research supported by Science and Technology Agency of Japan refs
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Compression-after-impact (CAI) tests are conducted for stiffened panels as main components of aircraft wing structure. Difference of the delamination buckling behavior during CAI tests due to the material is compared in detail. Improvement of CAI strengths with AS4/PEEK (APC-2) over CF/epoxy is demonstrated. Before CAI testing, impact damages are given by a drop-weight impact analyzer and delamination area is measured by a drop-weight impact analyzer and delamination area is measured by a robotic ultrasonic NDI system. Relationships between impact energy and delamination area are obtained. Level-off in the area for CF/epoxy is related to the change of damage mode; from delamination to penetration. In the CF/PEEK specimens, delamination propagation is arrested at the onset of catastrophic failure, and hence, high CAI strengths are obtained. CAI strength of CF/PEEK with the best quality is improved 37 percent to that of CF/epoxy. Author

A93-14503
CARBON MONOXIDE EMISSIONS IN LEAN PREMIXED COMBUSTION
SANJAY M. CORREA (GE Research and Development Center, Schenectady, NY) Journal of Propulsion and Power (ISSN 0748-4658) vol. 8, no. 6 Nov.-Dec. 1992 p. 1144-1151. Research supported by Gas Research Inst refs
Copyright

Lean premixed combustion (LPC) is being used to meet NO(x) regulations on stationary gas-turbines and is also being considered for supersonic aircraft. For example, sub-10 ppm NO(x) levels (less than 1 g NO(x)/kg of fuel) have been demonstrated in stationary applications. Emissions of carbon monoxide is one of the issues limiting the ultimate NO(x) reduction attainable by LPC. CO produced in the flame stabilization zone can survive the flame and must be oxidized in the turbulent postflame gas, introducing a much greater dependence on aerodynamics than is the case for NO(x) (in lean premixed flames). This articles assesses three physical mechanisms that might quench CO oxidation reactions: (1) boundary-layer flow of nonequilibrium postflame gas over a cooled wall; (2) microscale mixing of nonequilibrium postflames gas with dilution jets; and (3) interaction between postflame CO burnout and acoustic waves that can accompany premixed combustion. Analyses in this article suggest that in all three cases the CO will generally burn out, but also indicate circumstances that could lead to quenching. Author

A93-14504
EXPERIMENTAL TECHNIQUES FOR THE ASSESSMENT OF FUEL THERMAL STABILITY
J. S. CHIN and A. H. LEFEBVRE (Purdue Univ., West Lafayette, IN) Journal of Propulsion and Power (ISSN 0748-4658) vol. 8, no. 6 Nov.-Dec. 1992 p. 1152-1156. Previously cited in issue 10, p. 1591, Accession no. A92-27052 refs
Copyright

A93-14658
IMPROVED LUBRICATING GREASES FOR AIRCRAFT WHEEL BEARINGS
J. P. DONER Apr. 1992 8 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992 refs
(SAE PAPER 921038) Copyright

Aircraft wheel manufacturers, bearing builders and airlines are looking for better greases to prolong the life of current bearings and provide protection during more severe future conditions. Laboratory test performance of present aircraft wheel bearing grease compared to enhanced greases is presented. It is concluded that greases containing synthetic oil with a viscosity higher than MIL-G-81322 products are best for aircraft wheel bearings. R.E.P.

A93-15029
THERMOPLASTIC AND THERMOSETTING MATRIX COMPOSITE STRUCTURES - COMPARISON OF MECHANICAL PROPERTIES [LES COMPOSITES STRUCTURAUX A MATRICE THERMOPLASTIQUE ET THERMODURCISSABLE - COMPARAISON DES PROPRIETES MECANIQUES]
PHILIPPE VAUTEY (Dassault Aviation, Dept. Technologies Nouvelles, Saint-Cloud, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 140 1990 p. 52-58. In French. refs
Copyright

A review is presented of the research and development in advanced composite materials that incorporate heat-setting and thermoplastic matrices. Attention is given to the mechanical properties of polymers, resins, and composites, focusing on their damage resistance characteristics. The investment costs required to produce these new composites for the structures and operational modes of future aircraft are considered. R.E.P.

A93-15031
THE DEVELOPMENT OF TITANIUM ALLOYS FOR GAS TURBINES [LE DEVELOPPEMENT D'ALLIAGES DE TITANE POUR LES TURBINES A GAZ]
R. H. JEAL (Rolls-Royce, PLC, Derby, United Kingdom) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 140 1990 p. 66-71. In French.
Copyright

The requirements and constraints imposed by gas turbine designers on the use of titanium alloys is discussed. Though the alloys and materials may differ for each of the components of a gas turbine engine, the basic requirement of maximum strength versus minimum weight remains one of the primary considerations. Attention is given to the principal characteristics of titanium in the manufacture of compressor blades, compressor disks, and the primary structures of the engine cold section. R.E.P.

A93-15346
AN IMPACT DYNAMICS INVESTIGATION ON SOME PROBLEMS IN BIRD STRIKE ON WINDSHIELDS OF HIGH SPEED AIRCRAFT
LI-LI WANG, XI-XIONG ZHU, SHAO-CHIU SHIH, SU GAN, and HE-SHENG BAO (Ningbo Univ., Zhejiang, China) Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 5, no. 3 Aug. 1992 p. 205-213. Translation. Previously cited in issue 22, p. 3921, Accession no. A92-53330 Research supported by Ministry of Aeronautics and Astronautics of China refs
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A93-15748
ACCURACY OF A SIMPLE HOLE DAMAGE ANALYSIS METHOD IN COMPOSITE STRUCTURES
RIKARD B. HESLEHURST (Univ. College; Australian Defence Force Academy, Canberra, Australia) *In* International SAMPE Symposium and Exhibition, 37th, Anaheim, CA, Mar. 9-12, 1992, Proceedings Covina, CA Society for the Advancement of Material and Process Engineering 1992 p. 321-332. refs
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The repair of aerospace composite structures has, for the most part, neglected analysis of the damage prior to repair design. In the majority of repair cases to date an analysis of the criticality of the damage would have produced a much simpler repair. The analysis techniques currently available require extensive computations and, hence, computer support. The author has developed a simple analysis technique which can be used in the field, and does not require a personal computer. This simple analysis of hole damage is compared with the more complex and traditional techniques. The results show that not only is the simple analysis accurate, it can provide a better estimate of the hole stress state. This simple hole damage analysis method is very useful for in-the-field composite repair design and aircraft battle damage repair. Author

A93-15757
DEVELOPMENT OF POLYIMIDE ADHESIVES FOR 371 C (700 F) STRUCTURAL PERFORMANCE FOR AEROSPACE BONDING APPLICATIONS - FM 680 SYSTEM
DALIP K. KOHLI (American Cyanamid Co., Havre de Grace, MD) *In* International SAMPE Symposium and Exhibition; 37th, Anaheim, CA, Mar. 9-12, 1992, Proceedings Covina, CA Society for the Advancement of Material and Process Engineering 1992 p. 430-439.
Copyright

Development of a new series of polyimide adhesives for aerospace structural bonding applications is described. The FM 680 family of condensation polyimide adhesives is based on Avimid N chemistry, and is designed for continuous service up to 371 C. These adhesives can be processed at 177 C in conventional autoclaves and develop optimum mechanical properties after a free standing post cure at 315 C to 371 C. The FM 680 product group (film, pastes and primers) is suitable for bonding metallic substrates and cocuring or secondary bonding of high temperature composite structures. This paper describes the development and the performance characteristics of these new polyimide adhesives. Author

A93-16623
ACCELERATED CORROSION FATIGUE TEST METHODS FOR AGING AIRCRAFT
S. H. SMITH, T. K. CHRISTMAN, F. W. BRUST, and M. L. OLIVER (Battelle, Columbus, OH) *In* 1991 SEM Spring Conference on Experimental Mechanics, Milwaukee, WI, June 10-13, 1991, Proceedings Bethel, CT Society for Experimental Mechanics, Inc. 1991 p. 328-335. refs
Copyright

The primary purpose of this paper is to present the results of recently developed analytical and experimental methods for corrosion fatigue evaluation of aging aircraft structures. The accelerated corrosion simulation techniques which were used are those experimental techniques for corrosion pitting and exfoliation corrosion as recommended by American Society of Testing and Materials (ASTM). The corrosion mechanism produced multisite fatigue damage initiation and subsequent fatigue cracking in specimens consisting of a collinear array of open fastener holes and subjected to a uniform tension cyclic stress. Various methods utilized in deriving linear elastic stress intensity factor solutions for multisite cracks emanating at a collinear array of fastener holes were examined for application to the experimental fatigue results. The experimental techniques, special instrumentation, and constant amplitude fatigue results for baseline and corroded 7075-T6, T651 and 2024-T3, T351 bare aluminum alloys are presented. Author

A93-17033
EFFECT OF STRESS LEVEL OF GUST CYCLES ON FATIGUE CRACK PROPAGATION BEHAVIOR (ACCELERATION AND RETARDATION OF CRACK PROPAGATION UNDER SIMPLIFIED FLIGHT SIMULATION LOADING)
HIROSHI MISAWA, SHOGO TOBE, and KOICHI AKITA (Tokyo Metropolitan Univ., Hachioji, Japan) Japan Society of Materials. Science, Journal (ISSN 0514-5163) vol. 41, no. 469 Oct. 1992 p. 1492-1498. In Japanese. refs
Copyright

The crack propagation behavior in 2024-T3 aluminum alloy sheet material was investigated during fatigue tests carried out under 11 conditions of flight simulation loading. It was found that, when the maximum stress of the ground-to-air cycle was equal to the maximum stress of gust cycles, the crack propagation rate was faster than that estimated by the linear damage law on the basis of crack propagation at constant stress amplitudes. When the maximum stress of gust cycles was 40 MPa or 80 MPa lower than that of the ground-to-air cycle, the crack propagation rate in a short crack was almost the same as the estimated value; with increasing crack length, the crack propagation slowed down, but then recovered to the estimated values as the crack length increased to approach the critical value of final fracture. When the maximum stress of gust cycles was 120 to 160 MPa lower than that of the ground-to-air cycle, the crack propagation rate was nearly equal to the estimated value, with no retardation behavior observed. I.S.

N93-12589*# Pratt and Whitney Aircraft, East Hartford, CT. Development Operations and Materials Engineering.
THERMAL BARRIER COATING LIFE PREDICTION MODEL DEVELOPMENT, PHASE 2 Final Report
SUSAN MANNING MEIER, KEITH D. SHEFFLER, and DAVID M. NISSLEY Jul. 1991 198 p
(Contract NAS3-23944)
(NASA-CR-189111; NAS 1.26:189111) Avail: CASI HC A09/MF A03

The objective of this program was to generate a life prediction model for electron-beam-physical vapor deposited (EB-PVD) zirconia thermal barrier coating (TBC) on gas turbine engine components. Specific activities involved in development of the EB-PVD life prediction model included measurement of EB-PVD ceramic physical and mechanical properties and adherence strength, measurement of the thermally grown oxide (TGO) growth kinetics, generation of quantitative cyclic thermal spallation life data, and development of a spallation life prediction model. Life data useful for model development was obtained by exposing instrumented, EB-PVD ceramic coated cylindrical specimens in a jet fueled burner rig. Monotonic compression and tensile mechanical tests and physical property tests were conducted to obtain the EB-PVD ceramic behavior required for burner rig specimen analysis. As part of that effort, a nonlinear constitutive model was developed for the EB-PVD ceramic. Spallation failure of the EB-PVD TBC system consistently occurred at the TGO-metal interface. Calculated out-of-plane stresses were a small fraction of that required to statically fail the TGO. Thus, EB-PVD spallation was attributed to the interfacial cracking caused by in-plane TGO strains. Since TGO mechanical properties were not measured in this program, calculation of the burner rig specimen TGO in-plane strains was performed by using alumina properties. A life model based on maximum in-plane TGO tensile mechanical strain and TGO thickness correlated the burner rig specimen EB-PVD ceramic spallation lives within a factor of about plus or minus 2X. Author

N93-12746# Pratt and Whitney Aircraft, West Palm Beach, FL. Government Engines and Space Propulsion.
FATIGUE IN SINGLE CRYSTAL NICKEL SUPERALLOYS Technical Progress Report, 16 Jun. - 15 Jul. 1992
DANIEL P. DELUCA 15 Jul. 1992 7 p
(Contract N00014-91-C-0124)
(AD-A254704; PW/GESP-FR-21998-09) Avail: CASI HC A02/MF A01

This program investigates the seemingly unusual behavior of single crystal airfoil materials. The fatigue initiation processes in single crystal (SC) materials are significantly more complicated and involved than fatigue initiation and subsequent behavior of a (single) macrocrack in conventional, isotropic, materials. To understand these differences is the major goal of this project. GRA

N93-13311*# Alabama Univ., Huntsville. Materials Processing Lab.
FNAS MODIFY MATRIC AND TRANSPARENT EXPERIMENTS Final Report, period ending Nov. 1991
GUY A. SMITH, SUE E. KOSTEN, and GARY L. WORKMAN Apr. 1992 50 p
(Contract NAS8-36955)
(NASA-CR-184442; NAS 1.26:184442) Avail: CASI HC A03/MF A01

Monotectic alloy materials are created by rapid melt/rapid solidification processing on the NASA KC-135. Separation of the uniform liquid into two liquids may occur by either of two processes; spinodal decomposition or nucleation followed by growth. In the first case, the liquid is unstable to composition waves, which form and grow, giving liquids of two different compositions. In the latter process discrete particles of the second liquid phase form via thermal fluctuations and then grow by diffusion. The two processes

are very different, with the determining process being dictated by temperature, composition, and thermodynamic characteristics of the alloy. The first two quantities are process variables, while the third is determined by electronic interactions between the atoms in the alloy. In either case the initial alloy decomposition is followed by coarsening, resulting in growth of the particle size at nearly constant volume fraction. In particular, reduced gravity experiments on monotectic solutions have shown a number of interesting results in the KC-135. Monotectic solutions exhibit a miscibility gap in the liquid state, and consequently, gravity driven forces can dominate the solidification parameters at 1 g. In reduced gravity however, the distribution of the phases is different, resulting in new and interesting microstructures. The Rapid Melt/Rapid Quench Furnace allows one to melt a sample and resolidify it in one parabola of the KC-135's flight path, thus eliminating any accumulative influence of multiple parabolas to affect the microstructure of the material. Author

N93-13414# Department of the Navy, Washington, DC.
HERMETIC SEALING AND EMI SHIELDING GASKET Patent Application
RAMANATHAN PANAYAPPAN, inventor (to Navy) (Courtney and Co., Philadelphia, PA.) and JOHN C. COOPER, inventor (to Navy) (Courtney and Co., Philadelphia, PA.) 2 Apr. 1992 15 p
(AD-D015359; US-PATENT-APPL-SN-864812; NAVY-CASE-70723) Avail: CASI HC A03/MF A01

A composition is disclosed for forming an electromagnetic interference (EMI) shielding gasket for installation against a metal object, such as an aluminum frame member of an aircraft, wherein the composition is comprised of a mixture of a prepolymer composition of a flexible polyurethane material, a sacrificial metallic material which provides electrical conductivity and anodic protection against corrosion of the metal object, and a curing agent for curing the prepolymer composition. The sacrificial metallic material can be a metal salt selected from the group consisting of water soluble zinc and cadmium salts. Water can also be present to serve two functions, as a curing agent for the polyurethane and as a foaming agent, producing carbon dioxide. A method is also providing for installing an EMI shielding gasket on an aircraft between a graphite skin panel and a metal frame member. The composition for forming the EMI shielding gasket on a metal surface can also include an agent that cleans the metal surface to which the gasket is applied. GRA

N93-14573# Cape Cod Research, Buzzards Bay, MA.
WATERBORNE POLYURETHANE BINDER RESINS FOR COMPLIANT AIRCRAFT COATINGS Final Report, 30 Aug. 1991 - 29 Feb. 1992
FRANCIS L. KOEHAN, REGINA M. STEWART, and WENDY M. GOMES Feb. 1992 32 p
(Contract N62269-91-C-0249)
(AD-A256246; NAWCADWAR-92060-60) Avail: CASI HC A03/MF A01

This Small Business Innovation Research (SBIR), Phase 1 research project investigated the feasibility of producing a one-component, water-borne, low volatile organic compounds (VOC) coating for the protection of naval aircraft and ground support equipment. Novel silane-terminated, silicone-modified, polyurethane copolymers were prepared and evaluated. GRA

N93-14627# Ecole Nationale Superieure de Mecanique et d'Aerotechnique, Poitiers (France).
COMBUSTION IN SUPERSONIC FLOWS
B. DESHAIES and M. CHAMPION *In* VKI, Modeling of Combustion and Turbulence 38 p 1992
Copyright Avail: CASI HC A03/MF A06

The main features of some basic elementary problems relevant to combustion in supersonic 1-D and 2-D flows involving premixed and nonpremixed configurations are presented. The flows are analyzed from a laminar stationary point of view. However, problems remain to be solved before designing and developing practical systems using supersonic combustion as a propulsion mechanism, and three different fields of investigation can be clearly identified: the influence of turbulence on combustion in a supersonic flow; special geometrical configurations have to be studied and developed to improve the mixing between oxidizer and combustible; and the stability of complex systems involving simultaneously, turbulence, combustion, shock waves, mixing, and boundary layers. ESA

N93-14726# Naval Air Warfare Center, Warminster, PA. Air Vehicle and Crew Systems Technology Dept.
HIP CONSOLIDATION OF ALUMINUM-RICH INTERMETALLIC ALLOYS AND THEIR COMPOSITES Final Report, Sep. 1990 - Sep. 1991
WILLIAM E. FRAZIER and MARY E. DONNELLAN 3 Feb. 1992 18 p
(NAWCADWAR-92003-60) Avail: CASI HC A03/MF A01

The near-net-shape processing of structural materials for application in advanced airframes and propulsion systems is of significant technological interest. The hot isostatic press (HIP) is considered an enabling technology for consolidating costly and difficult to melt-process intermetallics and intermetallic matrix composites (IMC). Concomitant with the development of HIP technology for IMC's is the formulation of intelligent processing of materials (IPM) concepts and technology. There has been significant research and development activity in the area of light weight, high temperature intermetallic alloys, e.g., alpha-two and gamma titanium aluminides. However, Al3Ti, an intermetallic which has a low density (3.35 gcm(exp -3)), a high elastic modulus (170 GPa), and a high melting point (1350 C) has received little scientific scrutiny, principally because of its intrinsically low ductility (1.2). Currently, research efforts are in progress examining the affects of rapid solidification, alloy chemistry, and consolidation processing on toughening. Rapid solidification enhances chemical uniformity and the addition of copper transforms the structure of Al3Ti from tetragonal DO(exp 22) into cubic L1(exp 2), a structure with a higher crystallographic symmetry. This paper describes preliminary work directed towards utilizing HIP technology to consolidate aluminum-rich intermetallics and aluminum-rich IMC's. Author

N93-15189# Naval Air Warfare Center, Warminster, PA. Air Vehicle and Crew Systems Technology Dept.
STRESS CORROSION SUSCEPTIBILITY OF ULTRA-HIGH STRENGTH STEELS FOR NAVAL AIRCRAFT APPLICATIONS Final Report
JOSEPH KOZOL and CHARLES E. NEU 10 Jan. 1992 48 p
LIMITED REPRODUCIBILITY: Availability: Document partially illegible
(AD-A256126; NAWCADWAR-92018-60) Avail: CASI HC A03/MF A01

Low alloy quenched and tempered steels used in current Naval aircraft applications, particularly the ultrahigh strength steels used in landing gear, have characteristically small critical flaw sizes and extreme susceptibility to stress corrosion cracking in a shipboard environment. Newly developed steels which develop ultrahigh strengths with secondary hardening based on precipitation of M2C carbides offer significantly larger critical flaw sizes; and while susceptible to stress corrosion cracking, their susceptibility is substantially less than that of low alloy steels. A long term test program conducted by the Naval Air Warfare Center Aircraft Division Warminster has characterized the stress corrosion cracking susceptibility of the newly developed steels. Results of the program have shown that, compared to low alloy steels, the newly developed steels show substantially reduced susceptibility to stress corrosion at short exposure times and maintain their advantage to a lesser extent at exposure times up to 1 0,000 hours. The test program has demonstrated also that 1,000 hour exposure times, characteristically used for stress corrosion tests of steels, are insufficient to establish stress corrosion thresholds (Klscc), as numerous failures were observed at exposure times between 1,000 and 10,000 hours. Fracture characteristics of the stress corrosion failures are shown. GRA

N93-15431*# Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
POLYMER INFILTRATION STUDIES Final Report, 1 Oct. - 31 Dec. 1992
JOSEPH M. MARCHELLO Dec. 1992 35 p
(Contract NAG1-1067)
(NASA-CR-191652; NAS 1.26:191652) Avail: CASI HC A03/MF A01

Significant progress has been made during the past three months on the preparation of carbon fiber composites using advanced polymer resins. The results are set forth in recent reports and publications, and will be presented at forthcoming national and international meetings. Current and ongoing research activities reported herein include: powdered tow ribbonizing; unitape from powdered tow; customized towpreg for textiles and ATP; and textile composite research. During the period ahead research will be directed toward further development of the new powder curtain prepregging method and on ways to customize dry powder towpreg for textile and robotic applications in aircraft part fabrication. Studies of multi-tow powder prepregging and ribbon preparation will be initiated in conjunction with continued development of prepregging technology and the various aspects of composite part fabrication using customized towpreg. Also, a major effort during the coming months will be participating in the analysis of the performance of the new solution prepregger. Author

N93-15490# Aerospatiale Aquitaine, Saint-Medard en Jalles (France).
FIBER REINFORCED COMPOSITES: A NEW CLASS OF GLASS AND GLASS CERAMIC MATERIALS FOR THERMOMECHANICAL APPLICATIONS
P. LESPADE, G. LARNAC, P. PERES, J. M. DONZAC, C. DROUET (Ceramiques et Composites, Bazet, France), E. MENESSIER (Ceramiques et Composites, Bazet, France), T. GRENIER (Office National d'Etudes et de Recherches Aerospatiales, Paris, France), M. PARLIER (Office National d'Etudes et de Recherches Aerospatiales, Paris, France), and Y. MONTARDI (Rhone-Poulenc Industries, Paris, France) 1992 7 p Sponsored by Direction des Recherches, Etudes et Techniques
(REPT-921-430-104; ETN-92-92352) Avail: CASI HC A02/MF A01

Silicon carbide (SiC) fiber reinforced MAS glass and glass ceramic type matrix composites were investigated as potential materials for advanced structural applications. Results on microstructural studies and mechanical properties of these composites fabricated by hot pressing are presented. The need for such strong and tough ceramic matrix composites is due to the merging needs of future aeronautic and space applications such as thermomechanical parts and structures and high dimensional stability frames. The starting materials and the fabrication techniques are presented. The mechanical properties of the materials at room temperature and the effect of temperature changes are analyzed. From the results of this investigation of the SiC fiber reinforced MAS type matrix composites system, it is demonstrated that these materials can be fabricated to give a glass MAS-Zr matrix composite and a family of glass ceramic matrix composites with high strength and good toughness properties. ESA

N93-15504*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SIMPLIFIED JET-A KINETIC MECHANISM FOR COMBUSTOR APPLICATION
CHI-MING LEE, KRISHNA KUNDU, and BAHMAN GHORASHI (Cleveland State Univ., OH.) Jan. 1993 11 p Presented at the 31st Aerospace Sciences Meeting, Reno, NV, 11-14 Jan. 1993; sponsored by AIAA Original contains color illustrations
(Contract RTOP 537-01-11)
(NASA-TM-105940; E-7457; NAS 1.15:105940; AIAA PAPER 93-0021) Avail: CASI HC A03/MF A01; 1 functional color page

Successful modeling of combustion and emissions in gas turbine engine combustors requires an adequate description of the reaction mechanism. For hydrocarbon oxidation, detailed mechanisms are only available for the simplest types of hydrocarbons such as methane, ethane, acetylene, and propane. These detailed mechanisms contain a large number of chemical species participating simultaneously in many elementary kinetic steps. Current computational fluid dynamic (CFD) models must include fuel vaporization, fuel-air mixing, chemical reactions, and complicated boundary geometries. To simulate these conditions a very sophisticated computer model is required, which requires large computer memory capacity and long run times. Therefore, gas turbine combustion modeling has frequently been simplified by using global reaction mechanisms, which can predict only the quantities of interest: heat release rates, flame temperature, and emissions. Jet fuels are wide-boiling-range hydrocarbons with ranges extending through those of gasoline and kerosene. These fuels are chemically complex, often containing more than 300 components. Jet fuel typically can be characterized as containing 70 vol pct paraffin compounds and 25 vol pct aromatic compounds. A five-step Jet-A fuel mechanism which involves pyrolysis and subsequent oxidation of paraffin and aromatic compounds is presented here. This mechanism is verified by comparing with Jet-A fuel ignition delay time experimental data, and species concentrations obtained from flametube experiments. This five-step mechanism appears to be better than the current one- and two-step mechanisms. Author

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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.

A93-13791
NIOBIUM ALLOY HEAT PIPES FOR USE IN OXIDIZING ENVIRONMENTS
C. C. WOJCIK (Teledyne Wah Chang Albany, OR) *In* Space nuclear power systems; Proceedings of the 8th Symposium, Albuquerque, NM, Jan. 6-10, 1991. Pt. 1 New York American Institute of Physics 1991 p. 326-333. Research supported by Teledyne Wah Chang Albany
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Nb-alloy heat pipes employing oxidation-protection silicide coatings in conjunction with P/M techniques for the production of porous wicks have been shown capable of comfortably operating in flame temperatures in excess of 3000 K. Attention is presently given to Li corrosion tests conducted with Nb-10Hf-1Ti alloy heat pipes at up to 1477 K, in conjunction with the thermal performance data derived for specific heat-pipe designs. An Hf-rich reaction was detected after 200 hrs of exposure. O.C.

A93-13943* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MIXED MODE STRESS INTENSITY-FACTORS IN TRANSVERSELY LOADED PLATES
KUNIGAL N. SHIVAKUMAR (North Carolina Agricultural and Technical State Univ., Greensboro) and J. C. NEWMAN, JR. (NASA, Langley Research Center, Hampton, VA) International Journal of Fracture (ISSN 0376-9429) vol. 57, no. 2 Sept. 15, 1992 p. R19-R25. refs
Copyright

An attempt is made to establish the validity of the antiplane solution and to calculate all components of the stress intensity factor (SIF) at the crack front for thin plates subjected to mode III loading. The stress analysis was performed for a range of thickness to crack length (b/a) ratio, which covered long cracks in a thin aircraft fuselage structure (b/a = 0.05). O.G.

A93-13976
HEAT TRANSFER, ADIABATIC EFFECTIVENESS, AND INJECTANT DISTRIBUTIONS DOWNSTREAM OF A SINGLE ROW AND TWO STAGGERED ROWS OF COMPOUND ANGLE FILM-COOLING HOLES
P. M. LIGRANI (Utah Univ., Salt Lake City), S. CIRIELLO, and D. T. BISHOP (U.S. Naval Postgraduate School, Monterey, CA) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X) vol. 114, no. 4 Oct. 1992 p. 687-700. Research supported by USAF refs
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The study reports experimental results that describe the development and structure of flow downstream of one row and downstream of two staggered rows of film-cooling holes with compound angle orientations. Findings are presented for an injectant to freestream density ratio near 1.0, x/d ranging from 6.7 to 96.7, injectant blowing ratios from 0.5 to 1.74, and momentum flux ratios from 0.25 to 3.03. Spanwise-averaged values of the adiabatic film cooling effectivness, eta-bar, measured downstream of two staggered rows of holes are highest with a blowing ratio, m, of 0.5, and decrease with blowing ratio because of injection lift-off effects for x/d of less than 20. As the boundary layers convect farther downstream, eta-bar values for m of 0.5 are lower than values for m of 1.0, 1.5, and 1.74, since smaller amounts of injectant are spread along the test surface. These results are compared to those obtained downstream of film cooling holes with simple angles in which holes are inclined at 35 deg with respect to the test surface in the streamwise/normal plane. P.D.

A93-13978
NAVIER-STOKES ANALYSIS OF TURBINE BLADE HEAT TRANSFER AND PERFORMANCE
D. J. DORNEY and R. L. DAVIS (United Technologies Research Center, East Hartford, CT) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X) vol. 114, no. 4 Oct. 1992 p. 795-806. Previously announced in STAR as N92-27468 Research supported by United Technologies Corp. refs
(Contract N00140-88-C-0677)
Copyright

A three dimensional Navier-Stokes analysis of heat transfer and aerodynamic performance is presented for a low speed linear turbine cascade. The numerical approach used consists of an alternate direction, implicit, approximate factorization, time marching technique. An objective was to establish the computational grid density requirements necessary to accurately predict blade surface and endwall heat transfer, as well as the exit plane aerodynamic total pressure loss and flow angle distributions. Also, a study was performed to determine a viable implementation strategy for the 3-D modeling of transition and turbulence in the turbine blade passage. Results are presented which show that the present procedure can accurately predict 3-D turbine blade heat transfer as well as the absolute level and spanwise distribution of aerodynamic performance quantities. Author

A93-13980
COMPARISON OF HEAT TRANSFER MEASUREMENTS WITH COMPUTATIONS FOR TURBULENT FLOW AROUND A 180 DEG BEND
D. L. BESSERMAN and S. TANRIKUT (Pratt & Whitney Group, East Hartford, CT) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X) vol. 114, no. 4 Oct. 1992 p. 865-871. refs
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Detailed heat transfer measurements for all four walls of a 180-deg 1:1 aspect ratio duct are reported. Experiments using a transient heat transfer technique with liquid crystal thermography were conducted for turbulent flow over a Reynolds number range of 12,500-50,000. Computational results using a Navier-Stokes code are also presented to complement the experiments. Two near-wall shear-stress treatments are evaluated in conjunction with k-epsilon formulation of turbulence to assess their ability to predict high local gradients in heat transfer. Results show that heat transfer on the convex and concave walls is a manifestation of the complex flow field created by the 180-deg bend. For the flat walls, the streamwise average Nusselt number increases approximately two times the fully developed turbulent flow value. The numerical predictions with the two-layer wall integration k-epsilon turbulence model show very good agreement with the experimental data. P.D.

A93-13981
INFLUENCE OF SURFACE HEAT FLUX RATIO ON HEAT TRANSFER AUGMENTATION IN SQUARE CHANNELS WITH PARALLEL, CROSSED, AND V-SHAPED ANGLED RIBS
J. C. HAN, Y. M. ZHANG (Texas A & M Univ., College Station), and C. P. LEE (General Electric Co., Cincinnati, OH) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X) vol. 114, no. 4 Oct. 1992 p. 872-880. Research supported by General Electric Co refs
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The paper investigates the effect of the wall heat flux ratio on the local heat transfer augmentation in a square channel with two opposite in-line ribbed walls for Reynolds numbers from 15,000 to 80,000. The square channel composed of 10 isolated copper sections has a length-to-hydraulic diameter ratio of 20. The rib height-to-hydraulic diameter ratio is 0.0625 and the rib pitch-to-height ratio equals 10. Six ribbed side to smooth side wall heat flux ratios are studied for four rib orientations. The results show that the ribbed side wall heat transfer augmentation increases with increasing ribbed side to smooth side wall heat flux ratios, but the reverse is true for the smooth side wall heat transfer augmentation. The average heat transfer augmentation of the ribbed side and smooth side wall decreases slightly with increasing wall heat flux ratios. The effect of wall heat flux ratio reduces with increasing Reynolds numbers. The 60-deg V-shaped rib and 60-deg parallel rib perform better than the 60-deg crossed rib and 90-deg rib, regardless of wall heat flux ratio and Reynolds number. P.D.

A93-13982
COMPUTATION OF LAMINAR FLOW AND HEAT TRANSFER OVER AN ENCLOSED ROTATING DISK WITH AND WITHOUT JET IMPINGEMENT
Y. NAKATA, J. Y. MURTHY, and D. E. METZGER (Arizona State Univ., Tempe) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X) vol. 114, no. 4 Oct. 1992 p. 881-890. refs
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The study examines a laminar flow field in the cavity of an enclosed rotating disk and accompanying local heat transfer coefficients on the rotating disk surface enclosed by a stationary shroud, including situations designed to provide a better understanding of the interactions between a rotating flow and an impinging jet. Two cases are modeled. The first is cavity flow without jet impingement, and the second introduces an impinging jet imposed as the source inside the cavity. In the former case, the flow patterns obtained correspond to those categorized as 'laminar flow, separate boundary layers' in the experimental results by Daily and Nece (1960). The effect of the cavity rim is limited to a very small radial extent, and the flow pattern near the rotating disk is similar to the free disk similarity solution of von Karman (1921). In the latter case, the transition from one regime to the other is found to occur when the mass flow ratio is approximately equal to 0.2-0.3 for the base source jet configuration. P.D.

A93-13988
ADAPTIVE MULTIGRID FOR THE STEADY EULER EQUATIONS
H. T. M. VAN DER MAAREL (Centrum voor Wiskunde en Informatica, Amsterdam, Netherlands) Communications in Applied Numerical Methods (ISSN 0748-8025) vol. 8, no. 10 Oct. 1992 p. 749-760. Research supported by EEC refs
Copyright

A method for solving the steady Euler equations is presented which is based on an upwind finite-volume discretization on a locally refined grid and multigrid convergence acceleration. A locally

refined grid consists of grids in a locally nested sequence. Nonlinear multigrid iteration is used to solve a set of equations derived from the first-order consistent finite-volume discretization on the composite grid. A computation process starts at some basic grid. After a number of nonlinear multigrid iterations a new level of refinement is generated. The initial solution in all newly generated cells is found from the interpolation on the next coarser grid. O.G.

A93-13990* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
APPLICATION OF MULTIGRID AND ADAPTIVE GRID EMBEDDING TO THE TWO-DIMENSIONAL FLUX-SPLIT EULER EQUATIONS
GARY P. WARREN (NASA, Langley Research Center, Hampton, VA) Communications in Applied Numerical Methods (ISSN 0748-8025) vol. 8, no. 10 Oct. 1992 p. 771-784. refs
Copyright

A numerical algorithm is presented for solving the two-dimensional flux-split Euler equations using a multigrid method with adaptive grid embedding. The method uses an unstructured data set along with a system of pointers for communication on the irregularly shaped grid topologies. An explicit two-stage time-advancement scheme is implemented. A multigrid algorithm is used to provide grid level communication and to accelerate the convergence of the solution to steady state. Results are presented for a NACA 0012 aerofoil in a free stream with a Mach number of 0.85 and an angle of attack of 1.0 degree. Excellent resolution of the shock structures is obtained with the adaptive grid embedding method with significantly fewer grid points than the comparable structured grid. Author

A93-14081
HOT END CLEANING - CORROSION PITTING OF TURBINE DISCS
CHRIS RICH (Brent Europe, Ltd., Iver, United Kingdom) and PAUL SOLEY (Ardrox, Inc., La Mirada, CA) Apr. 1992 19 p. SAE, Annual Aerospace/Airline Plating and Metal Finishing Forum and Exposition, 28th, San Diego, CA, Apr. 20-23, 1992
(SAE PAPER 920930) Copyright

Factors responsible for the corrosion pitting of turbine discs subjected to hot end cleaning process were investigated by comparing the degree of pitting corrosion of turbine-disc test pieces exposed to the normal acid descaling process (three 15-min cycles in 20 percent acid at 80-85 C) with the degree of corrosion after discs were subjected to solutions of other steps of the hot end cleaning process and to water contaminated by the descaling-process ingredients. The results of observations and SEM examinations indicate that pitting corrosion is caused not by acid treatment but by the following three conditions: low levels (but above 0.01 percent) of alkaline permanganate, levels of chloride above 30 ppm, and areas of high chromium commensurate with low iron within the steel. I.S.

A93-14090
HIGHER VELOCITY THERMAL SPRAY PROCESSES PRODUCE BETTER AIRCRAFT ENGINE COATINGS
GARY IRONS Apr. 1992 9 p SAE, Annual Aerospace/Airline Plating and Metal Finishing Forum and Exposition, 28th, San Diego, CA, Apr. 20-23, 1992
(SAE PAPER 920947) Copyright

The high-velocity oxyfuel (HVOF) coatings for aircraft engine applications exhibit coating quality superior to those of the plasma-sprayed or combustion coatings, such as higher density (i.e., lower porosity), higher hardness, lower oxide content, better wear resistance, higher bond strength, improved corrosion barrier, and smoother surfaces. This paper discusses various HVOF guns (JetKote, Diamond Jet, CDS, TopGun, and JP-5000) and compares them to other thermal spray processes, such as conventional combustion powder and wire guns, plasma spraying, and detonation gun). It is noted that the JP-5000 produces particle velocities which are 1000 fps higher than the other HVOF guns I.S.

A93-14114
A TOOLING TREND AT BCA - WHAT AND WHY
STEVEN ABBERGER (Boeing Commercial Airplane Group, Seattle, WA) Jan. 1992 15 p. Society of Manufacturing Engineers, Conference on Tooling for Composites '92, Anaheim, CA, Jan. 6, 7, 1992
(SME PAPER EM92-111) Copyright

It is noted that a near equal mixture of composite and metallic tooling to fabricate composite structures has been utilized over the years. It is shown that this balance between tooling materials has recently shifted toward metal, principally to achieve more durable tooling for high production rate applications. R.E.P.

A93-14168
A STUDY OF DYNAMIC CHARACTERISTICS OF AXIAL COMPRESSION SYSTEMS BY HEAT ADDITION
G. C. TANG, X. J. LI, and J. HU (Nanjing Aeronautical Inst., China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 77-82. refs
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The dynamic effects of heat addition on the operating point of compression system are modeled analytically to assess the introduction of instability in the system. A fluid-dynamic model is formulated of an inlet duct upstream of of an axial compressor in which the flow process includes heat addition into the plenum. Numerical results are given for the compression system at operating points near and far from the stall/surge limit varying such parameters as heat addition, time of addition, and a nondimensional stability parameter B. As B gets larger so does the dynamic effect on the system operation, and the dynamic effect for a given B increases with increases in the heat-addition rate. Heat addition can lead to instability when the system is operating in the hysteresis region, and two critical values of B are identified that can lead to rotating stall. The present model is of direct significance to modeling rotating stall and surge related to fuel injection in combustion chambers to optimize their design and use. C.C.S.

A93-14175
A NEW PRODUCTION TECHNOLOGY FOR COMPLEX-SHAPED STRUCTURAL ELEMENTS 'CREEP FORMING'
P. V. MIODUSHEVSKII, G. A. RAEVSKAIA, and O. V. SOSNIN (TsAGI, Zhukovski, Russia) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 144-146. refs
Copyright

A technique called 'creep forming' is introduced and reviewed for the industrial production of complex structural elements from stiffened panels of Al and Ti alloys and steels. The pressure treatment of the materials is enhanced by increasing the duration of the loading of the material substantially to impart time-dependent strain. Other mechanical properties are affected by the production technology, and forming techniques are described with attention given to the residual stresses associated with the panel forming. The equipment required for creep forming is described with illustrations of a universal monolithic panel-forming facility. Although the creep-forming process can extend the manufacturing time required for the panels the process provides: low-deformation loads, the combination of several manufacturing stages, and the increase in the static/fatigue strength of aerospace parts. C.C.S.

A93-14180
THE OPTIMUM DESIGN OF AIR CYCLE REFRIGERATION SYSTEM WITH HIGH PRESSURE WATER SEPARATION
YU WANG and XIU-GAN YUAN (Beijing Univ. of Aeronautics and Astronautics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 169-174. refs
Copyright

A mathematical model is developed for designing air-cycle refrigeration systems with known performance parameters and

functional characteristics. The refrigeration systems considered are designed with high-pressure water separation, and attention is given to the attendant problems of freezing at the condenser outlet and design strategies for the cooling turbine. The design point selected for the model is at the maximum flight envelope, and the performance of the system for a range of parameters is given. The modeled values are compared to experimental values, and the model is found to indicate appropriate efficiencies for the turbine, compressor, water separator, and reheater. The system described in the paper is shown to be effective for a range of flight conditions and for various aircraft types. C.C.S.

A93-14194
A VERY EFFICIENT TOOL FOR THE STRUCTURAL ANALYSIS OF HYPERSONIC VEHICLES UNDER HIGH TEMPERATURE ASPECTS
M. HAUPT, H. KOSSIRA, M. KRACHT, and J. PLEITNER (Braunschweig, Technische Univ., Germany) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 318-327. refs
(Contract DFG-SFB-257)
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This paper presents a Finite Element Tool, which has been adapted to the requirements of integrated thermal and mechanical analysis of structures. Thus, nonlinear and instationary heat-transfer as well as nonlinearities of the mechanical system are considered. The associated basic equations are given. To increase the efficiency of this finite element approach, adaptive grids and sophisticated linear and nonlinear solution algorithms are used. The general strategy is briefly outlined. Examples of instationary and nonlinear problems with special respect to mechanically and aerothermally loaded structures demonstrate the capabilities of the Finite Element Tool. Author

A93-14196
THE FRETTING DAMAGE AND EFFECT OF TEMPERATURE IN TYPICAL JOINT OF AIRCRAFT CONSTRUCTION
T. Z. TIAN (Shenyang Aircraft Inst., China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol., 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 334-339.
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The fatigue test results and the fatigue fracture for three types of joints, i.e., bolted joints, set-head rivet joints and countersunk rivet joints of the aluminum alloy, have been studied on the basis of more than 200 joints test at both elevated temperature and room temperature. It is revealed that the cracks initiated in the places where fretting had taken place and led to the failure of fretting fatigue. Different types of joints cause different modes of transmitting loads so that the places of cracks changed, which result in difference of fatigue strength. In this paper, the effect of fretting damage on fatigue strength and the effect of elevated temperature on fatigue strength and fracture appearance are also presented. Author

A93-14245* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NONINTRUSIVE SPECTROSCOPIC TECHNIQUES FOR SUPERSONIC/HYPERSONIC AERODYNAMICS AND COMBUSTION DIAGNOSTICS
R. J. EXTON (NASA, Langley Research Center, Hampton, VA) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 722-727. refs

This paper presents an overview of the primary nonintrusive diagnostic techniques being developed by the NASA Langley Research Center to address the validation needs of Computational Fluid Dynamic (CFD) codes. The techniques include absorption in the UV and IR, Laser Induced Fluorescence, electron beam fluorescence, and a number of scattering techniques including Rayleigh, spontaneous Raman, and several coherent Raman spectroscopies. Most of the techniques are highly specialized, require complex data interpretation, and can satisfy only a few of the CFD needs. For these reasons, the evolving trend in flowfield diagnostics appears to favor a mode in which the diagnostic researcher, the experimental aerodynamicist, and the CFD community jointly define experiments based on the aeronautical requirements and on available diagnostic techniques. Author

A93-14286
A SYNTHESIZED METHOD IN DURABILITY ANALYSIS
W. L. WANG and Z. N. LI (Beijing Univ. of Aeronautics and Astronautics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1067-1069. refs
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Probability fracture mechanics analysis and definite crack growth analysis methods are presently combined into a synthesized method in durability analysis which not only yields the growth law for the crack, but the leading crack's growth. In addition to enhancing the accuracy of damage determinations, the method improves the accuracy of durability analyses. O.C.

A93-14312
AEROELASTIC STABILITY CHARACTERISTICS OF COMPOSITE CYLINDRICAL SHELLS BY THE FINITE ELEMENT METHOD
GIUSEPPE SURACE and CECILIA SURACE (Torino Politecnico, Turin, Italy) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1263-1271. Research supported by CNR refs
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A finite-element analysis based on elastic theory is used to derive the stiffness matrix for composite cylindrical shells and subsequently the matrices for mass, initial stiffness, and aerodynamics are computed. Shell theory is extended to composite cylinders as 14-parameter elements with initial internal pressure and axial compressional loading. A kinematic boundary condition is applied to the assembled matrices to express the instability of the cylinder. The flutter expression shows that the aeroelastic instability is manifested when the amplitude of oscillation of the cylinder increases exponentially with time. Of particular interest is the determination of the minimum critical velocity that corresponds to the critical number of harmonics. The theoretical results from the analysis are found to agree with other analytical and experimental results on the important influence of fiber orientation on natural frequencies and flutter parameters in shells. C.C.S.

A93-14325
DEVELOPMENT OF A SYSTEM FOR AERODYNAMIC FAST-RESPONSE PROBE MEASUREMENTS
C. GOSSWEILER, H. HUMM, and P. KUPFERSCHMIED (Zuerich, Eidgenoessische Technische Hochschule, Zurich, Switzerland) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1371-1381. Research supported by SNSF refs
Copyright

This paper describes the development of a fast-response probe measurement system. Small pressure probes have been equipped with up to 4 miniature pressure sensors. The high frequency response of such sensors allied to minimized cavities between the flow and the sensing diaphragm enables the probe system to take measurements up to 40 kHz bandwidth (typical blade passing frequency: 2-10 kHz). First results of investigations on the aerodynamic of high frequency response measurement probes are presented including experiments in a water towing channel with unsteady flows around different probe geometries. The packaging of the sensor chip into the probe, the properties of the sensors and the measurement errors are examined. Probe calibration methods and aerodynamic evaluation procedures are discussed, followed by a presentation of the data acquisition system and of

the data evaluation software. Measurements in a radial compressor test rig and in a fully developed pipe flow are shown as applications. Author

A93-14334
POST BUCKLING OF LAMINATED COMPOSITE STIFFENED CURVED PANELS SUBJECTED TO CYCLIC SHEAR AND COMPRESSION
D. SHALEV, A. SEGAL (Israel Aircraft Industries, Ltd., Lod), and Y. FROSTIG (Technion - Israel Inst. of Technology, Haifa) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1460-1466. refs
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Results of an experimental study of postbuckling behavior of a composite materials box subjected to a combination of cyclic compression and shear loads is presented. The faces of the box are composite laminated curved panels, stiffened at both longitudinal and transverse directions. Results were recorded visually (moire shadow fringes) and strain gages were read at over than 100 locations of interest. Still camera pictures of fringe patterns and strain gages plots of behavior presented. Author

A93-14363
A NEW METHOD TO STUDY THE FORMING PROCESS OF COMPLICATED SHEETMETAL AERO-PARTS
H. L. XIONG, S. G. HU, and R. X. TANG (Beijing Univ. of Aeronautics and Astronautics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1701-1704. refs
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A simulation technique is advanced that permits the analysis of the forming of aerospace components from complex sheetmetal configurations. Nonlinear finite-element analysis is used to derive the stress and strain for the component as defined by parametric cubic patches, and grid measurements are conducted to confirm the analysis. Complicated forming processes can be simulated by means of the method in which changes of the boundary conditions and load distributions are tackled in the FEM calculations. C.C.S.

A93-14384
CONTACT ANALYSIS FOR RIVETED AND BOLTED JOINTS OF COMPOSITE LAMINATES
TIAN-QI YE (Northwestern Polytechnical Univ., Xian, China), WEI LI, and GUANQING SHEN (Shenyang Aircraft Research Inst., China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1901-1906. refs
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The computational strategy and numerical technique developed are demonstrated to be efficient for the analysis of riveted and bolted joints of composite laminates. The 3D contact analysis provides more accurate results for the evaluation of strength of the mechanically fastened joints in the composite structures. The method described can be extended to multibody contact problems, it has been implemented in the computer codes. R.E.P.

A93-14478
VISCOUS FLOW FIELD PREDICTION IN AXISYMMETRIC PASSAGES
GUOQING ZHANG and YAONAN HUA (Chinese Academy of Sciences, Beijing, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 7, no. 4 Oct. 1992 p. 309-311. In Chinese. refs

The viscous flowfields in the inflow axisymmetric passages of centrifugal compressors are predicted with vorticity-stream function (omega-psi) method. The expressions of q-tau turbulence model equations in orthogonal curvilinear coordinate system are derived here, and they are used to predict the turbulent flow fields. The q-tau turbulence model has an advantage in capability of treating the boundary conditions. The unsteady terms are introduced in the omega-equation and q, tau equations, and the time-marching method is applied to solution of these equations. In the case of turbulent flow prediction, the wall function is used in the near-wall region. Several numerical examples of laminar and turbulent flows in a 2D channel and axisymmetric passages with complex boundaries show that their solutions obtained with the present method is in good agreement with their exact solution or their experimental data. Author

A93-14482
A SIMPLE SPANWISE MIXING MODEL FOR TURBULENT DIFFUSION AND SECONDARY FLOWS IN MULTISTAGE AXIAL-FLOW COMPRESSORS
SHIMING LI (Tsinghua Univ., Beijing, China) and MAOZHANG CHEN (Beijing Univ. of Aeronautics and Astronautics, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 7, no. 4 Oct. 1992 p. 319-324. In Chinese. refs

Three kinds of coefficients are defined and introduced into the basic equations for meridional throughflow fields in multistage axial-flow compressors deduced in the paper, which describes different kinds of spanwise mixing mechanism in a unified form. Then, a novel much simpler equation system is obtained without any unknown correlation terms included. It has been shown that these coefficients involve the full information of all the kinds of mixing mechanism. This novel equation system not only unifies the two analytical models for meridional throughflow with mixing, which were presented by Adkins and Smith (1981) and Gallimore and Cumpsty (1986), respectively, but also makes the computations for multistage machines much easier. The calculations of the flow through multistage machines have been made by incorporating the new model into a streamline curvature throughflow calculation method. The agreement of the calculation results with experimental data has been improved. It is believed that this simpler equation system can be applied to the flows not only in subsonic compressors, but also in transonic and supersonic compressors, provided that a more appropriate model is proposed for the coefficients. Author

A93-14483
A METHOD FOR OPTIMIZING THE MERIDIONAL PASSAGE IN A CENTRIFUGAL COMPRESSOR
JIANG RAO and JINGPING LI (Chinese Academy of Sciences, Research and Development Center, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 7, no. 4 Oct. 1992 p. 325-328. In Chinese. refs

A method for optimizing the meridional passage of the rotor in a centrifugal compressor was developed on the basis of the theory of S1 and S2 stream filaments, using two optimization principles. The first is the minimization of the static pressure gradient in the streamline direction, as the factor which is mainly responsible for the boundary layer separation at the hub and the shroud. The second is the minimization of the static pressure gradient from hub to shroud, since such gradient might trigger the second flow in the passage. Two approaches are provided for optimizing meridional passage automatically, using computer programming. Two numerical examples are presented in which results are obtained using the two approaches. I.S.

A93-14484
DYNAMIC CHARACTERISTICS OF TWO NEW VIBRATION MODES OF THE DISK-SHELL SHAPED GEAR
LITANG YAN, SHIJUNG QIU (Beijing Univ. of Aeronautics and Astronautics, China), and XIANGQUNG GAO (Nanhua Power Plant Research Inst., China) Journal of Aerospace Power (ISSN 1000-8055) vol. 7, no. 4 Oct. 1992 p. 329-334. In Chinese. refs

Two new vibration modes of the disk-shell-shaped big medium gears placed on three separate medium shafts of a turboprop engine have been found. They have the same nodal diameters as the conventional ones, but their frequencies are higher. The tooth ring vibrates both radially and axially and has greater deflection than the gear hub. The resonance of these two new nodal diameter modes is much more dangerous than that of the conventional

nodal diameter modes. Moreover, they occur nearly at the upper and the lower bounds of the gear operating speed range. A special detuning method is developed for removing the resonance of these two new modes out of the upper and the lower bounds, respectively, and the effectiveness of the damping rings in this case has been researched. The vibration responses measured on the reductor casing have been then reduced to a quite low level after the damping rings were applied to the three big medium gears.
Author

A93-14489
OPTIMUM BALANCING OF FLEXIBLE ROTOR
QIZHOU LIU and XIANDE TAO (Northwestern Polytechnical Univ., Xian, China) Journal of Aerospace Power (ISSN 1000-8055) vol. 7, no. 4 Oct. 1992 p. 351-354. In Chinese. refs

A new criterion for optimum balancing of a flexible rotor is introduced, which is the minimum rotor strain energy criterion with constraints. This criterion meets the requirements for integral design of structure strength and performance of a gas turbine aeroengine. In this criterion, the balance correction masses (quantity and orientation) are the optimum design variable, the objective function of optimization is the total strain energy of the rotor and its supports. The response amplitudes at several cross sections along the rotor are taken as its constraints. The Powell's method and the net random-ray method are chosen as optimum methods. A program is written with FORTRAN 77 for the whole optimization procedure. The program has been testified by a numerical example in comparison with its experiments. Author

A93-14493
STUDY ON FRACTURE FAILURE OF TURBINE BLADES IN A SERIES OF TURBOJETS
LEXIN LI, XUEPING WANG, and DELI KANG (Air Force, Aeronautical Engineering Research Inst., China) Journal of Aerospace Power (ISSN 1000-8055) vol. 7, no. 4 Oct. 1992 p. 368-370. In Chinese.

The fracture failures of the stage I turbine blades in a series of turbojets have been investigated by means of macrographic examination and microfractographic analysis. The SEM and TEM have been applied to fracture surface examination as well. It has been revealed that the failed blades featured multicracking. The cracks came from porosity in the leading edge of the blade, then propagated along the treelike crystal boundaries. The crack were of the nature of thermomechanic fatigue cracks. The investigation of gamma-prime phase at the fracture surfaces of the failed blades indicates that the blades have been subjected to very high temperature at 1000 to about 1080 C, which exceeds the design temperature of the blade material. This off-design regime resulted from nonuniform temperature distribution and superhigh maximum temperature. The undiscovered foundary defects were the additional cause for the fracture failure. Author

A93-14517
AXIAL LENGTH INFLUENCE ON THE PERFORMANCE OF CENTRIFUGAL IMPELLERS
S. N. J. AL-ZUBAIDY (United Arab Emirates Univ., Al Ain) Journal of Propulsion and Power (ISSN 0748-4658) vol. 8, no. 6 Nov.-Dec. 1992 p. 1245-1251. refs
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This article describes a general direct-design method for radial flow impellers (based on a prescribed relative velocity schedule). The design procedure has been used as a systematic means of studying the effects of impeller length along its axis of rotation on performance. This was achieved by analyzing a group of impellers with the same performance requirements, inlet and exit geometry, and meridional profile, but different in the blade-angle distributions. The axial length of each impeller was varied systematically in order to assess its impact on the efficiency. The results have shown that for impellers capable of delivering 1 kg of air/s and having a total-to-total pressure ratio of 6:1, there is a specific region of axial length band where the highest efficiency for all designs were calculated and found to vary between 37-49 mm (the measured axial length does not include the disk thickness).
Author

A93-14518
NONCOAXIAL MIXING IN A RECTANGULAR DUCT
T.-M. LIOU, K.-L. HSIAO, and M.-K. TSAI (National Tsing Hua Univ., Hsinchu, Taiwan) Journal of Propulsion and Power (ISSN 0748-4658) vol. 8, no. 6 Nov.-Dec. 1992 p. 1252-1257. refs
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Experimental and theoretical investigations are reported on noncoaxial turbulent mixing in a rectangular duct. A temperature tracer technique was used to measure the fuel concentration distribution and a surface tufts method to identify the length of the recirculating zone. The governing partial differential equations were solved numerically with the two-equation k-epsilon turbulence model. Reasonable agreement is demonstrated between the measured and calculated reattachment length and fuel concentration profiles. The effects of air-to-fuel mass ratio, Reynolds number, and side-inlet angle on the position, size, and number of recirculating zones as well as on the mixing pattern are documented. The results of this cold study are believed to be a useful reference to the corresponding hot test. Author

A93-14523* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MIXING AND COMBUSTION STUDIES USING DISCRETE ORIFICE INJECTION AT HYPERVELOCITY FLIGHT CONDITIONS
R. BAKOS, J. TAMANGO, R. TRUCCO, O. RIZKALLA, W. CHINITZ, and J. I. ERDOS (General Applied Science Labs., Inc., Ronkonkoma, NY) Journal of Propulsion and Power (ISSN 0748-4658) vol. 8, no. 6 Nov.-Dec. 1992 p. 1290-1296. Previously cited in issue 18, p. 3141, Accession no. A91-44226 refs
(Contract NAS1-18450)
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A93-14542
OPTICAL MICROPHONE FOR THE DETECTION OF HIDDEN HELICOPTERS
CECIL F. HESS (MetroLaser, Irvine, CA) AIAA Journal (ISSN 0001-1452) vol. 30, no. 11 Nov. 1992 p. 2626-2631. Previously cited in issue 09, p. 1423, Accession no. A92-26235 refs
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A93-14543* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NONLINEAR VIBRATION AND RADIATION FROM A PANEL WITH TRANSITION TO CHAOS
LUCIO MAESTRELLO (NASA, Langley Research Center, Hampton, VA), ABDELKADER FRENDI (Analytical Services and Materials, Inc., Hampton, VA), and DONALD E. BROWN (Lockheed Engineering & Sciences Co., Hampton, VA) AIAA Journal (ISSN 0001-1452) vol. 30, no. 11 Nov. 1992 p. 2632-2638. refs
(Contract NAS1-19317; NAS1-19000)
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The dynamic response of an aircraft panel forced at resonance and off-resonance by plane acoustic waves at normal incidence is investigated experimentally and numerically. Linear, nonlinear (period doubling), and chaotic responses are obtained by increasing the sound pressure level of the excitation. The response time history is sensitive to the input level and to the frequency of excitation. The change in response behavior is due to a change in input conditions, triggered either naturally or by modulation of the bandwidth of the incident waves. Off-resonance bifurcation is diffused and difficult to maintain; thus the panel response drifts into a linear behavior. The acoustic pressure emanated by the panel is either linear or nonlinear as is the vibration response. The nonlinear effects accumulate during the propagation with distance. Results are also obtained on the control of the panel response using damping tape on an aluminum panel and a graphite

epoxy panel having the same size and weight. Good agreement is obtained betwen the experimental and numerical results.
Author

A93-14545
UNSTEADY TURBULENT SKIN-FRICTION MEASUREMENT IN AN ADVERSE PRESSURE GRADIENT
KIRK J. FLITTIE and EUGENE E. COVERT (MIT, Cambridge, MA) AIAA Journal (ISSN 0001-1452) vol. 30, no. 11 Nov. 1992 p. 2647-2652. Previously cited in issue 07, p. 1047, Accession no. A91-21391 refs
(Contract F49620-79-C-0226; AF-AFOSR-81-0282)
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A93-14561
DYNAMICS OF SKIN-STRINGER PANELS USING MODIFIED WAVE METHODS
DONALD E. HUNTINGTON and C. S. LYRINTZIS (San Diego State Univ., CA) AIAA Journal (ISSN 0001-1452) vol. 30, no. 11 Nov. 1992 p. 2765-2773. refs
(Contract NSF MSM-90-08953)
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The response of a damped, periodic, simply supported skin-stringer structure is studied by two variants of the decaying wave method. The proposed method is based on a combination of a wave propagation method with transfer matrices. One variant of the decaying wave method is based on an exact solution transfer matrix; the other is based on a finite element formulation. It is shown that both variants give response curves that compare very well with previous results for the undamped structure, which illustrates both the accuracy and the numerical stability of the decaying wave method variants. Numerical results, including deflections at various points at various frequencies as well as mode shapes, are presented, and comparisons are offered. The numerical results demonstrate the accuracy and reliability of both variants of the decaying wave method, and this is because advantages of three methods are combined in each variant.
Author

A93-14569
STIFFNESS DESIGN METHOD OF SYMMETRIC LAMINATES USING LAMINATION PARAMETERS
HISAO FUKUNAGA and HIDEKI SEKINE (Tohoku Univ., Sendai, Japan) AIAA Journal (ISSN 0001-1452) vol. 30, no. 11 Nov. 1992 p. 2791-2793. refs
Copyright
A method is proposed for determining laminate configurations corresponding to the lamination parameters of a symmetric laminate whose in-plane and out-of-plane stiffness characteristics are governed by four in-plane and four out-of-plane lamination parameters, respectively. The relation between the lamination parameters is obtained, and the limitation of conventional laminates is discussed from the design viewpoint.
O.C.

A93-14571
FOURIER ANALYSIS OF CLAMPED MODERATELY THICK ARBITRARILY LAMINATED PLATES
REAZ A. CHAUDHURI and HUMAYUN R. H. KABIR (Utah Univ., Salt Lake City) AIAA Journal (ISSN 0001-1452) vol. 30, no. 11 Nov. 1992 p. 2796-2798. refs
Copyright
An effort is made to derive a boundary-continuous-displacement solution, using the Kabir and Chaudhuri (1992) generalized Navier-Stokes approach to the problem of static response of an arbitrarily laminated plate. This involves five highly coupled second-order-linear partial differential equations in conjunction with rigidly clamped boundary conditions at all four edges. Numerical results are presented for the convergence characteristics of the deflection and moment, the effects of thickness, and the variations of displacements and moments along the length of the laminated plate.
O.C.

A93-14616
ANALYSIS OF COMPLICATED PLATES BY A NINE-NODE SPLINE PLATE ELEMENT
M. H. LUAH and S. C. FAN (Nanyang Technological Univ., Singapore) Computers & Structures (ISSN 0045-7949) vol. 45, no. 2 Oct. 3, 1992 p. 243-252. refs
Copyright
The analysis of complicated plates using a newly developed nine-node quadrilateral spline plate element is presented. The element is based on Kirchhoff's plate theory with biquadratic Lagrangian shape functions for the transformation of geometry and B-spline shape functions for the interpolation of displacements. The accuracy and robustness of the element are checked by using a set of test problems that are capable of detecting inaccuracies due to shape distortion, large aspect ratio and other irregularities. Numerical examples on complicated plate structures such as plates with interior openings or mixed boundary conditions are reported to demonstrate the practical usefulness of the element.
Author

A93-14627
PREDICTION OF ENGINE CASING TEMPERATURE OF FIGHTER AIRCRAFT FOR INFRARED SIGNATURE STUDIES
SHRIPAD P. MAHULIKAR (Indian Inst. of Technology, India) Apr. 1992 12 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992
(SAE PAPER 920961) Copyright
Prediction of engine casing temperature of combat aircraft for various operating conditions needs modeling of convective and radiative heat flow from the jet pipe to the casing. Radiation modeling which implies modeling of multiple reflections and scattering is done here by the radiance-irradiance approach. The engine layout is approximated by three co-axial cylinders and axially discretized. The shape factors (which account for the directional dependence of radiation heat flow) for various configurations needed in radiation modeling are analytically obtained by a sequence of shape factor algebra from standard configurations. The resulting non-linear algebraic equations of combined convection and radiation heat flow are solved by an iterative technique to give the engine casing temperatures which may be used for infrared signature studies.
Author

A93-14639
A MODEL-BASED MONITORING SYSTEM FOR TURBINE ENGINES
DAN T. HORAK (Allied-Signal Aerospace Co., Columbia, MD) Apr. 1992 9 p. SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 7-10, 1992 refs
(SAE PAPER 921006) Copyright
This paper describes a project aimed at developing a practical model-based monitoring system for turbine engines which is capable of monitoring engines accurately and reliably in steady flight and during transients, and can detect and isolate sensor, actuator and system failures. The goal is to demonstrate the feasibility of such a system by including in a laboratory prototype all the functions required in a system that can monitor real engines. Emphasis is placed on accommodating model imperfections which are the main obstable to reliable model-based monitoring of mechanical and thermofluid systems.
Author

A93-14678
A PROPOSED MULTI-MODAL FM/CW AIRCRAFT RADAR FOR USE DURING GROUND OPERATIONS
CRAIG A. GRIMES (Lockheed Research Labs., Palo Alto, CA) and DALE M. GRIMES (Crale, Inc., Austin, TX) *In* 1992 IEEE Aerospace Applications Conference, Snowmass, CO, Feb. 2-7, 1992, Digest New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 7-18. refs
Copyright
A proposed forward looking, relatively small and inexpensive, multimodal radar is described. The design objective is to determine range, range rate, and bearing to targets at 2-500 m, at operational speeds, and at +/-8.5 deg either side of boresite. For this

open-loop, wide-angle, expanded monopulse-like, FM/CW radar, it is planned to time-share the transmitted power to TE10, TE20, and TE30 rectangular waveguide modes that, in turn, drive a small aperture horn antenna. By transmitting and receiving on the different modes, six independent views of the forward direction are obtained. Echoed returns into the transmitted mode are used to find range and range rate. Returns into all three modes are frequency integrated to reduce angle noise, then ratioed to obtain target angle. This inexpensive control radar, which is termed cradar, quickly obtains a two-dimensional forward plot of the protected pathway without moving parts. I.E.

A93-14811
TAILORING CONCEPTS FOR IMPROVED STRUCTURAL PERFORMANCE OF ROTORCRAFT FLEXBEAMS
JOHN C. FISH (McDonnell Douglas Helicopter Co., Mesa, AZ) and ANTHONY J. VIZZINI (Maryland Univ., College Park) Composites Engineering (ISSN 0961-9526) vol. 2, no. 5-7 1992 p. 303-312. Research supported by McDonnell Douglas Helicopter Co. refs
(Contract DAAG29-83-K-0002)
Copyright

Quasi-static tension tests were performed on tapered glass/epoxy laminates with internally dropped plies. In addition, a finite element analysis was conducted to determine the interlaminar stress states near the ply drop closest to the root of the taper. Four different internal ply drop configuration were examined, which achieved the same transition in thickness. The delamination loads and corresponding bending stiffness losses were measured. The delamination onset loads varied by 38 percent and the bending stiffness retention varied by 56 percent among the internal ply drop configurations. Three of the four configurations delaminated in an unstable manner, while stable delamination initiation and growth occurred in one of the configurations. In general, a trade-off existed between the delamination strength and retention of bending stiffness. However, the configuration which delaminated in a stable fashion had the best bending stiffness retention as well as intermediate delamination strength. Author

A93-14812
COMMON FAILURE MODES FOR COMPOSITE AIRCRAFT STRUCTURES DUE TO SECONDARY LOADS
A. M. RUBIN (McDonnell Aircraft Co., Saint Louis, MO) Composites Engineering (ISSN 0961-9526) vol. 2, no. 5-7 1992 p. 313-317, 319, 320. refs
Copyright

The most common examples of composite laminate failure in typical aircraft structures are discussed, with particular consideration given to the effects of out-of-plane loads (and the resulting interlaminar shear/interlaminar tension) and bolted joint failure modes on the composite substructure and skins. It is noted that design allowables and environmental strength reduction factors for these types of failure model can be easily developed by performing simple element tests under RT/Dry and worst-case environmental conditions. The strength/stiffness factors identified during these tests may then be used to modify data obtained during full-scale RT/Dry tests. I.S.

A93-15030
THE MODELING OF FORGING AND PRECISION-CASTING FORMING PROCESSES [LA MODELISATION DES PROCEDES DE MISE EN FORME EN FORGE ET EN FONDERIE DE PRECISION]
YVES HONNORAT (SNECMA, Corbeil, France) and ALAIN LASALMONIE (SNECMA, Gennevilliers, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 140 1990 p. 59-65. In French. refs
Copyright

A review is presented of turbojet development associated with the introduction of new procedures and materials as well as the requirement for the exacting control of proven manufacturing methods. Examples for the modeling techniques employed for forming structures by forging and by casting are discussed. R.E.P.

A93-15068
INFLUENCE OF HIGH MAINSTREAM TURBULENCE ON LEADING EDGE FILM COOLING HEAT TRANSFER - EFFECT OF FILM HOLE SPACING
A. B. MEHENDALE and J. C. HAN (Texas A & M Univ., College Station) International Journal of Heat and Mass Transfer (ISSN 0017-9310) vol. 35, no. 10 Oct. 1992 p. 2593-2604. Research supported by Textron Lycoming, Inc refs
Copyright

The effect of injection hole geometry on the leading edge heat transfer coefficient and film cooling effectiveness, under high mainstream turbulence condition, was experimentally studied for an incident mainstream Reynolds number of 100,000. Data were obtained for three blowing ratios of 0.4, 0.8, and 1.2 through two rows of film holes located at +/- 15 and +/- 40 deg for two injection geometries: (1) film holes spaced four hole diameters apart, and (2) film holes spaced three hole diameters apart, in the spanwise direction. The results show that the leading edge heat transfer coefficient increases and the film effectiveness decreases with increasing mainstream turbulence; however, the effect reduces with increasing blowing ratio. The leading edge heat transfer with coolant injection (heat load) for the three hole diameters case is lower than that for the four hole diameters case at low mainstream turbulence, but the difference reduces at higher mainstream turbulence. Author

A93-15070
EXAMPLE OF THE COUETTE ICEFORM DESIGN MODEL - FLAT PLATE ICEFORMATION
R. S. LAFLEUR (Clarkson Univ., Potsdam, NY) International Journal of Heat and Mass Transfer (ISSN 0017-9310) vol. 35, no. 10 Oct. 1992 p. 2631-2642. refs
Copyright

This paper presents an application of the Couette iceform design model. Two-dimensional iceformation over a flat plate is used to demonstrate the evolution theory approach to controlling the ice formation shaping process. Theoretical ice profiles reasonably matched experimental results. Optimal control parameter relationships for designing minimum energy dissipation shapes were obtained. These results could be used in iceform design of shapes for complex flows such as wing/fuselage and tube/fin junctures. Author

A93-15072
STEADY STATE MODEL FOR THE THERMAL REGIMES OF SHELLS OF AIRSHIPS AND HOT AIR BALLOONS
OLEG A. LUCHEV (Russian Academy of Sciences, Inst. of Energy Research, Moscow, Russia) International Journal of Heat and Mass Transfer (ISSN 0017-9310) vol. 35, no. 10 Oct. 1992 p. 2683-2693. refs
Copyright

A steady state model of the temperature regime of airships and hot air balloons shells is developed. The model includes three governing equations: the equation of the temperature field of airships or balloons shell, the integral equation for the radiative fluxes on the internal surface of the shell, and the integral equation for the natural convective heat exchange between the shell and the internal gas. In the model the following radiative fluxes on the shell external surface are considered: the direct and the earth reflected solar radiation, the diffuse solar radiation, the infrared radiation of the earth surface and that of the atmosphere. For the calculations of the infrared external radiation the model of the plane layer of the atmosphere is used. The convective heat transfer on the external surface of the shell is considered for the cases of the forced and the natural convection. To solve the mentioned set of the equations the numerical iterative procedure is developed. The model and the numerical procedure are used for the simulation study of the temperature fields of an airship shell under the forced and the natural convective heat transfer. Author

A93-15188
INSTABILITY OF THE PERIODIC DEFLECTION OF A PANEL SURFACE IN A TURBULENT BOUNDARY LAYER [O NEUSTOICHIVOSTI PERIODICHESKOGO PROGIBA PANEL'NOI POVERKHNOSTI V TURBULENTNOM POGRANICHNOM SLOE]
V. P. REUTOV PMTF - Prikladnaia Mekhanika i Tekhnicheskaia Fizika (ISSN 0044-4626) no. 4 July-Aug. 1992 p. 74-83. In Russian. refs
Copyright

The response of flow to the periodic deflection of a panel surface is determined in the context of an asymptotic stability theory for shear flows. The Rayleigh equation for a perturbed velocity profile in a boundary layer is solved numerically. The condition for the suppression of resistive instability due to losses in the plate material is determined. V.L.

A93-15342
IMPROVING ANTI-FATIGUE OPTIMUM DESIGN THROUGH AI-SEARCH STRATEGY
BIN XING (Air Force College of Engineering, China) and QING-XIONG YANG (Northwestern Polytechnical Univ., Xian, China) Chinese Journal of Aeronautics (ISSN 1000-9361) vol. 5, no. 3 Aug. 1992 p. 167-173. Translation. Previously cited in issue 22, p. 3958, Accession no. A92-53013 refs
Copyright

A93-15375
WELDING WIRE SELECTION CRITICAL TO JET ENGINE REPAIR WORK
Welding Journal (ISSN 0043-2296) vol. 71, no. 11 Nov. 1992 p. 57-59.
Copyright

A review is provided of issues related to the selection of welding wire for aircraft gas-turbine engines emphasizing the importance of cleanliness in the welding wire product. A three-step metallurgical control process is described for the production of welding wire that is clean and suitable for turbine repair. The process is based on: (1) vacuum induction melting; (2) contamination-free processing of the wire; and (3) environmentally controlled packaging. Weld work on aerospace casting is shown to be useful and suitable for many alloy and superalloy materials with various filler materials. C.C.S.

A93-15401
ON DYNAMIC BEHAVIOR OF CRACKED ROTORS
JIANMIN GAO and XIAOMEI ZHU (Northwestern Polytechnical Univ., Xian, China) Northwestern Polytechnical University, Journal (ISSN 1000-2758) vol. 10, no. 4 Oct. 1992 p. 434-440. In Chinese. refs

The parametric resonance of cracked rotors is studied analytically to determine the changing vibration characteristics of the cracked components in terms of harmonics and resonance speeds. Cracked rotors are shown to have parametric resonances near 2c/3 or 2c when c is the critical speed of the rotor without a crack. These parametric resonances always include (j/2)/rev (j = 1,3...9) and are specific to the occurrence of a crack. Therefore, a crack is argued to exist in a rotor when the vibration of the rotor at speeds near 2c/3 or 2c includes (1/2)/rev, (3/2)/rev...(9/2)/rev harmonics. The paper shows that the changes in (j/2)/rev harmonics can be monitored since they exist in several ranges that cause partametric resonances. The changes in harmonics should be investigated near the resonance speeds, particularly for q/rev harmonics since this harmonic is sensitive to crack depth. C.C.S.

A93-15402
ON ORTHOGONAL SEARCH METHOD OF FLUTTER ANALYSIS
LIFA YANG (Northwestern Polytechnical Univ., Xian, China) Northwestern Polytechnical University, Journal (ISSN 1000-2758) vol. 10, no. 4 Oct. 1992 p. 462-466. In Chinese. refs

An orthogonal graphical search method is proposed for effective flutter analysis by computer by means of conformal mapping of analytic functions. The conformal mapping is based on a search process that alternates between real and imaginary axes to derive values for the flutter equation with attention paid to damping. The orthogonal search method is shown to be a robust general technique that can be applied to a number of mathematical situations for which zero points of analytic function must be determined whether the function is a polynomial or other expression. Unlike classical techniques the orthogonal search method graphically analyzes the flutter phenomena and the flutter point for any corresponding damping value. The orthogonal search technique is shown to provide consistently more accurate results than methods based on the artificial contraction of mesh-function curves. C.C.S.

A93-15409
EFFECTS OF SUBSTRATE ANISOTROPY ON COUPLED BILATERAL FINLINES
THINH Q. HO (U.S. Navy, San Diego, CA) and BENJAMIN BEKER (South Carolina Univ., Columbia) Microwave and Optical Technology Letters (ISSN 0895-2477) vol. 5, no. 13 Dec. 5, 1992 p. 666-668. refs
Copyright

Coupled bilateral fin lines on uniaxial and biaxial substrates are studied using a spectral-domain method. The dispersion characteristics of numerous coupled bilateral finlines on various anisotropic substrates are calculated with respect to different structural parameters. O.G.

A93-15486
EXPERIMENTAL AND NUMERICAL STUDY ON THE BASIC PERFORMANCE OF A TWO-DIMENSIONAL RIGHT-ANGLED INTAKE FLOW
NOBUYUKI FUJISAWA and MASAKAZU SHIRAKAWA Japan Society of Mechanical Engineers, Transactions B (ISSN 0387-5016) vol. 58 Jan. 1992 p. 59-63. In Japanese. refs

The flow in and around two-dimensional right-angled intake has been studied both experimentally and numerically. Pressure distributions on the intake surfaces are measured at various velocity ratios of the intake flow to the main flow, and the basic intake performances, such as the total pressure loss, the cavitation and the drag, are evaluated. It is shown that they are reproduced well by the numerical results with a standard k-epsilon model of turbulence, while the agreement becomes poorer as the velocity ratio becomes large. It is also demonstrated by the smoke-wire visualization study that the recirculating region formed upstream of the intake flow is reduced as the velocity ratio increases, contributing to the relative decrease in the total pressure loss at large velocity ratios. Author

A93-15496
OSCILLATION OF CIRCULAR SHOCK WAVES WITH UPSTREAM NONUNIFORMITY
MYEONG-KWAN PARK, SHUZO OSHIMA, and RYUICHIRO YAMANE Japan Society of Mechanical Engineers, Transactions B (ISSN 0387-5016) vol. 58 Jan. 1992 p. 153-158. In Japanese. refs

Up to previous reports by Park et al. on the oscillation of the circular shock waves, the investigations have been concerned with situations where the upstream flow is uniform, and oscillation and deformation were induced by only downstream conditions. But in the centrifugal diffuser of a centrifugal compressor, the flow into the diffuser becomes nonuniform due to the impeller wake and the stall in the upstream impeller, which causes deformation and oscillation of the shock wave. Here, the above effects are considered, and the upstream disturbance is generated by cylindrical bars. The imperfect circular shock wave was induced by the effect of the wake, and the oscillation state, along with the oscillation modes caused by forced oscillation, is investigated experimentally. It was found that the basic mode of the oscillation is predominant and that the oscillation is weaker than in the case of uniform upstream. Author

A93-15525
1992 - THE YEAR OF THE RADOME?
BEN MACKENZIE (Norton Performance Plastics, Ravenna, OH) *Aerospace Engineering* (ISSN 0736-2536) vol. 12, no. 11 Nov. 1992 p. 11-15.
Copyright

Various technical and regulatory events which are focusing new attention on the weather radome for air transport and general aviation aircraft are discussed. Comparitive figures are provided for the principal properties and costs of glass, Kevlar, and quartz radomes. Attention is given to the diverter design and location on the radome that represents a compromise between transmission efficiency and diversion of lightning. R.E.P.

A93-15684
EXPERIMENTAL STUDY OF DYNAMIC FLUID FORCES AND MOMENTS FOR A LONG ANNULAR SEAL
YUJI KANEMORI (Torishima Pump Manufacturing Co., Ltd., Osaka, Japan) and TAKUZO IWATSUBO (Kobe Univ., Japan) ASME, Transactions, Journal of Tribology (ISSN 0742-4787) vol. 114, no. 4 Oct. 1992 p. 773-784. refs
(Contract MOESC-63460086)
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The dynamic fluid reaction forces and moments of a long annular seal were experimentally studied. A new testing apparatus was constructed in order to measure restoring forces and moments caused by the cylindrical whirling motion of a rotor. Experiments were conducted at various rotor speeds, whirling speeds, and with different pressure drops across the long seal. The rotor and outer cylinder were set in concentric alignment. The tangential force component was derived from the measured fluid force in order to determine the unstable threshold. Moments developed by the long seal were also obtained. Restoring forces and moments were expressed as stiffness, damping coefficients and added mass. These coefficients were then compared with Childs' theory and found to be compatible. Author

A93-15702* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
TECHNICAL NOTE - PLASMA-SPRAYED CERAMIC THERMAL BARRIER COATINGS FOR SMOOTH INTERMETALLIC ALLOYS
R. A. MILLER and J. DOYCHAK (NASA, Lewis Research Center, Cleveland, OH) Journal of Thermal Spray Technology (ISSN 1059-9630) vol. 1, no. 3 Sept. 1992 p. 211-213. refs
Copyright

A new approach for plasma spray deposition of ceramic thermal barrier coatings directly to smooth substrates is described. Ceramic thermal barrier coatings were directly applied to substrates that had been coated with low-pressure plasma sprayed NiCrAlY bond coats and then centerless ground to simulate a smooth oxidation-resistant substrate. As the high-temperature oxidation behavior of NiAl+Zr is superior to that of MCrALY alloy, the bond coat is not required for oxidation resistance. O.G.

A93-15738
PAA-CORE ALUMINUM HONEYCOMB - AN END USER'S EVALUATION
KEVIN G. OLIVO (Rohr Industries, Inc., Riverside, CA) *In* International SAMPE Symposium and Exhibition, 37th, Anaheim, CA, Mar. 9-12, 1992, Proceedings Covina, CA Society for the Advancement of Material and Process Engineering 1992 p. 198-212. refs
Copyright

An evaluation has been conducted of the next-generation, phosphoric acid-anodized (PAA) Al honeycomb core material for adhesively bonded sandwich structures relative to conventionally pretreated cores. Both flatwise tension tests of honeycomb sandwich panels (at room temperature and 177 C) and single cantilever-beam (SCB) tests were performed. The SCB test results obtained after up to 60-days exposure to condensing humidity indicated less crack extension in PAA-cored panels than conventional core panels; these SCB results imply improved adhesive bond durability. O.C.

A93-15789
AUTOMATIC THROUGH-THE-THICKNESS BRAIDING
RICHARD T. BROWN and EDDIE C. CROW, JR. (Atlantic Research Corp., Alexandria, VA) *In* International SAMPE Symposium and Exhibition, 37th, Anaheim, CA, Mar. 9-12, 1992, Proceedings Covina, CA Society for the Advancement of Material and Process Engineering 1992 p. 832-842. refs
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Three-dimensional braiding is a novel textile technology which provides significant improvements in composite toughness and delamination resistance. Techniques for three-dimensional braiding include Through-the-Thickness braiding, AYPEX, two-pass, and layer interlock. This paper summarizes the state-of-the-art and approaches to braider actuation and control. The authors illustrate the technique by describing the fabrication of complex structural shapes such as I-beams, ribs, and blade stiffened panels. The authors conclude that three-dimensional braiding is a rapidly maturing technology which is capable of automatic production of textile preforms for application in aircraft primary structures. Author

A93-15792
RAPID FABRICATION OF FLIGHT WORTHY COMPOSITE PARTS
PIERRE H. JOUIN, JOHN C. HEIGL, and TIMOTHY L. YOUTSEY (McDonnell Douglas Helicopter Co., Mesa, AZ) *In* International SAMPE Symposium and Exhibition, 37th, Anaheim, CA, Mar. 9-12, 1992, Proceedings Covina, CA Society for the Advancement of Material and Process Engineering 1992 p. 878-891. refs
Copyright

A 3D surfaced-model representation of aircraft composite structural components can be used to generate machining paths in a system which reduces paperwork and errors, and enhances accuracy and speed. Illustrative cases are presented for the use of such a system in the design and production of the Longbow radar housing, the fabrication of the flight test hardware for the 'no tail-rotor' helicopter control system, and the machining of a honeycomb core structure for a composite helicopter rotor blade. O.C.

A93-15804
COMPUTER-AIDED CURE OPTIMIZATION
D. FRANK-SUSICH, D. LAANANEN (Arizona State Univ., Tempe), and D. RUFFNER (McDonnell Douglas Helicopter Co., Mesa, AZ) *In* International SAMPE Symposium and Exhibition, 37th, Anaheim, CA, Mar. 9-12, 1992, Proceedings Covina, CA Society for the Advancement of Material and Process Engineering 1992 p. 1075-1088. refs
Copyright

It is presently shown that the cure parameters of resin systems can significantly reduce the amount of time and effort needed to develop cure cycles by elucidating the differences among materials. In particular, the point at which gelation occurs is controllable through proper selection of times and temperatures, thereby improving the quality of the finished component. Drastic reductions are obtainable in the number of autoclave runs associated with trial-and-error cure-cycle development. O.C.

A93-16163
RADIATED ELECTRIC FIELD MEASUREMENTS IN U.S. ARMY HELICOPTERS
JAMES E. BRUCKART (U.S. Army, Aeromedical Research Lab., Fort Rucker, AL) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 63, no. 11 Nov. 1992 p. 1019-1023. refs
Copyright

Aircraft systems and medical devices generate electromagnetic fields. EMI can cause faulty operation of aircraft systems or medical devices and endanger patients or aircraft crewmembers. A ground and inflight study was conducted to describe the electromagnetic

fields in typical operations. Broadband isotropic field sensors measured electric fields from 5 kHz to 3 MHz, 3 to 500 MHz, and 0.5 MHz to 6 GHz. Fields were measured at 0.5 m space intervals in JOH-58A, JUH-1H, and JUH-60A helicopters with systems off, operating RPM, 5-ft hover, 50-ft hover, and cruise. Electric fields in the environment were homogeneous and less than 0.1 V/m. Fields in the helicopters increased during ascent, but remained less than 2 V/m except during radio transmissions. EMI effect of the Physio Control Lifepack 8 was demonstrated during FM radio transmission. The results are useful in evaluating electromagnetic emissions and predicting operations that may result in an inflight malfunction of a medical device or aircraft system. Author

A93-16246
AIRCRAFT FATIGUE FAILURES AND TASKS OF STRUCTURAL RELIABILITY ANALYSIS
GENKICHI FUJIWARA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663) vol. 40, no. 465 1992 p. 523-534. In Japanese. refs

The aircraft structural inspection pattern and the statistical method of the structural fatigue life prediction are presented. The problems of the aircraft structural life span and the evaluation of fatigue strength are discussed, such as out of plane bending and deformation, and multiple site damage (MSD). The crack data of Boeing 747 section 41 upper deck frame and stringer is listed. Y.P.Q.

A93-16248
STRUCTURAL OPTIMIZATION OF A CANTILEVERED ROTATING BEAM
TOSHIFUMI NEKOHASHI, NAOHIRO IBOSHI, and TOMOARI NAGASHIMA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663) vol. 40, no. 465 1992 p. 553-559. In Japanese. refs

A basic study concerning the structural optimization of a rotor blade subject to steady combined loadings is conducted. The combined loadings are assumed to be composed of distributed axial and lateral loadings which simulate the centrifugal force and airloadings for a rotor blade in hover. To simplify the problem, the blade is modeled as a cantilevered rotating beam with the plane tapered cross section. The minimum deflection problem of the cantilevered rotating beam is formulated as an optimization problem involving inequality constraints and solved using optimal control methodology. Optimum area distributions are determined numerically for typical combinations of combined loading and the effects of the centrifugal force on the optimum solutions are discussed. Numerical results reveal clearly the important role of axial loading on the optimum solution; inclusion of the centrifugal force to the structural optimization of the rotor blade should be essential. Author

A93-16374
A DESIGN STUDY ON THE EFFECT OF SUPPORT AND SYSTEM PARAMETERS ON THE NATURAL FREQUENCIES OF ROTOR SYSTEMS
A. AMINI and T. S. SANKAR (Concordia Univ., Montreal, Canada) Canadian Society for Mechanical Engineering, Transactions (ISSN 0315-8977) vol. 16, no. 3-4 1992 p. 291-310. Research supported by NSERC refs
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The parametric study of a rotor bearing pedestal system supported on hydrodynamic bearings is evaluated utilizing the component mode synthesis method. By using this technique the size of the overall finite element system matrices can be substantially reduced without affecting the dynamic characteristics of the system response. The computational efficiency of component mode synthesis over finite element technique is shown especially for design studies. R.E.P.

A93-16604
PHOTOELASTIC STRESS ANALYSIS OF SKEWED CUTOUT IN A SANDWICH SKEW PLATE SUBJECTED TO INPLANE AND TRANSVERSE ECCENTRIC LOAD
K. LINGAIAH (Visvesvaraya College of Engineering, Bangalore, India) and S. T. MURTHY (Siddaganga Inst. of Technology, Tumkur, India) *In* 1991 SEM Spring Conference on Experimental Mechanics, Milwaukee, WI, June 10-13, 1991, Proceedings Bethel, CT Society for Experimental Mechanics, Inc. 1991 p. 21-30. Research supported by Bangalore Univ. and Defence Research and Development Organisation refs
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Results are presented of a photoelastic study of skew plates commonly employed in machine members and structures such as parts of airplane wings, missiles, ship decks and floor slabs of skew bridges and buildings. The investigation involved skew sandwich plates made of Araldite varying in width from 80 mm to 40 mm and skew angle varying from 0 to 40 deg with a 10 x 10 mm skewed cutout located at the center of the flat plate subjected to inplane loads offset from the centroidal axis of the plates. The maximum tangential stress was found to increase at critical point A around cutout boundary on the maximum stress face of the plate as the eccentricity increases for various values of skew angles and different cutout-to-width ratios. The minimum stress occurs on the minimum stress face of the skew plate at critical point C. The stress concentration factor decreases at C with an increase in eccentricity for various values of cutout-to-width ratios and skew angles. C.A.B.

A93-16611
VIDEO HOLOGRAPHY AND LASER VIBROMETRY...THE DYNAMIC DUO
GENE E. MADDUX (USAF, Wright Lab., Wright-Patterson AFB, OH) *In* 1991 SEM Spring Conference on Experimental Mechanics, Milwaukee, WI, June 10-13, 1991, Proceedings Bethel, CT Society for Experimental Mechanics, Inc. 1991 p. 191-197. refs
Copyright

This paper explores the simultaneous use of the laser based techniques of Video holography and laser vibrometry to characterize damage due to foreign object damage to composite plates. Although the original intent was to present pre and post damage results, only the undamaged panel characteristics will be presented at this time. Author

A93-16647
MEASUREMENT OF A ONE-DIMENSIONAL MOBILITY USING A LASER-DOPPLER VELOCIMETER
L. D. MITCHELL, K. KOCHERSBERGER, and R. L. WEST (Virginia Polytechnic Inst. and State Univ., Blacksburg) *In* 1991 SEM Spring Conference on Experimental Mechanics, Milwaukee, WI, June 10-13, 1991, Proceedings Bethel, CT Society for Experimental Mechanics, Inc. 1991 p. 846-853.
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The measurement of mobilities on a 2D structure, a flat plate, is described. LDVs measure velocity along the line of sight between the laser and the structure. Methods for the transformation of the line-of-sight velocity to an out-of-plane velocity are discussed and demonstrated. Calibration methods needed to obtain mobility measurements without an FFT processor are discussed, as well as methods which attempt to isolate structural resonance so that the mobility measured will reasonably represent an uncoupled model mobility of the point being measured. Phase-resonance methods, a phase-correction method, frequency precision requirements, and frequency selection methodologies are also considered. It is found that the assumption of 1D out-of-plane vibration results in out-of-plane measurement of surface velocity within about 4 percent of the true value, if there is no in-plane vibration occurring at the same time. If in-plane vibrations exist, then errors in velocity measurements can easily be 20 percent of the in-plane motion when the angles of attack approach 12.5 deg. C.A.B.

A93-16845
A PRELIMINARY INVESTIGATION OF A METHOD TO CALIBRATE STRAIN GAUGE BALANCES BY MEANS OF A REFERENCE BALANCE

BUZHANG HAN (Nanjing Aeronautical Inst., China), MINGYING WANG (Shenyang Aerodynamic Research Inst., China), G. I. JOHNSON, and S. WIDMARK (Aeronautical Research Inst. of Sweden, Bromma) Nanjing Aeronautical Institute, Journal (English Edition) vol. 9, no. 1 June 1992 p. 40-47. refs

This investigation was started in order to obtain preliminary experience on the concept of a reference balance planned to be used in the T1500 calibration rig. The reference balance was simulated by using an available half model balance in the MK5 calibration rig at FFA. First the reference balance was calibrated and then the result was used for calibration of an ordinary six component sting balance attached with its model end to the half model balance. Both balances had been previously calibrated by the reposition method. Evaluation of the reference balance nonrepositioning concept was obtained by comparison of results. Author

A93-16849
PROSPECTIVE APPLICATION OF NEURAL NETWORKS IN SUPERRESOLUTION RADARS
ZHAODA ZHU and ZHISHUN SHE (Nanjing Aeronautical Inst., China) Nanjing Aeronautical Institute, Journal (English Edition) vol. 9, no. 1 June 1992 p. 65-71. Research supported by Aeronautical Science Foundation of China refs

Recent progress in both theory and technology have created a chance of developing superresolution radars that may break through the radar resolution limitations imposed by the matched filter principle. The huge computational burden involved in a superresolution radar sometimes comes from a multidimensional search in solving a nonlinear least squares problem. Through two primary examples of detecting targets of a known number but with unknown directions using array processing and superresolution range-Doppler imaging of a commercial aircraft Boeing-727, we illustrate that the Hopfield neural network which is able to collectively compute a good solution to difficult optimization problems seems to be highly promising in prospective applications in superresolution radars. Author

A93-16861
PHOTOLUMINESCENT THERMOGRAPHY - FEASIBILITY STUDY WITH POINTWISE MEASUREMENTS [THERMOGRAPHIE PAR PHOTOLUMINESCENCE - ETUDE DE FAISABILITE EN MESURE PONCTUELLE]
PIERRE BAUMANN (ONERA, Div. d'Aerodynamique Experimentale, Chatillon, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 153 1992 p. 77-79. In French. Research supported by DRET refs
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This paper presents the exploratory research undertaken at ONERA on an original process of thermography in hypersonic wind tunnels. The technique is based on the heat sensitivity of a photoluminescent compound applied on the model. R.E.P.

A93-17140
OPTICAL DESIGN OF A WIDE-ANGLE SIMULATOR PROBE
IAN MARSHALL (MBM Technology, Ltd., Optical Products Group, Brighton, United Kingdom) Optical Engineering (ISSN 0091-3286) vol. 31, no. 11 Nov. 1992 p. 2434-2441. Research supported by Defence Research Agency refs
Copyright

An optical design concept is presented for a wide field of view camera, used to take pictures of a model board, which are displayed to the pilot of a simulated aircraft in real time. The concept achieves mapping functions and perspectives in three separate images that match the display system properties over 140 deg field of view. This enables fast feedback of the model board images to the pilot by avoiding the need for computer correction of optical distortion. The geometry of the lens system also ensures good uniformity of brightness over the wide field of view. The provision of three axes of angular movement and computer optical design techniques are discussed. The general design and fabrication of a prototype is described. Author

A93-17251
BOUNDARY LAYER TRANSITION AND CONTROL; PROCEEDINGS OF THE CONFERENCE, UNIV. OF CAMBRIDGE, UNITED KINGDOM, APR. 8-12, 1991
London Royal Aeronautical Society 1991 320 p.
(ISBN 0-903409-86-0) Copyright

The present conference discusses such boundary-layer transition (BLT) and boundary-layer control (BLC) topics as supersonic BLT on a swept cylinder, a high frequency secondary instability of crossflow leading to BLT, primary and secondary stability analyses of a 3D boundary layer, interacting wavetrains in the Blasius boundary layer, acoustic detection of BLT, laminar flow engine nacelles, BLT on blunted cones at hypersonic speeds, the cross-flow instability near a rotating disk, and the numerical simulation of a 3D wave packet. Also discussed are vortex formation in the late stages of BLT, a one-equation model for 3D boundary layers, BLT in laterally divergent and convergent flows, BLC flow research in the 1940s and 1950s, the role of wall instabilities in BLT over compliant walls, and the prediction of localized instability generation. (For individual items see A93-17252 to A93-17277) O.C.

A93-17392
DEMONSTRATION OF AN INTEGRATED, ACTIVE 4 X 4 PHOTONIC CROSSBAR
D. K. PROBST (Southeast Missouri State Univ., Cape Girardeau, MO), L. G. PERRYMORE, B. C. JOHNSON, R. J. BLACKWELL (McDonnell Douglas Electronic Systems Co., Saint Louis, MO), J. A. PRIEST (Laser Data Technology, Saint Louis, MO), and C. L. BALESTRA (McDonnell Douglas Electronic Systems Co., Saint Louis, MO) IEEE Photonics Technology Letters (ISSN 1041-1135) vol. 4, no. 10 Oct. 1992 p. 1139-1141. refs
Copyright

A monolithically integrated, active 4 x 4 photonic crossbar switch has been fabricated by using rib waveguides with etched-facet T-branches and turning mirrors. Switching functionality, simultaneous routing of two digital FM video signals, and routing pseudorandom NRZ data was demonstrated. Author

A93-17408
LORD RAYLEIGH AND HYDRODYNAMIC SIMILARITY
N. ROTT (Stanford Univ., CA) Physics of Fluids A (ISSN 0899-8213) vol. 4, no. 12 Dec. 1992 p. 2595-2600. refs
Copyright

The history of two domains in fluid mechanics, in which Lord Rayleigh made explicit use of hydrodynamic similarity, are investigated: the theory of aerodynamic drag and the treatment of the aeolian tones. The great impact of Rayleigh's ideas on the development of hydrodynamic similarity theory and applications is described, during his lifetime and beyond. Many historical details involving Lord Rayleigh's contemporaries are also presented in an attempt to give a vivid description of a crucial epoch in the history of fluid mechanics. A brief description of certain modern developments is appended. Author

A93-17417* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EXPERIMENTAL STUDY OF CONTROLLED TIP DISTURBANCE EFFECT ON FLOW ASYMMETRY
DAVID DEGANI (Technion - Israel Inst. of Technology, Haifa) and MURRAY TOBAK (NASA, Ames Research Center, Moffett Field, CA) Physics of Fluids A (ISSN 0899-8213) vol. 4, no. 12 Dec. 1992 p. 2825-2832. refs
(Contract NCA2-578)
Copyright

The effect on the asymmetric mean flow observed on pointed bodies of revolution at incidence of changing the size and location of a controlled disturbance as well as changes in angle of attack and flow conditions are evaluated experimentally. Flow visualization and side-force measurements are carried out for a generic ogive-cylinder body inclined at high angle of attack in a low-speed wind tunnel. For all angles of attack tested (30-60 deg), minute changes in the size or location of the controlled disturbance result

in finite changes in the asymmetric flow field, even to the extent of reversing the sign of the side force or becoming almost symmetric. The process is reversible; returning the wire to an original position likewise restores the corresponding flow field and mean side force. The variation of side force with continuous variation of a perturbation's size or location remains continuous and single valued, even in the incidence range of 50 to 60 deg, where 'bistable' behavior of the asymmetric flow field is observed. Author

N93-12555# Georgia Inst. of Tech., Atlanta.
APPLICATION OF CONCURRENT ENGINEERING METHODS TO THE DESIGN OF AN AUTONOMOUS AERIAL ROBOT M.S. Thesis
STEPHEN A. INGALLS Dec. 1991 162 p
(AD-A254968) Avail: CASI HC A08/MF A02

This paper documents the year-long efforts of a multidisciplinary design team to design, build, and support an autonomous aerial robotics system. The system was developed to participate in the Association for Unmanned Vehicle System's (AUVS) First International Aerial Robotics Competition which was held in Atlanta, Georgia on the Georgia Tech campus on July 29th, 1991. As development time and budget were extremely limited, the team elected to attempt the design using concurrent engineering design methods. These methods were validated in an IDA study by Winner 1 in the late- 1980's to be particularly adept at handling the difficulties to design presented by these limitations. GRA

N93-12674*# National Aeronautics and Space Administration, Washington, DC.
REQUIREMENTS FOR SOLDERED ELECTRICAL CONNECTIONS
Jan. 1992 114 p
(NHB-5300.4(3A-2); NAS 1.18:5300.4(3A-2)) Avail: CASI HC A06/MF A02

This publication is applicable to NASA programs involving solder connections for flight hardware, mission essential support equipment, and elements thereof. This publication sets forth hand and wave soldering requirements for reliable electrical connections. The prime consideration is the physical integrity of solder connections. Special requirements may exist which are not in conformance with the requirements of this publication. Design documentation contains the detail for these requirements, and they take precedence over conflicting portions of this publication when they are approved in writing by the procuring NASA installation. Author

N93-12735*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PROBABILISTIC EVALUATION OF FUSELAGE-TYPE COMPOSITE STRUCTURES
MICHAEL C. SHIAO (Sverdrup Technology, Inc., Brook Park, OH.) and CHRISTOS C. CHAMIS Nov. 1991 20 p Presented at the Ninth DOD/NASA/FAA Conference on Fibrous Composites, Reno, NV, 3-7 Nov. 1991
(Contract RTOP 553-13-00)
(NASA-TM-105881; E-7348; NAS 1.15:105881) Avail: CASI HC A03/MF A01

A methodology is developed to computationally simulate the uncertain behavior of composite structures. Uncertain behavior is the consequence of the random variation (scatter) of the primitive (independent random) variables at the constituent, ply, laminate and structural levels. This methodology is implemented in the IPACS (Integrated Probabilistic Assessment of Composite Structures) computer code. A fuselage-type composite structure is analyzed to demonstrate the code's capability. The probability distribution functions of structural responses are computed. Sensitivity of a given structural response to each primitive variable is also determined from the analyses. Author

N93-12736*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SPLIT TORQUE TRANSMISSION LOAD SHARING
T. L. KRANTZ, M. RASHIDI (Cleveland State Univ., OH.), and J. G. KISH (Sikorsky Aircraft, Stratford, CT.) Oct. 1992 25 p Presented at the Gearbox Configurations of the 1990's, Solihull, England, 28 Oct. 1992; sponsored by the Institute of Mechanical Engineers
(Contract DA PROJ. 1L1-62211-A-47-A; RTOP 505-63-36)
(NASA-TM-105884; E-7350; NAS 1.15:105884; AVSCOM-TR-92-C-030) Avail: CASI HC A03/MF A01

Split torque transmissions are attractive alternatives to conventional planetary designs for helicopter transmissions. The split torque designs can offer lighter weight and fewer parts but have not been used extensively for lack of experience, especially with obtaining proper load sharing. Two split torque designs that use different load sharing methods have been studied. Precise indexing and alignment of the geartrain to produce acceptable load sharing has been demonstrated. An elastomeric torque splitter that has large torsional compliance and damping produces even better load sharing while reducing dynamic transmission error and noise. However, the elastomeric torque splitter as now configured is not capable over the full range of operating conditions of a fielded system. A thrust balancing load sharing device was evaluated. Friction forces that oppose the motion of the balance mechanism are significant. A static analysis suggests increasing the helix angle of the input pinion of the thrust balancing design. Also, dynamic analysis of this design predicts good load sharing and significant torsional response to accumulative pitch errors of the gears. Author

N93-12977# Northern Research and Engineering Corp., Woburn, MA.
ALTERNATIVE SYSTEMS FOR FUEL GAS BOOSTERS FOR SMALL GAS TURBINE ENGINES Final Report, Nov. 1989 - Dec. 1991
HENRY B. FAULKNER Apr. 1992 98 p
(Contract GRI-5086-233-1436)
(PB92-223049; NREC-1626-3; GRI-92/0239) Avail: CASI HC A05/MF A02

The study was done to investigate alternative technologies for fuel gas boosters for gas turbine engines under 5 MW output. The goal was to identify concepts which would significantly reduce the overall life cycle cost of these boosters. In a broad review of alternative systems, centrifugal compressors were found to be most promising. Electrically driven centrifugals, either direct drive or gear driven, were found to be quite limited in speed. Therefore they require many stages for these applications, and no cost advantage was indicated. Considerable promise was indicated for centrifugals driven by bleed air from the engine compressor, using turbocompressor units which are conversions of existing turbochargers for internal combustion engines. A first cost advantage of 30 to 80 percent was indicated for applications with an annual market size of at least ten units. Considerable savings in installation and maintenance costs are expected in addition. GRA

N93-13052# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (Germany). Inst. fuer Hochfrequenztechnik.
MOTION ERRORS AND COMPENSATION POSSIBILITIES
DAVID HOUNAM *In* AGARD, Fundamentals and Special Problems of Synthetic Aperture Radar (SAR) 12 p Aug. 1992
Copyright Avail: CASI HC A03/MF A03

The synthetic aperture radar (SAR) technique relies on knowledge of the relative motion between the sensor and the target. If the flight path of the sensor is not accurately known or the SAR processor is limited in its ability to take the flight data into account, the SAR image will be degraded. Motion errors are particularly critical for SAR sensors on small, low-flying aircraft, due to turbulence, and where high spatial resolution is required. The lecture discusses the effects of motion errors on image quality and the requirements on the sensor and processor to compensate for motion errors. The DLR airborne sensor, E-SAR, and associated image processor will be used as examples. Techniques using a priori knowledge of the flight path from independent sensors, e.g.,

inertial navigation systems (INS), and by extracting the flight data from the SAR data, e.g., autofocus and reflectivity displacement method (RDM), are treated. Author

N93-13053# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (Germany). Inst. fuer Hochfrequenztechnik.
THE REAL APERTURE ANTENNA OF SAR, A KEY ELEMENT FOR PERFORMANCE
HERWIG OETTL *In* AGARD, Fundamentals and Special Problems of Synthetic Aperture Radar (SAR) 8 p Aug. 1992
Copyright Avail: CASI HC A02/MF A03

For a SAR system flying on an airborne or spaceborne platform, the real antenna must be designed in such a way so as to avoid ambiguities and achieve the envisaged resolution. Although a SAR is, with respect to geometric azimuth resolution, independent of its distance from a target, the ground range resolution depends on the incidence angle and, of course, on the bandwidth dependent slant range resolution. The antenna size and its half power beam width (HPBW) in azimuth and elevation define its azimuth resolution and, for a given off-nadir angle and chosen altitude, the swath width. The minimum antenna size, measured in wavelengths, depends on the altitude, velocity of the platform, and chosen off-nadir angle. In real antenna design, the aperture size will be somewhat larger in order to allow for amplitude taper (at least in elevation), for electronic beam steering and possibly for beam shaping. This paper explains the interdependence of antenna parameters with SAR system performance. Author

N93-13199# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics Panel.
AERODYNAMIC ENGINE/AIRFRAME INTEGRATION FOR HIGH PERFORMANCE AIRCRAFT AND MISSILES [L'INTEGRATION AERODYNAMIQUE DES MOTEURS ET DES CELLULES DANS LES AVIONS ET LES MISSILES A HAUTES PERFORMANCES]
Sep. 1992 449 p In ENGLISH and FRENCH Symposium held in Fort Worth, TX, 7-10 Oct. 1991
(AGARD-CP-498; ISBN-92-835-0672-3) Copyright Avail: CASI HC A19/MF A04

The objective of the symposium was to review the state-of-the-art in aerodynamic engine/airframe integration techniques and to report on the progress which has been achieved during engineering project work in recent years. Because the treatment of this subject requires an interdisciplinary approach, both experimentalists and theoreticians were invited to contribute to the meeting. Six sessions were organized to cover the essential subdisciplines requiring aerodynamic engine/airframe integration during the concept-assessment and design phases for new aerospace vehicles.

N93-13200# Aircraft Research Association Ltd., Bedford (England).
TEST TECHNIQUES FOR ENGINE/AIRFRAME INTEGRATION
A. E. HARRIS *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 17 p Sep. 1992
Copyright Avail: CASI HC A03/MF A04

The paper traces a path through modern experimental techniques in use for the study of installation performance in the context of military and civil engine/airframe integration studies. For military and civil transport designs it is shown that separate treatment of air intake and exhaust regions is generally undertaken in contemporary methods. An early entry into the aerodynamics of the complete engine/airframe is emphasized in order to avoid costly integration difficulties. Using examples largely drawn from direct experience gained during the period 1960 to 1990 the author presents a set of 'most preferred methods' for use in high speed configuration development model tests. It is noted that current trends in civil and military designs require increased attention to be paid to off-axis thrust/drag/lift variations in the engine/airframe integration process. Methods of flow visualization are briefly reviewed and the emerging laser methods are also identified. The paper closes with a conceptual configuration for a year 2000 totally integrated engine/airframe to meet 21st century civil transport mass transit requirements. Author

N93-13201# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
TESTS OF MODELS EQUIPPED WITH TPS IN LOW SPEED ONERA F1 PRESSURIZED WIND TUNNEL [ESSAIS DE MAQUETTES MOTORISEES EQUIPEES DE SIMULATEURS DE REACTEURS DANS LA SOUFFLERIE BASSE VITESSE PRESSURISEE F1, DE L'ONERA]
J. LEYNAERT *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 5 p Sep. 1992 In FRENCH Previously announced in IAA as A92-26371
Copyright Avail: CASI HC A01/MF A04

The particular conditions of tests of models equipped with a turbofan powered simulator (TPS) at high Reynolds numbers in a pressurized wind tunnel are presented. The high-pressure air supply system of the wind tunnel, the equipment of the balance with the high-pressure traversing flow and its calibration, and the thrust calibration method of the TPS and its verification in the wind tunnel are described. Author

N93-13203# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
DETAILED ANALYSIS OF WING-NACELLE INTERACTION FOR COMMERCIAL TRANSPORT AIRCRAFT [ANALYSE DETAILLEE DE L'INTERACTION VOILURE-NACELLE D'UN AVION DE TRANSPORT CIVIL]
J. L. GODARD, O.-P. JACQUOTTE, and D. GISQUET (Aerospatiale, Toulouse, France) *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 11 p Sep. 1992 In FRENCH Previously announced in IAA as A92-16122
Copyright Avail: CASI HC A03/MF A04

An experimental setup has been developed to study the wing-nacelle interaction of commercial transports during transonic operation. This stand allows the measurement of the overall loads, pressure distribution on the model, and velocities in the field by laser velocimetry. The analysis gives a better understanding of the wing-nacelle interaction and provides the best comparative elements for modeling calculations. IAA

N93-13204# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany). Inst. fuer Entwurfsaerodynamik.
INVESTIGATION OF INTERFERENCE PHENOMENA OF MODERN WING-MOUNTED HIGH-BYPASS-RATIO ENGINES BY THE SOLUTION OF THE EULER-EQUATIONS
C.-C. ROSSOW and A. RONZHELMER *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 11 p Sep. 1992
Copyright Avail: CASI HC A03/MF A04

With the development of Ultra-High Bypass (UHB) engines the aerodynamic interference between airframe and engine becomes increasingly important. In this study the solution of the Euler equations is used to simulate the flow field around the DLR-ALVAST wing-body combination with different wing-mounted engines. For a CFM-56 engine, which is taken here to represent a conventional engine, the contributions of single components like engine, pylon, and jet to the aerodynamic interference were investigated. The comparison with the flow field around the wing-body combination without engine showed that the presence of the engine alone lead to a forward movement of the shock on the complete upper surface of the wing. The pylon mainly influenced the lower surface and caused an additional loss of lift which is of the same order of magnitude as the loss due to the engine. The simulation of an inviscid jet showed no significant influence for the conventional engine. A further comparison of the interference effects of the CFM-56 engine and a UHB engine was made. The geometry of the UHB engine corresponds to the DLR-CRUF simulator for Ultra-High Bypass engines. Due to the closer installation to the wing and the larger dimensions, the UHB engine caused a local flow acceleration on the lower surface of the wing.

This lead to a significant loss of lift at the engine position, compared to the conventional engine. Simulation with and without jet revealed that the jet was mainly responsible for this behavior. In case of the UHB engine the jet passed very closely under the wing and the displacement effect of the jet caused a strong flow acceleration. Author

N93-13206# Vigyan Research Associates, Inc., Hampton, VA.
EULER ANALYSIS OF TURBOFAN/SUPERFAN INTEGRATION FOR A TRANSPORT AIRCRAFT
D. A. NAIK, H. C. CHEN (Boeing Co., Seattle, WA.), T. Y. SU (Boeing Co., Seattle, WA.), and T. J. KAO (Boeing Co., Seattle, WA.) *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 12 p Sep. 1992
Copyright Avail: CASI HC A03/MF A04

A three-dimensional general multi-block Euler solver (GMBE) has been developed to analyze the propulsion integration effects of turbofan/superfan installations. Either flow-through or powered nacelles can be modelled. The code is demonstrated on a generic NASA low wing transport model with an advanced turbofan flow-through nacelle. The results compare favorably with experimental data obtained in the NASA Langley 16-Foot (4.88 m) Transonic Tunnel. The computed pressure distributions are used to identify, in terms of pressure coefficient peaks (maximum negative values) and gradients, undesirable flow regions in the vicinity of the pylon and nacelle. The results suggest that a change in toe angle and pylon trailing edge closure geometry will improve the propulsion integration. Author

N93-13209# Universitaet der Bundeswehr Muenchen, Neubiberg (Germany). Inst. fuer Strahlantriebe.
OVERVIEW ON TEST CASES FOR COMPUTATION OF INTERNAL FLOWS IN TURBOMACHINES
LEONHARD FOTTNER *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 5 p Sep. 1992
Copyright Avail: CASI HC A01/MF A04

Aero engine component design and development makes increasing use of computer codes for flow field calculations, such as two- or three-dimensional flow fields and flow fields with strong viscous effects. The accuracy of these calculation methods depends on the mathematical models and numerical schemes used to describe the physical reality. The proof of validity and the refinement of such methods depend on verification against relevant test cases, primarily experimental test cases. The AGARD Propulsion and Energetics Panel established Working Group 18 to specify relevant reference test cases to serve as validation bases for new methods, but also as check for existing production codes. The present paper gives an overview on the results of the Working Group and briefly describes the different test cases. These test cases refer to analytical and experimental test cases for steady flow in linear compressor and turbine cascades, single blade rows, single and multistage axial compressors and turbines and ducts. In addition, suggestions for future tests designed to reduce the limitations are discussed. Author

N93-13210# Vrije Univ., Brussels (Belgium). Dept. of Fluid Mechanics.
THE PEP SYMPOSIUM ON CFD TECHNIQUES FOR PROPULSION APPLICATIONS
CH. HIRSCH *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 18 p Sep. 1992
Copyright Avail: CASI HC A03/MF A04

This is part of the PEP contribution to the 69th FDP meeting on Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles. It presents an overview of the main outcomes of the last PEP meeting dealing with CFD techniques for propulsion applications. The emphasis was given to computational work on realistic 3D configurations, covering the four following topics: full 3D validations; full 3D numerical techniques; unsteady flows and multidimensional reacting flows. In addition, an invited paper from FDP on the state of the art of computational techniques for 3D Navier-Stokes equations and a technical evaluation of the meeting were presented. The most widely stressed conclusion was the urgent need for a large scale effort on validation of numerical accuracy and of physical models. Author

N93-13211# Motoren- und Turbinen-Union Muenchen G.m.b.H. (Germany).
THE INFLUENCE OF INTAKE SWIRL DISTORTION ON THE STEADY-STATE PERFORMANCE OF A LOW BYPASS, TWIN-SPOOL ENGINE
W. MEYER, W. PAZUR (Universitaet der Bundeswehr Muenchen, Neubiberg, Germany), and LEONHARD FOTTNER (Universitaet der Bundeswehr Muenchen, Neubiberg, Germany) *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 20 p Sep. 1992
Copyright Avail: CASI HC A03/MF A04

Intakes of supersonic aircraft can produce intake swirl configurations in front of the engine which are important for intake/engine compatibility assessment throughout the flight envelope. The main objective of this investigation was to get more information about the influence of intake twin swirl on the steady-state engine behavior. The twin swirl was simulated using a movable delta wing positioned between the bellmouth intake and the engine. By changing the angle of attack of the delta wing, the intensity of the intake swirl could be varied. Increasing the intensity of the twin swirl resulted in a deterioration of engine performance. The analysis of the test results showed that these effects on engine performance were mainly due to a modified characteristic of the low pressure compressor (LPC). Therefore, it was very important to investigate the changed LPC performance to be able to understand the effects of an intake swirl distortion on the engine performance. Hence, an experimental method was set up to measure the performance map of the installed LPC by defined changing of the engine operating line. An analysis of experimentally determined compressor maps for varying intensities showed that the performance parameters of the LPC decrease. However, there is essentially no variation of the engine's working line due to an intake twin-swirl distortion. Semi-empirical calculations which took account of this influence of the generated swirl on the performance of the LPC confirmed the loss of engine performance observed during the engine tests. Author

N93-13215# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany). Military Aircraft Div.
A NOVEL-HIGH-PERFORMANCE SYSTEM FOR RECORDING AND ANALYSING INSTANTANEOUS TOTAL PRESSURE DISTORTION IN AIR INTAKES
K. W. LOTTER and R.-D. SCHERBAUM *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 16 p Sep. 1992
Copyright Avail: CASI HC A03/MF A04

Instantaneous intake total pressure distortion parameters are generally used to assess aerodynamic intake-engine compatibility. Different distortion parameters are applied by the various engine manufacturers. Distortion boundaries are specified which are not to be exceeded in the intake during the whole flight regime. The quantification of those parameters is generally made in intake wind-tunnel model tests. In these tests the instantaneous total pressure is measured in the Aerodynamic Interface Plane (AIP) (a short distance upstream of the engine compressor face) by high-response pressure transducers, typically installed on an eight-arm rake with five probes on each arm. In the past, after having undergone the relevant signal conditioning process, the signals from the transducers were combined to the above-mentioned distortion parameters by the use of an analog computer. Later on, this was supplemented by limited digital analysis of the high-frequency signals. Because of the large amount of data, the digital analysis was only applied over a predetermined short time period. The evolution of high-performance digital data storage facilities combined with highspeed analog-digital conversion now allows a major step forward to longtime digital recording and analysis during intake distortion tests. The novel system that has been installed at MBB and successfully applied during various intake wing-tunnel test campaigns is described. Dynamic signals

from up to 144 high-response differential transducers can be recorded. Individual control lines are used for sensing, power supply, and in-situ calibration. A specially configured computer system is used to control the signal frequency band, the number of signal channels, the control lines, and the sample rate. The computer is also used to control the storage of the digitized data on an advanced high density tape recording system that allows continuous recording of up to 1 hour on a cassette tape. The data rate for tape storage is as high as 107 Mbits/s. Parallel to this storage process it is possible to calculate, in an on-line real-time mode, the desired instantaneous distortion parameters using an analog computer. For recording times of up to 5 seconds for each data point, digital on-line analysis is also possible. The data can be displayed on a screen and are also plotted during the test, thus allowing the test engineer to react quickly and alter or adapt the test program. Typical results from tests with different intake models in various wind-tunnel facilities are presented. The effect of digitization rate and recording time on the error of the calculated instantaneous distortion parameters is shown. Author

N93-13216# Aeronautica Macchi S.p.A., Varese (Italy). Aerodynamics Div.
WATER TUNNEL STUDIES OF INLET/AIRFRAME INTERFERENCE PHENOMENA
R. MAGGIO *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 12 p Sep. 1992
Copyright Avail: CASI HC A03/MF A04

Some experimental studies of inlet/airframe interference, conducted at the Aermacchi's Water Tunnel facility about aircraft configurations under consideration for an Advanced Trainer Project, are presented. The chin inlet and the bifurcated inlet configurations have been considered, and the following phenomena have been investigated: inlet/forebody interference at low incidence; inlet/ground interference at take off conditions; and inlet/airframe interference. All the above mentioned studies are based on flow visualizations in water tunnel, merged with theoretical studies, semiempirical, and handbook methods. Author

N93-13220*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AGARD WG13 AERODYNAMICS OF HIGH SPEED AIR INTAKES: ASSESSMENT OF CFD RESULTS
N. C. BISSINGER (Messerschmitt-Boelkow-Blohm G.m.b.H., Munich, Germany), T. J. BENSON, and R. G. BRADLEY, JR. (General Dynamics Corp., Fort Worth, TX.) *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 24 p Sep. 1992
Copyright Avail: CASI HC A03/MF A04

A brief review of the work accomplished by the numerical subgroup of AGARD Working Group 13 on the aerodynamics of high speed air intakes is presented. This work comprised the selection of test cases for which experimental data were available. The test cases were chosen to range in complexity from normal-shock/boundary-layer interaction to full forebody-inlet combinations. Computations for these test cases were solicited from a large number of organizations and individual researchers within the NATO countries. The computation methods reached from Euler solvers (with and without boundary layer corrections) to full Reynolds averaged Navier-Stokes codes. The group compared these results with the test data available for each test case. A short overview of the CFD methods employed, a description of the test cases selected, and some of the comparisons between CFD solutions and test data are presented. The conclusions and recommendations drawn from this assessment are given. Author

N93-13226# General Dynamics Corp., Fort Worth, TX.
CFD CALIBRATION FOR THREE-DIMENSIONAL NOZZLE/AFTERBODY CONFIGURATIONS
CHRISTOPHER L. REED and ARNOLD MUYSHONDT *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 11 p Sep. 1992
Copyright Avail: CASI HC A03/MF A04

The current trend in fighter aircraft design is toward highly integrated propulsive exhaust systems. In order to achieve this level of integration, extensive testing and analysis is required. Modern computational fluid dynamics (CFD) techniques have become popular in performing a part of the required analyses. Because of the complexity of most nozzle/afterbody type flow fields, Navier-Stokes codes are generally the preferred CFD methods. To gain confidence in these solvers ability to provide useful design information, a number of calibration analyses must be conducted. Extensive test data are available for these comparisons. This paper describes three such analyses which were used to calibrate two Navier-Stokes codes. The first case deals with the internal flow through a vectored nozzle. The second case looks at the development of an exhaust plume issuing from a rectangular nozzle. The third case considers the flow over an afterbody with a high-aspect-ratio rectangular nozzle. In all cases, both qualitative and quantitative comparisons are made between the test data and the CFD data. Good comparisons are obtained and additional confidence is gained in these CFD codes ability to provide useful engineering data. Author

N93-13227# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany).
INVESTIGATION OF THE FLOWFIELD AROUND AN ISOLATED BYPASS ENGINE WITH FAN AND CORE JET
R. RUDNIK, A. RONZHEIMER, C.-C. ROSSOW, and H. HOHEISEL *In* AGARD, Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles 8 p Sep. 1992
Copyright Avail: CASI HC A02/MF A04

A finite-volume scheme for the discretization of the three-dimensional Euler equations is extended for the purpose of calculating the flowfield around an isolated bypass engine with fan- and core-jet. Flow calculations for a typical high bypass engine are performed for take-off and cruise conditions under consideration of realistic operational jet parameters. Several variations of the jet pressure and temperature ratio show that the jet flowfield is dominated by the pressure ratio as far as inviscid flow is concerned. A comparison of the numerical results to experimental investigations, which are carried out with a turbine powered simulator for low speeds, exhibits good agreement. The influence of numerical parameters on the solution in the region of the jet flow is analyzed by varying the coefficients of the artificial dissipation. Author

N93-13321# Los Alamos National Lab., NM.
A PRELIMINARY STUDY OF THE EFFECT OF EQUIVALENCE RATIO ON A LOW EMISSIONS GAS TURBINE COMBUSTOR USING KIVA-2
S. L. YANG (Michigan Technological Univ., Houghton.), R. CHEN (Michigan Technological Univ., Houghton.), and M. C. CLINE 1992 12 p Presented at the Winter Annual Meeting of the American Society of Mechanical Engineers, Anaheim, CA, 8-13 Nov. 1992
(Contract W-7405-ENG-36)
(DE92-018616; LA-UR-92-2391; CONF-921110-14) Avail: CASI HC A03/MF A01

The staged turbine combustor (STC) concept has drawn more and more attention since the late 70's because of its potential in reducing pollutant emissions where a high power output is required. A numerical study is performed to investigate the chemically reactive flow with sprays inside a STC combustor using a modified version of the KIVA-II code. This STC combustor consists of a fuel nozzle (FN), a rich-burn (RB) zone, a converging connecting section, a quick-quench (QQ) zone, a diverging connecting section, and a lean-combustion (LC) zone. An advanced airblast fuel nozzle, which has two fuel injection passages and four air flow passages for providing swirl, is used in this study. The effect of the equivalence ratio phi on the performance of the STC combustor is reported in this paper for phi range of 1.2 to 2.0. Preliminary results reveal some major features of the flow and temperature fields inside the STC combustor. Distributions of velocity, temperature, and some critical species information inside the FN/RB zone illustrate the effect of phi on the flame temperature and the NO(x) formation in rich burning. The co- and

counter-rotating bulk flow, and the sandwiched-ring-shape temperature field in the QQ/LC zone, typical of the confined inclined jet-in-cross flow, are clearly shown from the computation. The predicted mass-weighted standard deviation and the pattern factor of temperature show that the mixing performance of the STC combustor is very good. The temperature of the fluid leaving the LC zone is very uniform. As expected. lower value of the emission index of NO can be achieved with larger value of phi. Prediction of the NO(x) emission shows that there is no excessive thermal NO(x) produced in the QQ/LC zone for all the cases studied.
DOE

N93-13406*# California Univ., Los Angeles. Dept. of Mechanical, Aerospace and Nuclear Engineering.
FLUID FLOW AND HEAT CONVECTION STUDIES FOR ACTIVELY COOLED AIRFRAMES Report, May - Oct. 1992
A. F. MILLS Oct. 1992 9 p
(Contract NCC2-374)
(NASA-CR-190956; NAS 1.26:190956) Avail: CASI HC A02/MF A01

The work done during the progress report period from May-October 1992 is summarized. The effect of wall thermal boundary conditions on flows over a step or rib when repeated rib roughness is used for heating augmentation is examined. In numerical investigations of various such laminar and turbulent flows, the local heat transfer coefficients on a forward-facing step or on a rib were found to be very sensitive to the wall thermal boundary condition. For the computation of constant property laminar flow, the wall thermal boundary conditions were either a uniform heat flux or a uniform temperature. Results (Nusselt number and isotherms) of the studies are included. The second part of the work consisted of using PHOENICS to solve the conjugate heat transfer problem of flow over a rib in channel. Finally, the algebraic stress model in the TEAM (Turbulent Elliptic Algorithm-Manchester) code was tested for jet impingement flow, but there needs to be an addition of the energy equation to the code. L.R.R.

N93-13422* National Aeronautics and Space Administration. Pasadena Office, CA.
THREE-STAGE SORPTION TYPE CRYOGENIC REFRIGERATION SYSTEMS AND METHODS EMPLOYING HEAT REGENERATION Patent
STEVEN BARD, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) and JACK A. JONES, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 27 Oct. 1992 11 p Filed 22 Oct. 1991 Supersedes N92-17674 (30 - 8, p 1277)
(NASA-CASE-NPO-18366-1-CU; US-PATENT-5,157,938; US-PATENT-APPL-SN-781520; US-PATENT-CLASS-62-335; US-PATENT-CLASS-62-434; US-PATENT-CLASS-62-467; INT-PATENT-CLASS-F25B-1/00) Avail: US Patent and Trademark Office

A three-stage sorption type cryogenic refrigeration system, each stage containing a fluid having a respectively different boiling point, is presented. Each stage includes a compressor in which a respective fluid is heated to be placed in a high pressure gaseous state. The compressor for that fluid which is heated to the highest temperature is enclosed by the other two compressors to permit heat to be transferred from the inner compressor to the surrounding compressors. The system may include two sets of compressors, each having the structure described above, with the interior compressors of the two sets coupled together to permit selective heat transfer therebetween, resulting in more efficient utilization of input power.
Official Gazette of the U.S. Patent and Trademark Office

N93-13524# Midwest Research Inst., Golden, CO.
USER'S GUIDE FOR THE NREL FORCE AND LOADS ANALYSIS PROGRAM
A. D. WRIGHT Aug. 1992 238 p
(Contract DE-AC02-83CH-10093)
(DE92-010579; NREL/TP-257-4674) Avail: CASI HC A11/MF A03

The following report gives the reader an overview of and instructions on the proper use of the National Renewable Energy Laboratory Force and Loads Analysis Program (FLAP, version 2.2). It is intended as a tool for prediction of rotor and blade loads and response for two- or three-bladed rigid hub wind turbines. The effects of turbulence are taken into account. The objectives of the report are to give an overview of the code and also show the methods of data input and correct code execution steps in order to model an example two-bladed rigid hub turbine. A large portion of the discussion is devoted to the subject of inputting and running the code for wind turbulence effects. The ability to include turbulent wind effects is perhaps the biggest change in the code since the release of FLAP version 2.01 in 1988. This report is intended to be a user's guide. It does not contain a theoretical discussion on equations of motion, assumptions, underlying theory, etc. It is intended to be used in conjunction with Wright, Buhl, and Thresher (1988).
DOE

N93-13525# Midwest Research Inst., Golden, CO.
USER'S GUIDE FOR THE NREL TEETERING ROTOR ANALYSIS PROGRAM (STRAP)
A. D. WRIGHT Aug. 1992 212 p
(Contract DE-AC02-83CH-10093)
(DE92-010580; NREL/TP-257-4671) Avail: CASI HC A10/MF A03

The following report gives the reader an overview of instructions on the proper use of the National Renewable Energy Laboratory (formerly the Solar Energy Research Institute, or SERI) teetering Rotor Analysis Program (STRAP version 2.20). STRAP is a derivative of the Force and Loads Analysis program (FLAP). It is intended as a tool for prediction of rotor and blade loads and response for only two-bladed teetering hub wind turbines. The effects of delta-3, undersling, hub mass, and wind turbulence are taken into account. The objectives of the report are to give an overview of the code and also show the methods of data input and correct code execution steps in order to model an example two-bladed teetering hub turbine. A large portion of the discussion (Sections 6.0, 7.0, and 8.0) is devoted to the subject of inputting and running the code for wind turbulence effects. The ability to include turbulent wind effects is perhaps the biggest change in the code since the release of FLAP version 2.01 in 1988. This report is intended to be a user's guide. It does not contain a theoretical discussion on equations of motion, assumptions, underlying theory, etc. It is intended to be used in conjunction with Wright, Buhl, and Thresher (1988).
DOE

N93-13664*# Ohio State Univ., Columbus. Aeronautical and Astronautical Research Lab.
TIME DEPENDENT HEAT TRANSFER RATES IN HIGH REYNOLDS NUMBER HYPERSONIC FLOWFIELDS
MICHAEL J. FLANAGAN *In* NASA. Langley Research Center, The 1992 NASA Langley Measurement Technology Conference: Measurement Technology for Aerospace Applications in High-Temperature Environments p 51-68 Sep. 1992 Sponsored in part by AFFDL
Avail: CASI HC A03/MF A04

Time dependent heat transfer rates have been calculated from time dependent temperature measurements in the vicinity of shock-wave boundary-layer interactions due to conical compression ramps on an axisymmetric body. The basic model is a cylindrical body with a 10 degree conical nose. Four conical ramps, 20, 25, 30, and 35 degrees serve as shock wave generators. Flowfield surveys have been made in the vicinity of the conical ramp vertex, the separation point, and the reattachment point. A significant effort was made to characterize the natural frequencies and relative powers of the resulting fluctuations in heat transfer rates. This research effort, sponsored jointly by NASA and the Air Force, was conducted in the Air Force Flight Dynamics Directorate High Reynolds Facility. The nominal freestream Mach number was 6, and the freestream Reynolds numbers ranged from 2.2 million/ft to 30.0 million/ft. Experimental results quantify temperature response and the resulting heat transfer rates as a function of ramp angle and Reynolds number. The temperature response within

the flowfield appears to be steady-state for all compression ramp angles and all Reynolds numbers, and hence, the heat transfer rates appear to be steady-state. Author

N93-13669*# PRC Systems Services Co., Edwards, CA.
HIGH-TEMPERATURE STRAIN MEASUREMENT TECHNIQUES: CURRENT DEVELOPMENTS AND CHALLENGES
M. M. LEMCOE *In* NASA. Langley Research Center, The 1992 NASA Langley Measurement Technology Conference: Measurement Technology for Aerospace Applications in High-Temperature Environments p 127-169 Sep. 1992
Avail: CASI HC A03/MF A04

Since 1987, a very substantial amount of R&D has been conducted in an attempt to develop reliable strain sensors for the measurements of structural strains during ground testing and hypersonic flight, at temperatures up to at least 2000 deg F. Much of the effort has been focused on requirements of the NASP Program. This presentation is limited to the current sensor development work and characterization studies carried out within that program. It is basically an assessment as to where we are now and what remains to be done in the way of technical accomplishments to meet the technical challenges posed by the requirements and constraints established for the NASP Program. The approach for meeting those requirements and constraints has been multi-disciplinary in nature. It was recognized early on that no one sensor could meet all these requirements and constraints, largely because of the large temperature range (cryogenic to at least 2000 deg F) and many other factors, including the most challenging requirement that the sensor system be capable of obtaining valid 'first cycle data'. Present candidate alloys for resistance-type strain gages include Fe-Cr-Al and Pd-Cr. Although they have superior properties regarding withstanding very high temperatures, they exhibit large apparent strains that must either be accounted for or cancelled out by various techniques, including the use of a dual-element, half-bridge dummy gage, or electrical compensation networks. A significant effort is being devoted to developing, refining, and evaluating the effectiveness of those techniques over a broad range in temperature and time. In the quest to obtain first-cycle data, ways must be found to eliminate the need to prestabilize or precondition the strain gage, before it is attached to the test article. It should be noted that present NASP constraints do not permit prestabilization of the sensor, in situ. Gages are currently being 'heat treated' during manufacture in both the wire- and foil-type resistance strain gages, and evaluation is in progress. In addition, the 'gage-on-shim' concept is being revisited. That concept will permit heat treatment of the gage during manufacture, before attachment on the test article. Also, it may permit the individual calibration of each gage regarding gage factor and apparent strain. Candidate alloys for the NASP include titanium metal-matrix and carbon-carbon composites. Although those materials have very attractive properties at elevated temperatures in terms of strength and weight, they pose significant attachment problems. Methods for making reliable strain gage and thermocouple attachments to them are currently under development. Experience to date indicates that Rokide attachment of the sensor directly to the protective coating is easier than to the base material itself. However, interpreting strain data from gages attached in this way may prove difficult because of possible cracks in the coating that form 'islands' and the mobility of those 'islands'. It is concluded, therefore, that major technical challenges lie ahead as we proceed to meet the stringent strain sensor requirements and constraints of the NASP Program. Author

N93-13769 Virginia Polytechnic Inst. and State Univ., Blacksburg.
TRANSONIC AEROELASTIC ANALYSIS OF SYSTEMS WITH STRUCTURAL NONLINEARITIES Ph.D. Thesis
I. WAYAN TJATRA 1991 211 p
Avail: Univ. Microfilms Order No. DA9126888

Wing structures often contain nonlinearities which affect their aeroelastic behavior and performance characteristics. Aerodynamic flows at the transonic Mach numbers generate nonlinear aerodynamic forces on the wing affecting the aeroelastic response of the wing. Analysis techniques accounting for these structural and aero-dynamic nonlinearities, and an understanding of their potential influence on the flutter mechanism of two-dimensional and three-dimensional wing-structure models are the main objective of this study. Two different categories of structural nonlinearities are considered: (1) distributed nonlinearity and (2) concentrated nonlinearity. The concentrated nonlinearities are mathematically modeled using the Asymptotic Expansion method which is based on the Krylov-Bogoliubov-Mitropolski technique. The effective stiffness coefficient of a nonlinear element is defined as the ratio of the amplitude of the Fourier series expansion of the load and the amplitude of the displacement of that element. The effects of distributed nonlinearities on the aeroelastic characteristic of a three-dimensional wing model are also investigated. The influences of this type of nonlinearity are treated in a quasi-nonlinear approach which allows the variation of the natural frequencies and damping factor of the structure model with respect to the amplitude of the motion. The transonic aerodynamic pressure distributions were obtained by solving the unsteady Transonic Small Disturbance (TSD) flow equation using finite-difference techniques. An Alternating Direction Implicit (ADI) algorithm was used for the two-dimensional flow model, and an Approximate Factorization (AF) algorithm was used for the three-dimensional flow model. The finite-state generalized aerodynamic forces used in the aeroelastic analysis were calculated by employing the Method of Harmonic Oscillation and the Pulse Transfer Function analysis. The solution of the aeroelastic equation in the frequency domain is obtained by representing the equation in a finite-state form through the modal approach using Lagrange's equation. The flutter boundary is obtained by solving this equation using the classical U-g method and root locus analysis. Flutter analysis of two degree-of-freedom, two-dimensional typical wing sections with nonlinear torsional springs is studied. The aeroelastic responses of the system are obtained by integrating the nonlinear structural terms and aerodynamic terms simultaneously using Newmark-beta and Wilson-theta methods. Flutter results obtained from both the time integration and eigenvalue solutions are compared. These two results, in general, are in agreement. Flutter behavior of a simple three-dimensional swept wing model is also investigated. Comparison of the flutter boundary obtained by using the eigenvalue solution with flutter data from wind-tunnel experiments is made. Dissert. Abstr.

N93-13826 Texas Univ., Austin.
AN EXPERIMENTAL/COMPUTATIONAL STUDY OF HEAT TRANSFER IN SHARP FIN INDUCED SHOCK WAVE/TURBULENT BOUNDARY LAYER INTERACTIONS AT LOW HYPERSONIC MACH NUMBERS Ph.D. Thesis
PATRICK ELROY RODI 1992 302 p
Avail: Univ. Microfilms Order No. DA9225710

A combined experimental and computational study has been performed of sharp fin induced shock wave/turbulent boundary layer interactions at Mach numbers of 5, 6, and 11. New experimental data were obtained at Mach 5 and include mean surface heat transfer and pressure distributions and surface flow visualization for fin angles of attack of 6, 8, 10, 12, 14 and 16 degrees. Detailed heat transfer measurements were also taken radially at 8 and 16 degrees to study the flowfield's conical nature. Conical Navier-Stokes calculations have been performed using the Baldwin/Lomax turbulence model. Computations were made for two angles of attack at each of the three Mach numbers. The Mach 6 and 11 data used for comparison with the computations, were from the earlier experimental studies of Law and Holden. Careful evaluation of the performance of this numerical approach has been carried out with an emphasis on the surface heat transfer predictions. The new experimental results are described in detail and compared with existing empirical correlations. Comparisons of the experimental data with the computations reveal that the conical Navier-Stokes/Baldwin-Lomax approach underpredicts the physical extent of the interactions for the lower two Mach numbers. However, this trend is reversed at Mach 11. The numerical results overpredict peak heat transfer, although the outer scaling of the Baldwin-Lomax model prevent a grid independent solution. The

computed flowfields reveal a large primary vortex located adjacent to the surface just beneath the inviscid shock wave and a smaller corner vortex located very near the fin/surface junction.
Dissert. Abstr.

N93-13953 Salford Univ. (England).
FLOW PREDICTION FOR THREE-DIMENSIONAL INTAKES AND DUCTS USING VISCOUS-INVISCID INTERACTION METHODS Ph.D. Thesis
IAN EDWARD WRISDALE 1991 391 p
Avail: Univ. Microfilms Order No. BRD-96502

A numerical scheme for the prediction of flows in engine intakes is presented. The scheme, which employs a viscous-inviscid interaction approach, is aimed at the treatment of high Reynolds number flows in which a significant region of inviscid core flow exists in the intake. The scheme is restricted to the treatment of attached flows; however, it is suitable for the treatment of highly rotational flows. The subsonic core flow calculations in the intake duct are performed using an Euler space marching scheme. Accurate flow prediction using the scheme requires the specification of detailed boundary conditions at the inlet plane of the duct. Appropriate conditions have been obtained by using a finite volume time marching scheme to calculate the flow field around inlet cowls at incidence. Hence, the boundary conditions for the duct calculations take account of the lip flows which are dependent on free stream conditions, incidence, and the mass flow ratio. Careful matching of the cowl and duct calculations provides a solution of the complete inviscid flow field both internal and external. The viscous-inviscid interaction scheme couples the inviscid solutions to a fully three-dimensional boundary layer method using a displacement surface model. The integral boundary layer method is aimed at the treatment of attached, turbulent boundary layers and includes the effects of rotational outer flows. Although the method is restricted to attached flows it may be used to indicate the onset of three-dimensional flow separation. The coupling of the inviscid flows and the boundary layers on the internal and external surface of the intake provide a complete description of the entire flow field. Numerical examples are presented throughout the work to illustrate the various methods. The complete scheme is then used to calculate the flow in an S-shaped intake duct operating under choked conditions at varying angles of incidence.
Dissert. Abstr.

N93-14025 Mississippi State Univ., State College.
UNSTEADY THREE-DIMENSIONAL THIN-LAYER NAVIER-STOKES SOLUTIONS FOR TURBOMACHINERY IN TRANSONIC FLOW Ph.D. Thesis
JEN PING CHEN 1991 131 p
Avail: Univ. Microfilms Order No. DA9218186

This dissertation concerns the development of a numerical scheme to simulate the flow field generated by rotating machinery. The implicit Euler solver 'TURBO' developed at MSU and in use at NASA Lewis Research Center for analyzing compressible flows in general rotating machinery was augmented by including viscous effects. This was accomplished by making the thin-layer approximation with a Baldwin-Lomax turbulence model to simplify the Reynolds-averaged Navier-Stokes equations. This code is an implicit finite volume scheme with flux Jacobians evaluated by flux-vector-splitting and residual fluxes by Roe's flux-difference-splitting. Diffusive flux terms were treated explicitly in order to preserve the existing code structure. A modified two pass matrix solver based on the Gauss-Seidel iterative method was used in place of the standard LU approximate factorization to enhance the code's stability. Newton subiterations were used for unsteady flow computations. A localized grid distortion technique was applied for data communication between blocks in relative motion. An inlet boundary condition for preserving total reservoir conditions and a new approach for computing wall shear stress for nonorthogonal grids are also presented. Three engineering problems have been examined by this computational technique with fair results. Hamilton-Standard's advanced propfan design SR7 served as a test case for external flows. NASA's Rotor 67 with a rotating blade now and NASA's Stage 67 with both rotating and static blade rows with a different number of blades in each row test the code's ability for internal flow. Although some improvements are still needed for this code to become a real engineering design tool, the decent results obtained from applying this code to the above three real-world engineering problems suggest that it is moving in the right direction. Dissert. Abstr.

N93-14041 Mississippi State Univ., State College.
SOLUTION OF COMPRESSIBLE NAVIER-STOKES EQUATIONS USING SPECTRAL METHODS ON ARBITRARY TWO-DIMENSIONAL DOMAINS Ph.D. Thesis
GEORGE PAULOSE KOOMULLIL 1991 75 p
Avail: Univ. Microfilms Order No. DA9218201

A method is developed for obtaining higher order accurate solutions of the Navier-Stokes equations on arbitrary two-dimensional domains. The development of a method of solving grid generation equations using spectral methods and the solution of the compressible Navier-Stokes equations by spectral methods on these coordinates is discussed. Further, an analysis was conducted to establish the order of accuracy of the solutions in transformed coordinates. Grid generation equations are solved for two-dimensional domains including simply-connected and doubly-connected regions. For simply-connected domains, Chebyshev polynomials are used in spectral methods along both coordinate directions. For doubly-connected domains Chebyshev polynomial expansions are used along the non-periodic direction and Fourier expansions along the periodic direction. Results and convergence rates are shown in various figures. The Navier-Stokes equations are first transformed to a general curvilinear coordinate system and kept in the fully conservative form. Metric coefficients are derived from the grid generation routines. The numerical scheme uses a spectral collocation method with Fourier and Chebyshev expansions along the periodic and non-periodic directions, respectively. Solutions of the governing equations are given both for a circular cylinder and a NACA0012 airfoil. Comparison of the Navier-Stokes solutions obtained on an exact grid, where the metric coefficients are obtained analytically, and a numerical grid, where the metric coefficients are derived from the spectral grid generation routine, is given. Both solutions match very closely. This type of comparison was possible only for a circular cylinder but it gives credence to the accuracy of the numerically generated grids by spectral methods. Time accuracy of the solution is tested with the results from a finite volume scheme and the experimental values at low Reynolds numbers. Also given is a comparison of the solution over NACA0012 airfoil at a moderately high Reynolds number of 10000 with finite difference and finite element results. The order of accuracy of the solution scheme is analyzed and is shown that for sustaining the solution accuracy as that of the numerical scheme, the metric coefficients should at least be of the same order of accuracy. The present solution technique permits the high order accuracy to be retained because the metric coefficients are also obtained from a high order accurate spectral scheme. Dissert. Abstr.

N93-14254# Naval Postgraduate School, Monterey, CA.
EXTENDED SURFACE HEAT SINKS FOR ELECTRONIC COMPONENTS: A COMPUTER OPTIMIZATION M.S. Thesis
JOHN R. GENSURE Jun. 1992 117 p
(AD-A256134) Avail: CASI HC A06/MF A02

Heat sinks consisting of individual fins and arrays of fins are used extensively throughout the Navy and industry. The fins serve to increase the surface area through which heat is transferred to the surrounding environment by natural convection. Extended surfaces or fins are commonly found on electronic components ranging from power supplies to transformers. The dissipation and subsequent rejection of potentially destructive self produced heat is an important aspect of electronic equipment design. Fin design theory is examined starting with the optimization of individual fin dimensions. The insights obtained are utilized in an investigation of the optimal number and spacing of elements in an array of fins. The results are implemented in a computer program written in ADA and compiled for use on IBM compatible machines. The

program takes as inputs thermal and physical data and outputs an optimized fin configuration. GRA

N93-14400# University of Southern California, Los Angeles. Dept. of Aerospace Engineering.
CONTROL OF ASYMMETRIC JET Final Technical Report, 1 May 1990 - 30 Apr. 1992
CHIH-MING HO 30 Jun. 1992 127 p
(Contract AF-AFOSR-0301-90)
(AD-A255967; AFOSR-92-0864TR) Avail: CASI HC A07/MF A01

A passive method of enhancing the rate of entrainment by as much as 500 percent in subsonic open nozzle flows has been obtained by modifying axisymmetric nozzle geometry to a 2:1 aspect-ratio elliptic nozzle. Small aspect-ratio elliptical nozzles have been demonstrated to more efficiently control mixing processes and to exhibit increased rates of spreading, entrainment, and fine-scale mixing than axisymmetric nozzles at subsonic and supersonic conditions in a confined dump combustor and in high-temperature ramjets. Vortex self-induction is the principle mechanism controlling mixing processes in asymmetric jet nozzles. GRA

N93-14468 Strathclyde Univ., Glasgow (Scotland).
ONLINE VIBRATION CONTROL OF A FLEXIBLE ROTOR/BEARING SYSTEM Ph.D. Thesis
SHAUN CLEMENTS 1987 260 p
Avail: Univ. Microfilms Order No. BRD-96808

An electromagnetic controller was located between two conventional, 100 mm diameter oil film bearings in order to investigate the adoption of an open loop control strategy for synchronous vibration control of a flexible rotor/bearing system. Application of control in an open loop manner removes practical constraints previously imposed due to the adoption of a closed loop strategy. Consideration of the 'closed loop system' stability restricted attention to positive non-adaptive controller stiffness and damping coefficients only. Use of an efficient least squares algorithm and real time software enabled open loop control forces to be determined on-line using the control element as a force actuator. Thus the frequency dependent control forces could be determined without prior knowledge of the rotor/bearing system characteristics. A method is presented which aids in the identification of suitable measurement locations (sparse models) for control force estimation. Three sparse model cases were experimentally investigated, namely measurement of (1) Bearing locations only; (2) Bearing and one mid-span station only; and (3) Two mid-span stations only. Experimental behavior of the control forces and controlled responses for the three sparse model cases considered were in good agreement with simulated results. In all cases, controlled vibration levels were maintained at extremely low levels, effectively eliminating the characteristic resonance peak at the first flexural critical speed. However, results for journal bearing response showed that there was little advantage in the use of sparse model (1) over that of models (2) or (3). Alternatively mid span controlled response was significantly degraded by the use of sparse model (1). Interpretation of statistical data resulting from the use of the LSE indicated that for this rotor/bearing system at least, adequate control may be achievable by measuring at the controller location only. Dissert. Abstr.

N93-14475 Old Dominion Univ., Norfolk, VA.
CONTROL OF LOW-SPEED TURBULENT SEPARATED FLOW OVER A BACKWARD-FACING RAMP Ph.D. Thesis
JOHN CHING-NIEN LIN 1992 204 p
Avail: Univ. Microfilms Order No. DA9222141

The relative performance and flow phenomena associated with several devices for controlling turbulent separated flow were investigated at low speeds. Relative performance of the devices was examined for flow over a curved, backward-facing ramp in a wind tunnel, and the flow phenomena were examined in a water tunnel using dye-flow visualization. Surface static pressure measurements and oil-flow visualization results from the wind tunnel tests indicated that transverse grooves, longitudinal grooves, submerged vortex generators, vortex generator jets (VGJ's), Viets' fluidic flappers, elongated arches at (+)alpha (positive angle of attack), and large-eddy breakup devices (LEBUS's) at (+)alpha placed near the baseline separation location reduce flow separation and increase pressure recovery. Spanwise cylinders reduce flow separation but decrease pressure recovery downstream. Riblets, passive porous surfaces, swept grooves, Helmholtz resonators, and arches and LEBU's with alpha less than or equal to 0 deg had no significant effect in reducing the extent of the separation region. Wall-cooling computations indicated that separation delay on partially-cooled ramp is nearly the same as on a fully-cooled ramp, while minimizing the frictional drag increase associated with the wall cooling process. Dye-flow visualization tests in the water tunnel indicated that wishbone vortex generators in the forward orientation shed horseshoe vortices; wishbone vortex generators oriented in the reverse direction and doublet vortex generators shed streamwise counterrotating vortices; a spanwise cylinder located near the wall and LEBU's at alpha = -10 deg produced eddies or transverse vortices which rotated with the same sign as the mean vorticity in a turbulent boundary layer; and the most effective VGJ's produced streamwise co-rotating vortices. Comparative wind-tunnel test results indicated that transferring momentum from the outer region of a turbulent boundary layer through the action of embedded streamwise vortices is more effective than by transverse vortices for the separation control application studied herein. Dissert. Abstr.

N93-14483*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RELIABILITY OF STIFFENED STRUCTURAL PANELS: TWO EXAMPLES
W. JEFFERSON STROUD, D. DALE DAVIS, JR. (Army Aerostructures Directorate, Hampton, VA.), LISE D. MARING (Lockheed Engineering and Sciences Co., Hampton, VA.), THIAGARAJA KRISHNAMURTHY (Analytical Services and Materials, Inc., Hampton, VA.), and ISAAC ELISHAKOFF (Florida Atlantic Univ., Boca Raton.) Dec. 1992 20 p Presented at the ASME Winter Annual Meeting: Symposium on Reliability Technology, Anaheim, CA, 8-13 Nov. 1992
(Contract RTOP 505-63-53-01)
(NASA-TM-107687; NAS 1.15:107687; ATCOM-TR-92-B-015)
Avail: CASI HC A03/MF A01

The reliability of two graphite-epoxy stiffened panels that contain uncertainties is examined. For one panel, the effect of an overall bow-type initial imperfection is studied. The size of the bow is assumed to be a random variable. The failure mode is buckling. The benefits of quality control are explored by using truncated distributions. For the other panel, the effect of uncertainties in a strain-based failure criterion is studied. The allowable strains are assumed to be random variables. A geometrically nonlinear analysis is used to calculate a detailed strain distribution near an elliptical access hole in a wing panel that was tested to failure. Calculated strains are used to predict failure. Results are compared with the experimental failure load of the panel. Author

N93-14610# Naval Postgraduate School, Monterey, CA.
MODELING AND CONTROL OF A TRAILING WIRE ANTENNA TOWED BY AN ORBITING AIRCRAFT Ph.D. Thesis
JAMES M. CLIFTON Sep. 1992 244 p
(AD-A256450) Avail: CASI HC A11/MF A03

A model of the dynamics of a long trailing-wire antenna towed behind an orbiting aircraft was developed and then an investigation was made of several candidate schemes to control the wire's steady-state shape and oscillations due to wind gradients. A computer simulation was developed using the classic vibrating chain with free/fixed boundary conditions superimposed upon the wire's steady-state shape and tension distribution. Several forms of restorative and dissipative forces were considered in the analysis. The validity of the superposition approach was demonstrated for a wide operating range. A control law was developed which modulated the towplane orbit radius and demonstrated a potential for a 50 percent or better reduction in all oscillations. A second scheme using a controllable drogue at the trailing end of the wire

was investigated. The controllable drogue had a limited success in oscillation reduction, but was found useful in tailoring the steady state shape of the wire. GRA

N93-14677# Illinois Univ., Urbana. Dept. of Mechanical and Industrial Engineering.
A PLUME-INDUCED BOUNDARY LAYER SEPARATION EXPERIMENT Report, 1 Jan. - 30 Jun. 1992
RUSSELL J. SHAW and J. C. DUTTON 30 Jun. 1992 18 p
(Contract DAAL03-90-G-0021)
(AD-A255397; ARO-27558.9-EG) Avail: CASI HC A03/MF A01

The current paper describes an experimental investigation of a PIBLS flowfield produced by the interaction between two nonparallel, supersonic streams in the presence of a finite thickness base. The purpose of the study is to gain a better understanding of., the extent to which the fluid dynamic mechanisms and interactions present in the PIBLS flowfield influence the turbulence properties of the flow. A two-stream, supersonic wind tunnel, incorporating a two-dimensional planar geometry and operating in the blowdown mode, was specifically designed to produce a PIBLS flowfield. Preliminary experiments have demonstrated that the wind tunnel is capable of producing a wide range of PIBLS flowfields by simply regulating the stagnation pressure of the lower stream (jet flow) relative to the upper stream (freestream flow). One PIBLS flowfield has been chosen in which to conduct a detailed set of measurements. This flowfield has its separation point located about 6 delta 0 upstream of the base corner. A detailed study of this PIBLS flowfield is under way using schlieren photography and shadowgraph pictures, surface streakline visualization, surface static pressure measurements, and two-component, coincident LDV measurements. GRA

N93-14692*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PASSIVE CONTROL OF SUPERSONIC ASYMMETRIC VORTICAL FLOWS AROUND CONES
C. H. LIU, OSAMA A. KANDIL (Old Dominion Univ., Norfolk, VA.), and TIN-CHEE WONG (Old Dominion Univ., Norfolk, VA.) *In* Old Dominion Univ., Analysis and Control of Asymmetric Vortex Flows and Supersonic Vortex Breakdown 17 p Nov. 1992 Repr. from Impact of Computing in Science and Engineering, v. 4, 1992 p 80-96
(Contract NAS1-18584) (ISSN 0899-8248)
Avail: CASI HC A03/MF A02

The unsteady, compressible, thin-layer Navier-Stokes equations are used to numerically study the passive control of steady and unsteady supersonic asymmetric flows around circular and noncircular cones. The main computational scheme of the present study is an implicit upwind, flux-difference splitting, finite-volume scheme. Passive control of flow asymmetry is studied by using a vertical fin in the leeward plane of geometric symmetry and side strakes with and without thickness at different orientations. The study focuses on circular-section cones since they are the most likely section-shapes for strong flow asymmetry. Side-strake passive control is shown to be more efficient and practical than vertical-fin passive control. Author

N93-14763*# Alabama Univ., Huntsville. Materials Processing Lab.
FIBER PULLING APPARATUS MODIFICATION Final Report
GUY A. SMITH and GARY L. WORKMAN Nov. 1992 14 p
(Contract NAS8-38609)
(NASA-CR-184498; NAS 1.26:184498) Avail: CASI HC A03/MF A01

A reduced gravity fiber pulling apparatus (FPA) was constructed in order to study the effects of gravity on glass fiber formation. The apparatus was specifically designed and built for use on NASA's KC-135 aircraft. Four flights have been completed to date during which E-glass fiber was successfully produced in simulated zero, high, and lunar gravity environments. In addition simulated lunar soil samples were tested for their fiber producing properties using the FPA. Author

N93-14766*# Technion Research and Development Foundation Ltd., Haifa (Israel). Faculty of Aerospace Engineering.
MULTI-DISCIPLINARY OPTIMIZATION OF AEROSERVOELASTIC SYSTEMS Annual Report, 1 Oct. 1991 - 30 Sep. 1992
MARDECHAY KARPEL (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.) 15 Nov. 1992 24 p
(Contract NAGW-1708)
(NASA-CR-191255; NAS 1.26:191255; REPT-160-573) Avail: CASI HC A03/MF A01

The purpose of the research project was to continue the development of new methods for efficient aeroservoelastic analysis and optimization. The main targets were as follows: to complete the development of analytical tools for the investigation of flutter with large stiffness changes; to continue the work on efficient continuous gust response and sensitivity derivatives; and to advance the techniques of calculating dynamic loads with control and unsteady aerodynamic effects. An efficient and highly accurate mathematical model for time-domain analysis of flutter during which large structural changes occur was developed in cooperation with Carol D. Wieseman of NASA LaRC. The model was based on the second-year work 'Modal Coordinates for Aeroelastic Analysis with Large Local Structural Variations'. The work on continuous gust response was completed. An abstract of the paper 'Continuous Gust Response and Sensitivity Derivatives Using State-Space Models' was submitted for presentation in the 33rd Israel Annual Conference on Aviation and Astronautics, Feb. 1993. The abstract is given in Appendix A. The work extends the optimization model to deal with continuous gust objectives in a way that facilitates their inclusion in the efficient multi-disciplinary optimization scheme. Currently under development is a work designed to extend the analysis and optimization capabilities to loads and stress considerations. The work is on aircraft dynamic loads in response to impulsive and non-impulsive excitation. The work extends the formulations of the mode-displacement and summation-of-forces methods to include modes with significant local distortions, and load modes. An abstract of the paper,'Structural Dynamic Loads in Response to Impulsive Excitation' is given in appendix B. Another work performed this year under the Grant was 'Size-Reduction Techniques for the Determination of Efficient Aeroservoelastic Models' given in Appendix C. Author

N93-14797*# High Technology Corp., Hampton, VA.
BLSTA: A BOUNDARY LAYER CODE FOR STABILITY ANALYSIS Final Report
YONG-SUN WIE Dec. 1992 114 p
(Contract NAS1-19299; RTOP 505-59-10)
(NASA-CR-4481; HTC-9204; NAS 1.26:4481) Avail: CASI HC A06/MF A02

A computer program is developed to solve the compressible, laminar boundary-layer equations for two-dimensional flow, axisymmetric flow, and quasi-three-dimensional flows including the flow along the plane of symmetry, flow along the leading-edge attachment line, and swept-wing flows with a conical flow approximation. The finite-difference numerical procedure used to solve the governing equations is second-order accurate. The flow over a wide range of speed, from subsonic to hypersonic speed with perfect gas assumption, can be calculated. Various wall boundary conditions, such as wall suction or blowing and hot or cold walls, can be applied. The results indicate that this boundary-layer code gives velocity and temperature profiles which are accurate, smooth, and continuous through the first and second normal derivatives. The code presented herein can be coupled with a stability analysis code and used to predict the onset of the boundary-layer transition which enables the assessment of the laminar flow control techniques. A user's manual is also included. Author

N93-14799*# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
SAPNEW: PARALLEL FINITE ELEMENT CODE FOR THIN SHELL STRUCTURES ON THE ALLIANT FX-80 Final Report

MANOHAR P. KAMAT and BRIAN C. WATSON Nov. 1992 42 p
(Contract NAG3-895; RTOP 505-63-1B)
(NASA-CR-189212; E-7422; NAS 1.26:189212) Avail: CASI HC A03/MF A01

The finite element method has proven to be an invaluable tool for analysis and design of complex, high performance systems, such as bladed-disk assemblies in aircraft turbofan engines. However, as the problem size increase, the computation time required by conventional computers can be prohibitively high. Parallel processing computers provide the means to overcome these computation time limits. This report summarizes the results of a research activity aimed at providing a finite element capability for analyzing turbomachinery bladed-disk assemblies in a vector/parallel processing environment. A special purpose code, named with the acronym SAPNEW, has been developed to perform static and eigen analysis of multi-degree-of-freedom blade models built-up from flat thin shell elements. SAPNEW provides a stand alone capability for static and eigen analysis on the Alliant FX/80, a parallel processing computer. A preprocessor, named with the acronym NTOS, has been developed to accept NASTRAN input decks and convert them to the SAPNEW format to make SAPNEW more readily used by researchers at NASA Lewis Research Center. Author

N93-14805# Physics and Electronics Lab. TNO, The Hague (Netherlands).
DEFINITION STUDY PHARUS Final Report
P. HOOGEBOOM, P. J. KOOMEN, W. P. KEIZER, M. P. OTTEN, and M. H. PAQUAY Nov. 1991 108 p
(AD-A256560; FEL-91-A375; TDCK-91-3982) Avail: CASI HC A06/MF A02

This report describes the results of the PHARUS definition stage which can be distinguished in three main parts: antenna technology study, motion compensation study, realization of a SAR. The antenna technology study was mainly focussed on the theory and design of patch antennae. Further the study included the theory of internal calibration of SAR systems, microwave components under pulsed conditions and measurements of phased arrays under operational conditions. The second study was focussed on finding a solution for the motion compensation in PHARUS. The study included the development of a SAR data simulator to evaluate the degradation of the SAR image by the motion of the aircraft. A motion sensor package for PHARUS was proposed. For verification, this motion sensor package was used in the SAR testbed. GRA

N93-14871* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
BEARING SERVICING TOOL Patent
REX A. BOYCE, inventor (to NASA) 24 Nov. 1992 8 p Filed 31 Oct. 1991
(NASA-CASE-MSC-21881-1; US-PATENT-5,165,169; US-PATENT-APPL-SN-785637; US-PATENT-CLASS-29-898.08; US-PATENT-CLASS-29-898.01; US-PATENT-CLASS-29-898.07; US-PATENT-CLASS-29-426.5; US-PATENT-CLASS-29-263; INT-PATENT-CLASS-B23P-19/00) Avail: US Patent and Trademark Office

A tool for removing and/or replacing bearings in situ is presented. The tool is comprised of a brace having a first end adapted to engage a first end of the bearing housing, and a second end adapted to engage a second end of the bearing housing. If the two ends of the bearing housing are different in configuration, then the respective ends of the brace are configured accordingly. An elongate guide member integral with the brace has two parts, each projecting endwise from a respective end of the brace. A removable pressure plate can be mounted on either part of the guide member for longitudinal movement therealong and has first and second ends of different configurations adapted to engage the first and second ends of the bearing. A threaded-type drive is cooperative between the guide and the pressure plate to move the pressure plate longitudinally along the guide and apply a force to the bearing, either to remove the bearing from its housing, or to emplace a new bearing in the housing.
Official Gazette of the U.S. Patent and Trademark Office

N93-15065# Cincinnati Univ., OH. Dept. of Aerospace Engineering and Engineering Mechanics.
L.D.V. MEASUREMENTS OF UNSTEADY FLOW FIELDS IN RADIAL TURBINE Final Report
W. TABAKOFF and M. PASIN Jul. 1992 164 p
(Contract DAAL03-90-G-0129)
(AD-A255728; REPT-92-105) Avail: CASI HC A08/MF A02

Detailed measurements of an unsteady flow field within the inlet guide vanes (IGV) and the rotor of a radial inflow turbine were performed using a three component Laser Doppler Velocimeter (LDV) system together with a rotary encoder. The mean velocity, the flow angle and the turbulence contours for IGV passages are presented at four blade-to-blade planes for different rotor positions to give three dimensional, unsteady behavior of the IGV flow field. These results are compared with the measurements obtained in the same passage in the absence of the rotor. The flow field of the IGV passage was found to be affected by the presence of the rotor. The ratio of the tangential normal stresses to the radial normal stresses at the exit of the IGV was found to be more than doubled when compared to the case without the rotor. The rotor flow field measurements are presented as relative mean velocity and turbulence stress contours at various cross section planes throughout the rotor. The cross flow and turbulence stress levels were found to be influenced by the incidence angle. Transportation of the high turbulence fluid by the cross flow was observed downstream in the rotor blade passages. GRA

N93-15160# Sundstrand Data Control, Inc., Redmond, WA.
REWRITABLE OPTICAL DISK: APPLICATION TO FLIGHT RECORDING [DER EINSATZ WIEDERBESCHREIBBARER OPTISCHER PLATTEN FUER DIE AUFZEICHNUNG VON FLUGDATEN]
DUANE A. TEACHOUT *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 149-168 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

As avionic systems have become more complex, the need for acquiring and storing flight data has increased. Historically, tape drives have filled the role of the recording systems. Emerging rewritable optical disk technology and its application as an alternative to tape based recording systems is discussed. The design for airborne use is described along with two application examples: a mass memory peripheral to the airborne computers, and a flight test recorder with an embedded acquisition system. ESA

N93-15167# Loral Data Systems, Sarasota, FL.
SOLID STATE FLIGHT DATA RECORDER WITH RAPID DATA ACCESS [FESTKOERPER-FLUGDATENSCHREIBER MIT SCHNELLEM DATENZUGRIFF]
HANS F. NAPFEL *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 267-286 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologen, Germany, HC

Solid state recorders which have replaced magnetic tape recorders as airborne crash recorders are described. Processes for data retrieval are reviewed. Solid state recorders promise higher reliability and faster data access. However, the memory elements are more fragile. ESA

N93-15187# Amtec Engineering, Inc., Bellevue, WA.
THE 3D NAVIER-STOKES FLOW ANALYSIS FOR SHARED AND DISTRIBUTED MEMORY MIMD COMPUTERS Final Report, 15 May 1990 - 30 Jul. 1992
SCOTT T. IMLAY and MOELJO SOETRISNO 15 Sep. 1992 119 p

(Contract DAAH01-90-C-0373; ARPA ORDER 6685)
(AD-A256038) Avail: CASI HC A06/MF A02

Multiple instruction multiple data (MIMD) parallel computers were investigated as a means of obtaining the immense computer power required to analyze the flow about a complete aircraft configuration. A computational fluid dynamics computer program for solving the Navier-Stokes equations, with coupled nonequilibrium chemistry, was parallelized on three MIMD computers: the Intel Touchstone distributed memory computer, the Cray Y/MP supercomputer, and the Silicon Graphics IRIS 4-D/380 shared memory computer. The program used an LU-SGS implicit algorithm. The parallelization was performed using permanent domain decomposition. The parallel efficiency and the main limitations to efficient parallelization were evaluated for a series of real life engineering problems. On the Intel Touchstone, the parallel efficiency decreased slowly as the number of processors was increased. The main deterrent to parallel performance was the latency time for interprocessor communication. On the Cray Y/MP, the parallel efficiency dropped rapidly as the number of processors was increased. The main deterrent to parallel performance was the reduction in vector length during domain decomposition. GRA

N93-15232# Department of the Navy, Washington, DC.
LIQUID FLOW REACTOR AND METHOD OF USING Patent Application
DENNIS R. HARDY, inventor (to Navy), ERNA J. BEAL, inventor (to Navy), and JACK C. BURNETT, inventor (to Navy) 30 Apr. 1992 12 p Filed 30 Apr. 1992
(AD-D015392; US-PATENT-APPL-SN-875955) Avail: CASI HC A03/MF A01

The tendency of liquid hydrocarbon-based fuels, such as kerosene, diesel fuel, and jet fuel toward the formation of fuel-insoluble solids during thermal stress in an aircraft fuel system is assessed by an accelerated test method comprising passing a predetermined quantity of a sample of fuel through a heated test section maintained at a predetermined temperature, at a predetermined fuel flow rate. A metal test strip, weighed before the test, is clamped in the heated test section during the test. It is weighed again after the test and the weight of solids buildup during the test is determined. It is related directly to the tendency of the fuel to form fuel-insoluble solids during thermal stress. A filter is weighed before the test. It is then connected to the outlet of the test section, and liquid fuel leaving the test section during the test is passed through it. The filter is then weighed a second time and the weight increase of the filter due to its capture of fuel-insoluble solids is calculated. It also is directly related to the tendency of the fuel to form fuel-insoluble solids during thermal stress. GRA

N93-15278# Oak Ridge National Lab., TN.
VARIABLE SPEED ROTARY COMPRESSOR AND ADJUSTABLE SPEED DRIVE EFFICIENCIES MEASURED IN THE LABORATORY
W. A. MILLER 1992 8 p Presented at the Winter Annual Meeting of the American Society of Mechanical Engineers, Anaheim, CA, 8-13 Nov. 1992
(Contract DE-AC05-84OR-21400)
(DE92-040026; CONF-921110-26) Avail: CASI HC A02/MF A01

Two state-of-the-art variable-speed rotary compressors, of nominal one ton cooling capacity, were instrumented and tested in the laboratory. Both compressors were identical except for their respective variable-speed drive systems (i.e., motor and inverter). One compressor had an inverter driven induction motor (IDIM) drive, and the other had a permanent magnet electronically commutated motor drive (PM-ECM). The laboratory study evaluated the compressor's efficiency under representative variable-speed conditions. Testing was conducted as a function of compressor drive frequency and of refrigerant condensing and evaporating conditions. Saturated refrigerant conditions, inlet superheat, and subcooling were controlled using a secondary refrigerant calorimeter. Spectrum analysis was conducted on the current input to one phase of the three-phase drive systems to measure motor speed and characterize harmonic content of the inverters. An optimal volt per Hz ratio was determined at 120-, 90-, 60-, and 30-Hz drive frequencies and at different load conditions for the rotary with induction motor as driven by a PWM inverter and also by a motor generator set (ideal induction motor drive). Variation of voltage input to the compressor had the largest effect at the lowest drive frequency (30Hz). A 5 percent variation about the optimal voltage at 30 Hz frequency caused a roughly 5 percent drop in compressor isentropic efficiency. Calorimeter data were used to develop modulating compressor and drive system performance maps. Performances of the two compressors were compared and the rotary with PM-ECM drive showed better efficiency trends at 30-Hz drive frequency. Above the 30-Hz drive frequency no clear advantage was observed for the PM-ECM vs the IDIM, possibly due to oversizing of the PM-ECM inverter. DOE

N93-15343*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ROOT DAMAGE ANALYSIS OF AIRCRAFT ENGINE BLADE SUBJECT TO ICE IMPACT
E. S. REDDY (Sverdrup Technology, Inc., Brook Park, OH.), G. H. ABUMERI (Sverdrup Technology, Inc., Brook Park, OH.), C. C. CHAMIS, and P. L. N. MURTHY Aug. 1992 16 p
(Contract RTOP 505-62-0K)
(NASA-TM-105779; E-7206; NAS 1.15:105779) Avail: CASI HC A03/MF A01

The blade root response due to ice impact on an engine blade is simulated using the NASA in-house code BLASIM. The ice piece is modeled as an equivalent spherical object impacting on the leading edge of the blade and has the velocity opposite to that of the aircraft with direction parallel to the engine axis. The effect of ice impact is considered to be an impulse load on the blade with its amplitude computed based on the momentum transfer principle. The blade response due to the impact is carried out by modal superposition using the first three modes. The maximum dynamic stresses at the blade root are computed at the quarter cycle of the first natural frequency. A combined stress failure function based on modified distortion energy is used to study the spanwise bending damage response at the blade root. That damage function reaches maximum value for very low ice speeds and increases steeply with increases in engine speed. Author

N93-15434*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FINITE-DIFFERENCE SOLUTION FOR LAMINAR OR TURBULENT BOUNDARY LAYER FLOW OVER AXISYMMETRIC BODIES WITH IDEAL GAS, CF4, OR EQUILIBRIUM AIR CHEMISTRY
H. HARRIS HAMILTON, II, DANIEL R. MILLMAN (George Washington Univ., Hampton, VA.), and ROBERT B. GREENDYKE (Vigyan Research Associates, Inc., Hampton, VA.) Washington Dec. 1992 23 p
(Contract RTOP 506-40-91-01)
(NASA-TP-3271; L-17102; NAS 1.60:3271) Avail: CASI HC A03/MF A01

A computer code was developed that uses an implicit finite-difference technique to solve nonsimilar, axisymmetric boundary layer equations for both laminar and turbulent flow. The code can treat ideal gases, air in chemical equilibrium, and carbon tetrafluoride (CF4), which is a useful gas for hypersonic blunt-body simulations. This is the only known boundary layer code that can treat CF4. Comparisons with experimental data have demonstrated that accurate solutions are obtained. The method should prove useful as an analysis tool for comparing calculations with wind tunnel experiments and for making calculations about flight vehicles where equilibrium air chemistry assumptions are valid. Author

N93-15487# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany).
MODELING LIMITS OF THE EMV ANALYSIS PROGRAM CONCEPT BY EXAMPLE OF THE INFLUENCE OF A HELICOPTER STRUCTURE ON A FRAME ANTENNA [MODELLIERUNGSGRENZEN DES EMV-ANALYSEPROGRAMMS CONCEPT AM BEISPIEL DES EINFLUSSES EINER HUBSCHRAUBERSTRUKTUR AUF EINE RAHMENANTENNE]
WOLFGANG TAUBER (Eurocopter G.m.b.H., Ottobrunn, Germany) 1992 15 p In GERMAN Presented at the 3rd Internationale Fachmesse und Kongress fuer Elektromagnetische Vertraeglichkeit, Karlsruhe, Germany, 25-27 Feb. 1992
(MBB-UD-0614-92-PUB; ETN-92-92109) Avail: CASI HC A03/MF A01

Examinations showed that the EMV (German acronym for electromagnetic compatibility) program CONCEPT can be perfectly used for solutions where wavelengths are much greater than helicopter dimensions. The emphasis is put on the necessity of carrying out the right model in the case of ill conducting helicopter structure modeling. The selection of rod radius is shown to be difficult. It is made easier by using alternating current resistance, in particular for good conducting structures. For complex arrangements, a large computer is to be used for the verification and the determination of exact values. ESA

N93-15635# Naval Postgraduate School, Monterey, CA.
PREDICTION OF TURBINE CASCADE FLOWS WITH A QUASI-THREE-DIMENSIONAL ROTOR VISCOUS CODE AND THE EXTENSION OF THE ALGEBRAIC TURBULENCE MODEL M.S. Thesis
CHUN-WEI WANG Jun. 1992 69 p
(AD-A256831) Avail: CASI HC A04/MF A01

A quasi-three-dimensional rotor viscous code is used to predict high subsonic flow through an annular cascade of turbine blades. The well known Baldwin-Lomax turbulence model is used in the program. An attempt was made to implement a new turbulence model based on renorminalization group theory. This was done to improve the prediction of the boundary layer transition on the blade surfaces and subsequent wake development. The comparison of these two turbulence models with experimental data are presented. Pressure, velocity ratio, flow angle distributions, and downstream wake predictions were studied using results from RVCQ3D (Rotor Viscous Code Quasi-Three-Dimensional) code. The computed results showed good agreement with experiment when comparing the blade surface local static pressure to inlet total pressure ratio at the midspan position of the annular turbine cascade. The computational approach used to implement the turbulence model is also described. GRA

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GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

A93-15079
WIND LIFTING OF AEROSOL PARTICLES [O VETROVOM POD'EME AEROZOL'NYKH CHASTITS]
M. V. BUIKOV (NPO Taifun, Obninsk, Russia) Meteorologiia i Gidrologiia (ISSN 0130-2906) no. 6 June 1992 p. 45-53. In Russian. refs
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An analysis of aerosol particle motion within the turbulent air flow near the ground is presented. It is shown that the frequency of turbulent air velocity pulsations induces either saltation or entrainment of particles by the air flow. A method is developed for calculating the air lifting and dry deposition rates as functions of particle size and drag velocity. P.D.

A93-16324
WIND IDENTIFICATION ALONG A FLIGHT TRAJECTORY. I - 3D-KINEMATIC APPROACH
A. MIELE, T. WANG (Rice Univ., Houston, TX), and W. W. MELVIN (Delta Air Lines, Inc., Atlanta, GA; Air Line Pilots Association, Washington) Journal of Optimization Theory and Applications (ISSN 0022-3239) vol. 75, no. 1 Oct. 1992 p. 1-32. Research supported by Air Line Pilots Association, U.S. Aviation Underwriters, and Texas Advanced Technology Program refs
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This paper deals with the identification of the wind profile along a flight path trajectory by employing a 3D kinematic approach. In this approach, the wind velocity components are computed as the difference between the inertial velocity components and the airspeed components. Key to the precision of the identified wind profile is the correct identification of the impact velocity components and the accelerometer biases. R.E.P.

N93-12818# National Center for Atmospheric Research, Boulder, CO. Atmospheric Technology Div.
MEETING REVIEW: THIRD NCAR RESEARCH AIRCRAFT FLEET WORKSHOP
LAWRENCE F. RADKE and PAUL SPYERS-DURAN May 1992 104 p *Workshop held in Boulder, CO, 27-28 Feb. 1992* Sponsored by NSF
(PB92-222710; NCAR/TN-374+PROC) Avail: CASI HC A06/MF A02

The Third NCAR Research Aircraft Fleet Workshop was held at NCAR on February 27-28, 1992, to examine and forecast the evolving needs for geosciences research aircraft to the end of the 20th century and to recommend how the configuration of the NCAR aircraft fleet should change to meet the perceived needs. The broad spectrum of participants included geoscientists with a strong history of research aircraft usage, leaders from the Atmospheric Technology Division, and other users from groups within NCAR. Because of the desire to receive the broadest possible viewpoints, distinguished representatives from outside of the usual National Science Foundation supported groups were also included. The workshops consisted of a briefing by RAF staff on the current fleet, an overview of forecast science needs, and a review of new aircraft and options under consideration. The briefing was followed by presentations from the user community of their perceived future science needs as they relate to airborne platform capabilities. The workshop then broke into five working groups that focused on options and opportunities for the future NCAR/RAF fleet changes. GRA

N93-13288*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
STRATOSPHERIC TURBULENCE MEASUREMENTS AND MODELS FOR AEROSPACE PLANE DESIGN
L. J. EHERNBERGER Dec. 1992 28 p Proposed for presentation at the AIAA Fourth International Aerospace Planes Conference, Orlando, FL, 1-4 Dec. 1992
(Contract RTOP 763-21-51)
(NASA-TM-104262; H-1865; NAS 1.15:104262) Copyright
Avail: CASI HC A03/MF A01

Progress in computational atmospheric dynamics is exhibiting the ability of numerical simulation to describe instability processes associated with turbulence observed at altitudes between 15 and 25 km in the lower stratosphere. As these numerical simulation tools mature, they can be used to extend estimates of atmospheric perturbations from the present gust database for airplane design at altitudes below 15 km to altitudes between 25 and 50 km where aerospace plane operation would be at hypersonic speeds. The amount of available gust data and number of temperature perturbation observations are limited at altitudes between 15 and 25 km. On the other hand, in-situ gust data at higher altitudes are virtually nonexistent. The uncertain potential for future airbreathing hypersonic flight research vehicles to encounter strong turbulence

at higher altitudes could penalize the design of these vehicles by undue cost or limitations on performance. Because the atmospheric structure changes markedly with altitude, direct extrapolation of gust magnitudes and encounter probabilities to the higher flight altitudes is not advisable. This paper presents a brief review of turbulence characteristics observed in the lower stratosphere and highlights the progress of computational atmospheric dynamics that may be used to estimate the severity of atmospheric transients at higher altitudes. Author

N93-13655# Lawrence Livermore National Lab., CA.
IMPACT OF SUPERSONIC AND SUBSONIC AIRCRAFT ON OZONE: INCLUDING HETEROGENEOUS CHEMICAL REACTION MECHANISMS
D. E. KINNISON and D. J. WUEBBLES Jul. 1992 4 p Presented at the 1992 Quadrennial Ozone Symposium, Charlottesville, VA, 4-13 Jun. 1992
(Contract W-7405-ENG-48)
(DE92-019619; UCRL-JC-108951; CONF-9206262-1) Avail: CASI HC A01/MF A01

Preliminary calculations suggest that heterogeneous reactions are important in calculating the impact on ozone from emissions of trace gases from aircraft fleets. In this study, three heterogeneous chemical processes that occur on background sulfuric acid aerosols are included and their effects on O3, NO(x), Cl(x), HCl, N2O5, ClONO2 are calculated. DOE

N93-13790 Illinois Univ., Urbana-Champaign.
A LABORATORY INVESTIGATION OF RAINDROP OSCILLATIONS Ph.D. Thesis
RODNEY JOSEPH KUBESH 1991 134 p
Avail: Univ. Microfilms Order No. DA9136642

Knowledge of raindrop shape is crucial to analyses of microwave scattering from precipitation, including the use of polarization radar in inferring the rainfall rate. The equilibrium shape of a water drop falling in air is nearly a sphere for millimetric drops, while larger drops are increasingly oblate with size; oscillations of the drop cause its shape to vary in time about the equilibrium shape. Oscillations are excited by collisions with other drops, or may be self-excited by aerodynamic effects arising from the airflow around the drop. The latter mechanism was studied with two experiments, one for water drops 1.1 to 1.5 mm diameter, and the other for 2.0 and 2.5 mm drops. Drops of the desired size were produced using a computer-controlled drop generator, and stroboscopic photographs of the drops a distance below the generator yielded instantaneous axis ratios. Measurements of the oscillation frequency for 2.0 and 2.5 mm drops were made from photographs of interruptions in the backscattered light of the primary rainbow. Significant variations in axis ratio were observed (as large as 15 percent, with standard deviations of up to 3 percent of the mean axis ratio), indicating oscillations were present for each dropsize. In addition, the axis ratios were shifted higher than the equilibrium value by as much as 3.5 percent, making oscillating drops more spherical on average than quiescent drops. A large fraction of the drops did not possess symmetry about the vertical axis, due to forcing caused by the detachment of eddies that form in the drop wake. Drops around 1.5 mm diameter were the exception--they displayed a strong axisymmetric component as well. The oscillation measurements showed the presence of both the fundamental frequency and the first harmonic. The research revealed that equilibrium axis ratios should not be used in differential reflectivity calculations, as the observed axis ratio shift translates into Z(DR) changes of up to 30 percent.
Dissert. Abstr.

N93-14547# Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
TERMINAL DOPPLER WEATHER RADAR/LOW-LEVEL WIND SHEAR ALERT SYSTEM INTEGRATION ALGORITHM SPECIFICATION, VERSION 1.1
RODNEY E. COLE 24 Feb. 1992 33 p
(Contract DTFA01-89-Z-02033; F19628-90-C-0002)
(AD-A255319; MIT-ATC-187; DOT/FAA/NR-92/3) Avail: CASI HC A03/MF A01

There will be a number of airports that receive both a Terminal Doppler Weather Radar (TDWR) windshear detection system and a phase 3 Low-Level Wind Shear Alert System (LLWAS). At those airports, the two systems will need to be combined into a single windshear detection system. This report specifies the algorithm to be used to integrate the two subsystems. The algorithm takes in the alphanumeric runway alert messages generated by each subsystem and joins them into integrated alert messages. The design goals of this windshear detection system are (1) to maintain the probability of detection for hazardous events while reducing the number of false alerts and microburst overwarnings and (2) to increase the accuracy of the loss/gain estimates. The first design goal is accomplished by issuing an integrated alert for an operational runway whenever either subsystem issues a 'strong' alert for that runway; by canceling a 'weak' windshear alert on an operational runway if only one subsystem is making the declaration; and by reducing a 'weak' microburst alert on an operational runway to a 'strong' windshear alert if only one subsystem is making the declaration. The second design goal is accomplished by using the average of the two loss/gain values, when appropriate. GRA

N93-14588 Georgia Inst. of Tech., Atlanta.
A SIMULATION MODEL OF ATMOSPHERIC TURBULENCE FOR ROTORCRAFT APPLICATIONS Ph.D. Thesis
JAMSHED RIAZ 1992 137 p
Avail: Univ. Microfilms Order No. DA9231747

Stochastic description of atmospheric turbulence for rotorcraft applications is a complex cyclostationary process. Due to its nonstationary structure, this process is not amenable to conventional filtering techniques; consequently, researchers have found it difficult to construct turbulence sample functions for rotorcraft simulation studies. The present study addresses this need and presents a method for generating turbulence sample functions suitable for rotorcraft applications. In this method, the cyclostationary process is expanded into a series of multi-dimensional cosine functions with rotational sampling embedded into the parameters. It is shown that this simulation technique generates turbulence sample functions containing appropriate second-order statistics in terms of mean and covariance. The simulation method takes into account the cross-correlation between elements of the rotor blades--a consideration that has been neglected in the past. The method avoids complicated filter designs, and can easily be integrated into rotorcraft simulation programs that are based on blade element analysis. The simulation method is used to investigate the effect of atmospheric turbulence on the flapping response of an isolated blade. Using the concept of 'phase-randomization', the response statistics of blade flapping are explained in physically meaningful terms. Finally, the turbulence simulation method is used to predict the response of the UH-60A Black Hawk helicopter to atmospheric turbulence. Dissert. Abstr.

N93-14655# Wyle Labs., Inc., El Segundo, CA.
AIR FORCE PROCEDURE FOR PREDICTING NOISE AROUND AIRBASES: NOISE EXPOSURE MODEL (NOISEMAP) Technical Report, Jan. 1989 - Mar. 1992
CAREY L. MOULTON May 1992 167 p
(Contract AF PROJ. 622-02-F-7231)
(AD-A255769; AL-TR-1992-0059) Avail: CASI HC A08/MF A02

NOISEMAP was the name given to the original Fortran program, developed for the USAF in the mid 1970's to calculate total noise exposure around military airbases. NOISEMAP now refers to a suite of programs that automate the noise exposure calculation process from operations data collection to final contour plotting. The noise calculation part of this suite of programs is now called NMAP 6.1 (the 6.1 being the current version number). New algorithms for calculating lateral attenuation and an expanded database are included in this version 6.1. NOISEMAP has also been rehosted from operation on a CDC mainframe computer to run on a desktop microcomputer (IBM compatible). This report is a technical overview of the algorithms used in NMAP 6.1. Most of

these algorithms were originally outlined by Dr William Galloway in the report 'Community Noise Exposure Resulting from Aircraft Operations: Technical Review' published in November 1974. This report covers all the current algorithms used in NMAP 6.1 and includes an example computation for a single aircraft takeoff and ground runup operation. 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.

A93-14177
A FUZZY DYNAMIC ANALYSIS METHOD FOR AEROMAINTENANCE SYSTEM
XUEREN LI and HONG YAO (Air Force College of Engineering, Xian, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 151-154. refs
Copyright

Fuzzy optimum estimation is applied to traditional system dynamics and control theory for use in the analysis of maintenance systems for aerospace vehicles/facilities. The system principle is modeled by means of a block diagram and a system-flow diagram, and the mathematical model is developed with a coupling evaluation matrix and a fuzzy operator. The optimum targets for the fuzzy matrix are defined, and fuzzy-system dynamic equations are determined for a typical system. The analytical technique is discussed in terms of an 'aeromaintenance' system with six flow-level variables including quality of the maintenance staff and cost of maintenance. Fuzzy mathematics and control theory are shown to be useful for considering the indefinite complex influence of factors in large systems. C.C.S.

A93-14178
APPLICATION OF SPEED IN AVIATION INDUSTRY
XINLI ZHAO and XINXIONG ZHU (Beijing Univ. of Aeronautics and Astronautics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 155-163. Research supported by China 863 Hi-Tech Committee, Shenyang Aircraft Corp., Chengdu Aircraft Corp., et al refs
Copyright

A Chinese computer project is outlined called the Specification for Exchange of Engineering Data (SPEED) which is intended to facilitate the implementation of the ISO project Standard for Transfer and Exchange of Product data (STEP). SPEED is based on the use of the STEP Integrated Product Information Model for modeling information regarding models of industrial machinery and products. A computer-aided modeling system called Bucams is designed for this purpose that defines the form and features (attributes) of structural and other components of such industrial products as aircraft bodies. The product manifestation model of Bucams defines the aircraft subassemblies by means of: profile model, airframe structural model, technological equipment model, manufacturing part model, and part-manufacturing technology model. The combined characteristics give the data required to identify and specify an aircraft component according to computerized international standards. C.C.S.

A93-14201
A PARAMETRIC APPROACH TO PRELIMINARY DESIGN FOR AIRCRAFT AND SPACECRAFT CONFIGURATION
YUAN LI (Northwestern Polytechnical Univ., Xian, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 367-371. refs
Copyright

Based on a few aircraft and spacecraft configuration parameters, a parametric preliminary design system for aircraft configuration has been developed. Contrary to the existing CAD systems, which consider structural and aerodynamics aspects in more detail and even lead to a CAM interface, in the system presented here the initial configurational development is emphasized, with special focus on the utilization of configuration parameters. After configuration development, the next step is to modify the configuration according to the fast area rule computation and to fair it. Thus, an initial configuration obeying the aera rule is established. The system is an interactive, user-friendly, completely menu-driven. Graphic displays are provided to assist the user in the visualization of the effect of each development and modification. The computed configuration may be viewed from any angle by using the code's 3D graphic package. The capabilities of the system are demonstrated in several design examples. Author

A93-14202
INTEGRATION OF AIRCRAFT DESIGN AND MANUFACTURE USING ARTIFICIAL INTELLIGENCE PARADIGMS
J. S. SAGGU (Cranfield Inst. of Technology, United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 372-380. Research supported by SERC and Cranfield Inst. of Technology refs
Copyright

This paper presents an approach for reducing the design cycle time and integrating design with manufacturing by focusing on the development of a design support system which employs artificial intelligence (AI) paradigms. A design support system (IKADE: (An Intelligent Knowledge Assisted Design Environment Incorporating Manufacturing and Production Information) toolkit system concept) has been developed and tested through a prototype system. The IKADE prototype provides prima facie information on the manufacturing and production implications of design decisions. A description of the possible knowledge representation schemes and inferencing strategies that are required for 'intelligently' linking the design and its association downstream manufacturing and production innformation have been developed and tested through this prototype. A description of the software components of the prototype have been developed by using an object-oriented formalism through the Smalltalk/V software tool. Author

A93-14278
PARALLEL IMPLEMENTATION OF THE FEATURE ASSOCIATED MESH EMBEDDING METHOD FOR THE 2D-EULER EQUATIONS (FAME2D)
M. W. BOWERS and R. K. COOPER (Belfast Queen's Univ., United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1000-1011. Research supported by SERC refs
Copyright

FAME is a new approach to the problem of a flexible mesh system for complex geometries, which are now more frequently encountered in CFD. Three relatively simple parallel versions of FAME2D, characterized by their increasing complexity of domain decomposition, have been developed to run on a chain of transputers. For a single element aerofoil the simplest version produces a speedup of 5.7 using 8 transputers, while the most complex produces a speedup of 8.6 using 13 transputers. All versions can be easily extended to cater for 2 or 3 element aerofoils and they provide a good basis for the parallelization of FAME3D. Author

A93-14290
AN ENGINEERING METHOD WITH ARTIFICIAL INTELLIGENCE CHARACTERISTICS USED FOR STRUCTURAL LAYOUT OF WINGS
LINSHU HE (Beijing Univ. of Aeronautics and Astronautics, China)

and XIAOPING ZENG (China Aero Polytechnological Establishment, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1094-1098. refs

The optimization of the structural layout of aircraft wings by means of artificial intelligence (AI) is studied by developing a software for this design application. The existing software for wing-design problems - Structural Layout of Wings (SLOW) - is described and shown to suffer from the need for expert input for certain key aircraft structural parameters. A program that incorporates an AI expert system for this design system - ESSLOW - is proposed. The ESSLOW program is shown to require an established knowledge base, an inference mechanism, and an evaluating module for assisting in the design development of wing structures. A structural optimization program is also required to optimize element size and calculate the wing mass. The complete ESSLOW interactive design system is shown to be available for use in wing design and redesign for preliminary engineering applications. C.C.S.

A93-14311
APPLICATION OF VIBRATION-AND-FLUTTER INTEGRATION ANALYSIS SYSTEM FOR A TRAINER

KUILIN CHEN and MING XU (Nanchang Aircraft Manufacturing Co., China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1258-1262. Research supported by Nanchang Aircraft Manufacturing Co. and Nanjing Aeronautical Inst refs

A system is presented for the analysis of integrated vibration and flutter in aircraft, and applications of the system are compared to experimental data. Corrected frequencies and mode shapes are computed for the dynamic structural analysis by means of finite-element analysis and measured vibration results, and the flutter is characterized according to the corrected data. The equations used for the flutter determination are processed in the system with a k-method looping procedure, and results are given for mode shapes such as aileron rotation and wing torsion. The flutter speeds obtained are in good agreement with wind-tunnel results and data from other analytical evaluations. The present vibration-and-flutter integration analysis system is of interest in the design and engineering of aircraft under development. C.C.S.

A93-14337
RISK - INTERACTIVE MULTIDISCIPLINARY SYSTEM FOR DESIGNING AIRFRAMES

V. I. IVANTEEV and V. D. CHUBAN (TsAGI, Zhukovski, Russia) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1482-1488. Research supported by A.I. Mikoyan Design Office

The concepts and the state-of-the-art of a system called RISK, developed at the TsAGI for a structural analysis of airframes, are described. RISK is an integrated system which includes a finite-element representation of the elastic structures, a method for computing the aerodynamic flow over the aircraft at Mach numbers less than and greater than unity, a description of an airborne automatic remote-control system, and nonlinear models of a landing gear. It is an interactive system operating on personal computers and working stations with dot-matrix color displays and a 'mouse'. I.S.

A93-14340
STRUCTURAL OPTIMIZATION IN PRELIMINARY AIRCRAFT DESIGN - A FINITE-ELEMENT APPROACH

C. BIL, F. VAN DALEN, A. ROTHWELL (Delft Univ. of Technology, Netherlands), P. ARENDSEN, and J. F. M. WIGGENRAAD (National Aerospace Lab., Amsterdam, Netherlands) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1505-1515. refs

The paper describes a computer-based system which is being presently developed for the design and optimization of an aircraft structure, which is an extension and modification of the existing Aircraft Design and Analysis System (ADAS). The modifications of ADAS made it possible to define major structural components such as ribs, spars, frames, bulkheads, and floor structures and to semiautomatically generate a finite element model suitable for input to a structural analysis program. The mesh generation procedure used in ADAS is described, and results of a structural analysis of a typical transport aircraft subject to static loads are presented. I.S.

A93-14375
THE EMPLOYMENT OF ARTIFICIAL INTELLIGENCE FOR ANALYZING AIR ACCIDENTS

F. M. ZHANG and E. Z. SU (Air Force College of Engineering, Xian, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1810-1818. refs

The necessity and possibilities of developing a computer-aided system to analyze aviation accident causes with the AI expert system are presented. The recently developed design concept and structure of the aviation accident analysis expert system are reviewed. The bidirectional knowledge representation technique in the area of aviation accident analysis, the model of interactive automatic knowledge acquisition, and control strategies and reasoning mechanism in the accident analysis process are discussed. R.E.P.

A93-14396
THE AIRCRAFT/PROPULSION INTEGRATED ASSESSMENT SYSTEM

JIAYUN WANG, JIN ZHANG, and YIKUN ZHU (Beijing Univ. of Aeronautics and Astronautics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1989-1997. refs

A review is presented of a computer aided assessment system that has been developed for the conceptual and preliminary design phase of modern military aircraft. This system enables evaluation of a wide range of combinations of aircraft and engines or to obtain the optimal solution with the numerical algorithm for multiobjective optimization with constraints. During the optimization process the best combinations of design parameters are determined. R.E.P.

A93-14415
A CONTROL TECHNOLOGY OF INTEGRATED SYSTEM OF ENGINEERING SUPPORTED BY SOFTWARE ENGINEERING ENVIRONMENTS

GUANQING SHEN and ZHENGPING SHA (Shenyang Aircraft Research Inst., China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 2144-2152. refs

The paper describes the principles and operation methods used for the integration of engineering application programs into a computer-integrated engineering and manufacturing (CIEM) system for applications in aircraft design at multiple levels. Particular attention is given to the structure of the integrated system, the main functions of the executive control, and an integrated model of engineering application programs. The configuration of the CIEM and the main techniques of flow control are described. I.S.

A93-14417
STOCHASTIC MODELING AND ADAPTIVE CONTROL ALGORITHM OF BRAKE BENDING
Z. E. MA (Northwestern Polytechnical Univ., Xian, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 2157-2162. Research supported by NNSFC refs
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The paper presents a stochastic model of brake bending in which the variation of material characteristics is considered to be the most important disturbance in the processes used in the upstream stages of sheet metal production. An adaptive control algorithm was developed which can handle such variation automatically and thus reduce the amount of scrap and machine downtime and increase productivity. The stochastic model and the adaptive control algorithm were verified by a comparison with results of a series of brake bending tests. I.S.

A93-14526
THE ACCURACY OF CELL VERTEX FINITE VOLUME METHODS ON QUADRILATERAL MESHES
ENDRE SULI (Oxford Univ., United Kingdom) Mathematics of Computation (ISSN 0025-5718) vol. 59, no. 200 Oct. 1992 p. 359-382. refs
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For linear first-order hyperbolic equations in two dimensions we restate the cell vertex finite volume scheme as a finite element method. On structured meshes consisting of distorted quadrilaterals, the global error is shown to be of second order in various mesh-dependent norms, provided that the quadrilaterals are close to parallelograms in the sense that the distance between the midpoints of the diagonals is of the same order as the measure of the quadrilateral. On tensor product nonuniform meshes, the cell vertex scheme coincides with the familiar box scheme. In this case, second-order accuracy is shown without any additional assumption on the regularity of the mesh, which explains the insensitivity of the cell vertex scheme to mesh stretching in the coordinate directions, observed in practice. Author

A93-14685
RAPID PROTOTYPING VIA AUTOMATIC SOFTWARE CODE GENERATION FROM FORMAL SPECIFICATIONS - A CASE STUDY
S. RAHMANI, A. G. STONE, W. S. LUK, and S. M. SWEET (Rockwell International Corp., Downey, CA) *In* 1992 IEEE Aerospace Applications Conference, Snowmass, CO, Feb. 2-7, 1992, Digest New York Institute of Electrical and Electronics Engineers, Inc. 1992 p. 95-105. refs
Copyright

A modeling and prototyping approach for defining system and software requirements and validating them through rapid prototyping is described, and the results of a case study for generating prototype software (representing the total system hardware and software) directly and automatically from the requirements are presented. System/software definitions, which include the requirements and design (architecture), are addressed. The case study applied this approach to selected systems of Boeing 747-400 aircraft. A formal model of system specification was generated. The rapid prototyping task automatically generated thousands of lines of Ada source code from the specification model. The software was executed successfully the first time. The functions and behavior of the system were demonstrated and validated by its users. This study indicated that early execution and validation of system requirements, through the use of formal modeling and rapid prototyping with direct user involvement, can be accomplished. I.E.

A93-15044
COST CONTROL OF THE A320 SOFTWARE - THE AIRCRAFT MANUFACTURER'S POINT OF VIEW [LA MAITRISE DES COUTS DES LOGICIELS A320 - LE POINT DE VUE DE L'AVIONNEUR]
JEAN-MICHEL NOGUE (Institut National des Sciences Appliquees, Toulouse, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 144 1990 p. 30-32. In French.
Copyright

Two complementary aspects of the manufacturer's approach to reduce production cycles of digital equipment are presented. The increase of the size of the airborne software and the production cycle reduction require the manufacturer to evaluate and apply methods permitting increased productivity while maintaining the required level of safety. The particular methods employed by the aircraft manufacturer's to limit the influence of cost drivers during the development and integration of the digital systems in the aircraft are discussed. R.E.P.

A93-15406
IMPROVEMENT IN APPLICATION OF EIGENSTRUCTURE ASSIGNMENT TO FLIGHT CONTROL SYSTEM DESIGN
ZHONGJUN WANG and YUNXIANG JIANG (Northwestern Polytechnical Univ., Xian, China) Northwestern Polytechnical University, Journal (ISSN 1000-2758) vol. 10, no. 4 Oct. 1992 p. 526-534. In Chinese. refs

The stability properties of eigenstructure assignment based on output feedback is considered in the context of designing flight-control systems. Eigenvalues and eigenvectors that do not satisfy the required design specifications are reassigned as often as required until all of the state eigenvalues match the design requirements. Constrained output feedback is defined and utilized in the eigenstructure assignment to simplify controller structure and enhance operational reliability. The constraints are imposed on the feedback matrix by assigning zero values to the outputs that are not fed to significant inputs. Output feedback and constrained output feedback are employed in the sample design of a flight-control system, and the techniques are found to improve the tradeoffs between performance and reliability. C.C.S.

A93-16472
IDENTIFICATION OF WEAKLY NONLINEAR DYNAMIC SYSTEMS BY MEANS OF RANDOM EXCITATIONS
O. FILLATRE (ONERA, Chatillon, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X) no. 3 1992 p. 11-22. refs
Copyright

This article discusses weakly nonlinear dynamical systems from the standpoint of linearization. In the first part, a minimization criterion is proposed and leads to the definition of a linearized system. In the second part, the variation of this system is analyzed as the bandwidth of the excitation approaches infinity. To improve the proximity of the mass matrices for the linearized system and the nonlinear system, a new minimization criterion is proposed, along with an iterative algorithm for equalizing the second order moments of the two systems. In the third and last part, numerical results are presented. Author

A93-16777
SYNTHESIS OF ROBUST MOTION STABILIZATION LAWS FOR FLIGHT VEHICLES [K SINTEZU ROBASTNYKH ZAKONOV STABILIZATSII DVIZHENIIA LETATEL'NYKH APPARATOV]
S. N. DILIGENSKII and A. IU. EFREMOV (RAN, Inst. Problem Upravleniia, Moscow, Russia) Avtomatika i Telemekhanika (ISSN 0005-2310) no. 8 Aug. 1992 p. 31-38. In Russian. refs
Copyright

A numerical method is proposed for determining the feedback law for the stabilization system of flight vehicles whose motion is described by a mathematical model consisting of a finite set of plant-control matrix pairs. The closed-loop stabilization system of the short-period longitudinal motion of the F4-B aircraft is considered as an example. V.L.

A93-16778
SOLUTION OF THE TERMINAL GUIDANCE PROBLEM FOR A FLIGHT VEHICLE USING ANALYTICAL MECHANICS METHODS [RESHENIE TERMINAL'NOI ZADACHI UPRAVLENIIA DVIZHENIEM LETATEL'NOGO APPARATA S PRIMENENIEM METODOV ANALITICHESKOI MEKHANIKI]
S. A. KABANOV and A. S. SHALYGIN (Mekhanicheskii Inst., St. Petersburg, Russia) Avtomatika i Telemekhanika (ISSN 0005-2310) no. 8 Aug. 1992 p. 39-45. In Russian. refs
Copyright

The terminal guidance problem considered here concerns the longitudinal motion of a flight vehicle as a material point in the presence of wind. The problem is solved in terms of the theory of invariant systems. The use of analytical mechanics methods makes it possible to reduce the computational effort in control synthesis in comparison with the existing algorithms and to synthesize control in real time. V.L.

A93-16783
MODELING OF HUMAN OPERATOR ACTIONS IN THE STOCHASTIC TRAJECTORY TRACKING PROBLEM FOR A DYNAMIC PLANT [MODELIROVANIE DEIATEL'NOSTI CHELOVEKA-OPERATORA V ZADACHE OTSLEZHIVANIIA STOKHASTICHESKOI TRAEKTORII UPRAVLIAEMYM DINAMICHESKIM OB'EKTOM]
I. V. KUROCHKIN (NII Aviatsionnogo Oborudovaniia, Nizhni Novgorod, Russia) and A. A. MAL'TSEV (Nizhegorodskii Gosudarstvennyi Univ., Nizhni Novgorod, Russia) Avtomatika i Telemekhanika (ISSN 0005-2310) no. 8 Aug. 1992 p. 126-133. In Russian. refs
Copyright

A model for human-operator actions in the stochastic trajectory tracking problem for a dynamic plant is synthesized on the basis of the general theory of statistically optimal estimation and control. As an example of an application of the model, consideration is given to the problem of estimating the permissible altitude of a flight vehicle in low-level flight. V.L.

A93-16979
MARCHING GRID GENERATION FOR EXTERNAL VISCOUS FLOW PROBLEMS
KAZUHIRO NAKAHASHI (Osaka Prefecture Univ., Sakai, Japan) Japan Society for Aeronautical and Space Sciences, Transactions (ISSN 0549-3811) vol. 35, no. 108 Aug. 1992 p. 88-102. refs

A marching procedure to generate a grid around a complex geometry is developed for external viscous flow problems. The grid spacings in the marching direction are controlled by using an optimization technique in which the advancing grid surface is minimized under an isoperimetric constraint. This is physically similar to the minimization of the free surface of liquid by the surface tension. Thus the resulting grid is expected to be naturally smooth. For three-dimensional problems, the method is applied to a directionally-structured, prismatic grid. The bases of grid cells are triangles which cover the 3D surface in an unstructured manner. In the direction away from the body, on the other hand, the grid has a structured numbering so as to achieve an efficient computation for viscous flows. The capability of the method is demonstrated by applying it to the generations of a two-dimensional structured O-grid around a multielement airfoil, and a prismatic grid around a wing-fuselage-nacelle configuration of an airplane.
Author

A93-17389* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
REPRESENTATION AND PRESENTATION OF REQUIREMENTS KNOWLEDGE
W. L. JOHNSON, MARTIN S. FEATHER (Southern California Univ., Marina del Rey, CA), and DAVID R. HARRIS (Lockheed-Sanders Signal Processing Center of Technology, Nashua, NH) IEEE Transactions on Software Engineering (ISSN 0098-5589) vol. 18, no. 10 Oct. 1992 p. 853-869. Research supported by DARPA refs
(Contract F30602-85-C-0221; F30602-89-C-0103; NCC2-520)
Copyright

An approach to representation and presentation of knowledge used in the ARIES, an experimental requirements/specification environment, is described. The approach applies the notion of a representation architecture to the domain of software engineering and incorporates a strong coupling to a transformation system. It is characterized by a single highly expressive underlying representation, interfaced simultaneously to multiple presentations, each with notations of differing degrees of expressivity. This enables analysts to use multiple languages for describing systems and have these descriptions yield a single consistent model of the system. O.G.

N93-12554# Pennsylvania Univ., Philadelphia. Dept. of Computer and Information Sciences.
ACTION COMPOSITION FOR THE ANIMATION OF NATURAL LANGUAGE INSTRUCTIONS Final Report, Nov. 1990 - Oct. 1991
LIBBY LEVISON Mar. 1992 23 p
(Contract FQ7624-91-C-0019)
(AD-A254963; MS-CIS-91-28; AL-TP-1992-0020) Avail: CASI HC A03/MF A01

This report is an investigation of issues encountered in generating a short maintenance task simulation from a set of instructions. A method for specifying simulations at a task level, rather than by individual motion, is discussed. The research was conducted using a set of instructions that describe the removal of a fuel control valve from an aircraft. The agent for performing this simulation was the JACK human modeling environment, developed at the University of Pennsylvania. GRA

N93-12958*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A BRIEF OVERVIEW OF NASA LANGLEY'S RESEARCH PROGRAM IN FORMAL METHODS
In its The Second NASA Formal Methods Workshop 1992 p 9-22 Nov. 1992 Revised
Avail: CASI HC A03/MF A03

An overview of NASA Langley's research program in formal methods is presented. The major goal of this work is to bring formal methods technology to a sufficiently mature level for use by the United States aerospace industry. Towards this goal, work is underway to design and formally verify a fault-tolerant computing platform suitable for advanced flight control applications. Also, several direct technology transfer efforts have been initiated that apply formal methods to critical subsystems of real aerospace computer systems. The research team consists of six NASA civil servants and contractors from Boeing Military Aircraft Company, Computational Logic Inc., Odyssey Research Associates, SRI International, University of California at Davis, and Vigyan Inc.
Author

N93-13154*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
TURBOMACHINERY CFD ON PARALLEL COMPUTERS
RICHARD A. BLECH, EDWARD J. MILNER, ANGELA QUEALY (Sverdrup Technology, Inc., Brook Park, OH.), and SCOTT E. TOWNSEND (Sverdrup Technology, Inc., Brook Park, OH.) Nov. 1992 22 p Proposed for presentation at the Symposium on High-Performance Computing for Flight Vehicles, Washington, DC, 7-9 Dec. 1992
(Contract RTOP 505-62-52)
(NASA-TM-105932; E-7443; NAS 1.15:105932) Avail: CASI HC A03/MF A01

The role of multistage turbomachinery simulation in the development of propulsion system models is discussed. Particularly, the need for simulations with higher fidelity and faster turnaround time is highlighted. It is shown how such fast simulations can be used in engineering-oriented environments. The use of parallel processing to achieve the required turnaround times is discussed. Current work by several researchers in this area is summarized.

Parallel turbomachinery CFD research at the NASA Lewis Research Center is then highlighted. These efforts are focused on implementing the average-passage turbomachinery model on MIMD, distributed memory parallel computers. Performance results are given for inviscid, single blade row and viscous, multistage applications on several parallel computers, including networked workstations. Author

N93-13370*# Information and Control Systems, Inc., Hampton, VA.
A STOCHASTIC OPTIMAL FEEDFORWARD AND FEEDBACK CONTROL METHODOLOGY FOR SUPERAGILITY Final Report
NESIM HALYO, HALDUN DIRESKENELI, and DEBORAH B. TAYLOR Washington Nov. 1992 150 p Sponsored by NASA. Langley Research Center
(Contract NAS1-19091; RTOP 324-02-01-01)
(NASA-CR-4471; NAS 1.26:4471; FR-692101) Avail: CASI HC A07/MF A02

A new control design methodology is developed: Stochastic Optimal Feedforward and Feedback Technology (SOFFT). Traditional design techniques optimize a single cost function (which expresses the design objectives) to obtain both the feedforward and feedback control laws. This approach places conflicting demands on the control law such as fast tracking versus noise atttenuation/disturbance rejection. In the SOFFT approach, two cost functions are defined. The feedforward control law is designed to optimize one cost function, the feedback optimizes the other. By separating the design objectives and decoupling the feedforward and feedback design processes, both objectives can be achieved fully. A new measure of command tracking performance, Z-plots, is also developed. By analyzing these plots at off-nominal conditions, the sensitivity or robustness of the system in tracking commands can be predicted. Z-plots provide an important tool for designing robust control systems. The Variable-Gain SOFFT methodology was used to design a flight control system for the F/A-18 aircraft. It is shown that SOFFT can be used to expand the operating regime and provide greater performance (flying/handling qualities) throughout the extended flight regime. This work was performed under the NASA SBIR program. ICS plans to market the software developed as a new module in its commercial CACSD software package: ACET. Author

N93-13925 Stanford Univ., CA.
ROBUST CONTROLLER AND ESTIMATOR DESIGN USING MINIMAX METHODS Ph.D. Thesis
RAYMOND ARTHUR MILLS 1992 215 p
Avail: Univ. Microfilms Order No. DA9221645

Optimal control methods yield high performance for the plant model used to design the controller, but the resulting closed-loop system is sometimes sensitive to plant parameter variations. This sensitivity causes performance degradation and even instability when the control is applied to the actual plant, since the plant parameters are never known exactly. Such sensitivity occurs especially in plants containing lightly damped oscillatory modes, which are common in aerospace systems. We propose a minimax algorithm for designing controllers that give the best closed-loop linear-quadratic-gaussian (LQG) performance over a set of worst plant parameter changes from nominal. The algorithm combines a multi-plant optimal control design code, SANDY, with a worst-parameter algorithm that uses an ellipsoidal norm on parameter changes. The minimax algorithm is unique in the way it weights worst plants to expand the stable region in the parameter space. A new LQG derivation is used to derive saddle-point necessary conditions which are stopping criteria for the minimax algorithm. The minimax derivation suggests a calculus of variations H(infinity) derivation, which shows that the H(infinity) controller is simply a differential game between the control and the worst bounded disturbance. Minimax control design compares favorably with H(infinity)-based 'mu-synthesis'. The optimal LQG estimator (Kalman filter) is formulated as a special case of the LQG controller, making all controller results equally valid for estimation. Thus, the worst-parameter algorithm also assesses estimator robustness and the minimax algorithm also designs robust estimators. The minimax algorithm is applied to a three-parameter two-mass/spring benchmark problem, a six-parameter helicopter near hover, and a four-parameter space telescope. The results show that minimax control provides near-optimal nominal performance with significant robustness and parameter margin improvements. Surprisingly the minimax controllers differ relatively little from the nominal LQG controllers. Dissert. Abstr.

N93-14470 California Univ., Berkeley.
ADAPTIVE CONTROL OF NONLINEAR NONMINIMUM PHASE SYSTEMS Ph.D. Thesis
SWAMINATHAN GOPALSWAMY 1991 130 p
Avail: Univ. Microfilms Order No. DA9228668

We consider square, nonlinear systems, affine in the input. Furthermore, we assume that the systems have a (locally) well defined relative degree (i.e., in a sense, the input output dynamics is invertible). Then, using standard techniques, it is possible to make y track y(sub d) asymptotically, where y(sub d) is any smooth desired trajectory. Two issues involved in tracking such systems, using the input-output invertibility, are addressed in this dissertation: (1) The dynamics of the output reflects only a part of the dynamics of the entire system. The remaining part of the system dynamics is called the internal dynamics (when the output is held identically zero, it is the zerodynamics). If this internal dynamics is unstable, the system is said to be non-minimum phase (analogous to right half plane transmission zeros in linear system). In this dissertation, a methodology is proposed to deal with systems that have unstable, or unacceptable zero dynamics. For a class of such systems and trajectories an ideal internal dynamics, i.e., a particular solution of the internal dynamics that is acceptable, is identified. Then, the ideal internal dynamics is made attractive by an appropriate output redefinition. (2) Tracking is made robust to uncertainties satisfying some conditions, by either using increased control gains or through adaptive estimation techniques. In this dissertation, a robust adaptive control methodology is presented for MIMO systems, where all constant uncertainties that appear linearly in the input output dynamics are adaptively estimated, while other uncertainties and disturbances satisfying a matching condition are accounted for by using appropriate control gains. The development of the two issues enable one to combine the techniques to apply adaptive control to non-minimum phase systems. The theory developed is illustrated through numerical simulations on the pitch axis dynamics of an AFTI-F16, a high performance aircraft. The pitch axis dynamics of the AFTI-F16 suffers from undesirable internal dynamics (zerodynamics), and the simulations demonstrate the effectiveness of the output-redefinition approach. Further, we present simulations where the aerodynamic coefficients related to the control surfaces are adaptively estimated, and improved tracking is achieved. Dissert. Abstr.

N93-15052# Naval Research Lab., Washington, DC.
SOFTWARE REQUIREMENTS FOR THE A-7E AIRCRAFT Final Report
THOMAS A. ALSPAUGH, STUART R. FAULK, KATHRYN H. BRITTON, R. A. PARKER, and DAVID L. PARNAS 31 Aug. 1992 435 p Revised
(AD-A255746; NRL/FR/5530-92-9194) Avail: CASI HC A19/MF A04

The Software Cost Reduction (SCR) research project introduced a new approach to specifying requirements for real-time embedded systems. The principles were applied in the development of the Software Requirements of the A-7E Aircraft, as an example of the use of the approach. The system software requirements specification document comprises the first product in a series of products which the SCR methodology produces. The methodology is intended to be adaptable for various types of systems. Specification properties which it supports include: (1) conciseness; (2) preciseness; (3) aids to completeness; (4) avoidance of redundancy; (5) descriptions of all externally visible behavior; (6) ease of change; (7) good reference tool; (8) record of fundamental assumptions which might otherwise be only implicit; (9) record of responses to error conditions; (10) specification of constraints on

the system; and (11) separation of concerns; that is, a division of the information into distinct, independent parts. GRA

N93-15163# Deutsche Lufthansa A.G., Frankfurt am Main (Germany). Abt. Flugbetriebstechnik.
SOFTWARE FOR FLIGHT RECORDER DATA EVALUATION DEVELOPED BY LUFTHANSA [VON LUFTHANSA ENTWICKELTE EDV PROGRAMME ZUR AUSWERTUNG VON FLUGSCHREIBERN]
MATTHIAS KRUEDENER *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 201-217 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

Since the introduction of aircraft equipped with analog or digital flight data recorder devices, computer software has been developed to evaluate the flight recorder data. Results of evaluations are applied to various investigations. The latest software developments, in particular video animation, are presented on the basis of an actual incident. ESA

N93-15183# Paderborn Univ. (Germany). Dept. of Electrical Engineering.
NEURAL NETWORK BASED CONDITION MONITORING [ZUSTANDSUEBERWACHUNG AUF DER BASIS NEURONALER NETZWERKE]
DIETER BARSCHDORFF *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 585-606 Jan. 1992
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

In the case of impending failures in complex technical systems, only sophisticated real time methods of trend monitoring and fault prediction can avoid catastrophic situations. Neural network based adaptive diagnostic systems have demonstrated reliable results in various applications. The systems are trained by learning, but compute their diagnostic analysis within defined time intervals. Accepting even noisy or incomplete sensor input data, they show robust performance. A case study with aircraft flight data demonstrates the applicability of neural network based condition monitoring. ESA

N93-15502*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
FLIGHT DYNAMICS SYSTEM SOFTWARE DEVELOPMENT ENVIRONMENT (FDS/SDE) TUTORIAL
JOHN BUELL and PHILIP MYERS Jul. 1986 135 p
(NASA-TM-108580; NAS 1.15:108580; SEL-86-003) Avail: CASI HC A07/MF A02

A sample development scenario using the Flight Dynamics System Software Development Environment (FDS/SDE) is presented. The SDE uses a menu-driven, fill-in-the-blanks format that provides online help at all steps, thus eliminating lengthy training and allowing immediate use of this new software development tool. Author

N93-15578*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
SOFTWARE MANAGEMENT ENVIRONMENT (SME) INSTALLATION GUIDE
DAVID KISTLER and KELLYANN JELETIC Jan. 1992 35 p
(NASA-TM-108578; NAS 1.15:108578; SEL-92-001) Avail: CASI HC A03/MF A01

This document contains installation information for the Software Management Environment (SME), developed for the Systems Development Branch (Code 552) of the Flight Dynamics Division of Goddard Space Flight Center (GSFC). The SME provides an integrated set of management tools that can be used by software development managers in their day-to-day management and planning activities. This document provides a list of hardware and software requirements as well as detailed installation instructions and trouble-shooting information. Author

N93-15579*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
DATA COLLECTION PROCEDURES FOR THE SOFTWARE ENGINEERING LABORATORY (SEL) DATABASE
GERARD HELLER, JON VALETT, and MARY WILD Mar. 1992 143 p
(NASA-TM-108579; NAS 1.15:108579; SEL-92-002) Avail: CASI HC A07/MF A02

This document is a guidebook to collecting software engineering data on software development and maintenance efforts, as practiced in the Software Engineering Laboratory (SEL). It supersedes the document entitled Data Collection Procedures for the Rehosted SEL Database, number SEL-87-008 in the SEL series, which was published in October 1987. It presents procedures to be followed on software development and maintenance projects in the Flight Dynamics Division (FDD) of Goddard Space Flight Center (GSFC) for collecting data in support of SEL software engineering research activities. These procedures include detailed instructions for the completion and submission of SEL data collection forms. Author

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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.

A93-14099* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THEORETICAL STUDY OF THE BOND DISSOCIATION ENERGIES OF PROPYNE (C3H4)
CHARLES W. BAUSCHLICHER, JR. and STEPHEN R. LANGHOFF (NASA, Ames Research Center, Moffett Field, CA) Chemical Physics Letters (ISSN 0009-2614) vol. 193, no. 5 June 5, 1992 p. 380-385. refs
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The C-C and C-H bond dissociation energies (BDEs) of propyne have been computed using the modified coupled-pair functional method. Due to hyperconjugation, the C-C and methyl C-H single bonds are stronger and weaker, respectively than those in ethane. The acetylenic C-H and C triple bond C BDEs are larger and smaller, respectively, than in acetylene, also as a result of the hyperconjugation. Our best estimate of 92.5 +/- 2 kcal/mol for the methyl C-H BDE in propyne is slightly larger than the experimental value. For the acetylenic C-H BDE in propyne we predict 135.9 +/- 2 kcal/mol. Author

A93-14266
EXPERIMENTAL STUDY OF THE ACOUSTIC SPINNING MODES GENERATED BY A HELICOPTER TURBOSHAFT ENGINE
S. LEWY and H. GOUNET (ONERA, Chatillon, France) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 898-906. Research supported by Turbomeca refs
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Turboshaft engines may be the main noise source radiated by helicopters during take-off if the sound levels are measured in dBa or PNdB. The engine inlet is often non-axisymmetric and one can take advantage of this for reducing the ground perceived noise simply by modifying the radiated directivity. The study is focused on the blade passing frequency of the first axial compressor, which dominates the acoustic spectra. The objective is to better understand the space structure (spinning modes) of the generated waves in order to predict the directivity pattern (model of Tyler and Sofrin). The tests were performed at the Turbomeca outdoor facility. Some experiments using an array of

fixed microphones in an inlet cross section of a TM333 engine show that the spinning mode analysis can yield useful results even if the cross section is far from being circular. However, the number of microphones remains necessarily small, which entails a spatial aliasing on high-order modes. Tests were thus conducted with moving microphones in the very near field of an Arriel engine, just outside the intake. The measured spinning modes can be used as input data into a computer code predicting the far field directivity. Author

A93-14268
THE NUMERICAL CALCULATION FOR THE COUPLING OF MULTIPLE PROPELLER DISCRETE NOISE AND ITS INTERACTION WITH THE FUSELAGE BOUNDARY
TONGQING WANG, YUANSHENG SHENG (Shenyang Inst. of Aeronautical Engineering, China), and SHENG ZHOU (Beijing Univ. of Aeronautics and Astronautics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 914-919. Research supported by Aeronautics Scientific Research Foundation of China refs
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This paper presents a numerical method for calculating multiple subsonic propeller discrete noise with the influence of rigid fuselage boundary condition of arbitrary shape, the method described unites the multiple propeller discrete noise coupling effect with the effect caused by its interaction with the fuselage boundary. The interaction of the discrete noise of the Y12 scaled propeller model with a cylindrical fuselage model boundary was calculated. The interpretation of every terms of the governing equation and the discussion of the calculation results illustrated that the mathematical model is acceptable. Substantially, the method can be used to calculate the interaction of any known harmonic sound sources and rigid boundary. The calculation results explain the propeller's sychronizer role, and its applicable principles. Author

A93-14269
CALCULATION OF SOUND FIELD RADIATED BY OSCILLATING CASCADE
SHU-HUA WANG, XIAO-FENG SUN, and CHUAN-JUN CAO (Beijing Univ. of Aeronautics and Astronautics, China) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 1 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 920-924. refs
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In the present aeroacoustic model of an oscillating cascade, the frequency and propagation characteristics of the sound generated are analyzed by combining the model with the calculation of the cascade's unsteady field. Bending and tortion vibration, and coupled bending-tortion vibration, are all dependent on the relative Mach number of the inlet flow and the frequency of blade vibration, in addition to the geometrical parameters of the fan or compressor in question. Steady blade forces produce higher sound pressure levels than the unsteady blade forces in the acoustic near-field. O.C.

A93-14353
A SEMI-EMPIRICAL THEORY OF THE NOISE IN SLOTTED TUNNELS CAUSED BY DIFFUSER SUCTION
D. G. MABEY (Imperial College of Science, Technology, and Medicine, London, United Kingdom) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1612-1622. refs
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This semiempirical analysis develops a model of noise - represented by pressure fluctuations - caused by diffuser suction and radiated upstream in a slotted tunnel. The problem is formulated for a tunnel working section with a uniform velocity and with a plenum chamber in which air is at rest, and slots are assumed to line the working-section wall. Expressions are derived for determining: (1) far-field noise at low speeds; (2) the directivity of radiation due to convection of sound sources; and (3) the effect of speeds approaching low Mach numbers. Theory describes slot/fan resonance and a peak in the pressure fluctuations in the working section for Mach numbers of near 0.80, two effects which are confirmed by experiment. The results indicate that the resonance effects and noise in slotted tunnels can be avoided by means of specific slot designs. C.C.S.

A93-14539* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AEROACOUSTIC ENVIRONMENT OF AN ADVANCED SHORT TAKEOFF AND VERTICAL LANDING AIRCRAFT IN HOVER
RICHARD W. WLEZIEN (McDonnell Douglas Research Labs., Saint Louis, MO) and PETER J. FERRARO (McDonnell Aircraft Co., Saint Louis, MO) AIAA Journal (ISSN 0001-1452) vol. 30, no. 11 Nov. 1992 p. 2606-2612. Previously cited in issue 02, p. 235, Accession no. A91-12528 refs
(Contract NAS1-18745)
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A93-14540* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ACTIVE CONTROL OF INTERIOR NOISE IN MODEL AIRCRAFT FUSELAGES USING PIEZOCERAMIC ACTUATORS
C. R. FULLER (Virginia Polytechnic Inst. and State Univ., Blacksburg), S. D. SNYDER, C. H. HANSEN (Adelaide Univ., Australia), and R. J. SILCOX (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452) vol. 30, no. 11 Nov. 1992 p. 2613-2617. Previously cited in issue 02, p. 227, Accession no. A91-12438 refs
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N93-12967*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
COMPUTER PROGRAM FOR CALCULATING AND FITTING THERMODYNAMIC FUNCTIONS
BONNIE J. MCBRIDE and SANFORD GORDON (Gordon, Sanford, Cleveland, OH) Nov. 1992 91 p Sponsored in cooperation with Sverdrup Technology, Inc., Brook Park, OH
(Contract NAS3-25266; RTOP 505-62-52)
(NASA-RP-1271; E-5894; NAS 1.61:1271) Avail: CASI HC A05/MF A01

A computer program is described which (1) calculates thermodynamic functions (heat capacity, enthalpy, entropy, and free energy) for several optional forms of the partition function, (2) fits these functions to empirical equations by means of a least-squares fit, and (3) calculates, as a function of temperture, heats of formation and equilibrium constants. The program provides several methods for calculating ideal gas properties. For monatomic gases, three methods are given which differ in the technique used for truncating the partition function. For diatomic and polyatomic molecules, five methods are given which differ in the corrections to the rigid-rotator harmonic-oscillator approximation. A method for estimating thermodynamic functions for some species is also given. Author

N93-12986*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
REPORT ON THE FINAL PANEL DISCUSSION ON COMPUTATIONAL AEROACOUSTICS Final Report
JAMES LIGHTHILL (University Coll., London, England) Oct. 1992 15 p Proceedings held at the ICASE/NASA Workshop on Computational Aeroacoustics, 6-9 Apr. 1992
(Contract NAS1-18605; RTOP 505-90-52-01)
(NASA-CR-189718; NAS 1.26:189718; ICASE-92-53; AD-A257106) Avail: CASI HC A03/MF A01

Some important conclusions about future prospects for aeroacoustics in general, and for computational aeroacoustics in particular, that were reached in the course of the Final Panel Discussion of the Workshop on Computational Aeroacoustics held from 6 to 9 April 1992 by ICASE and NASA Langley Research Center are summarized by the panel chairman. Aeroacoustics must now be involved in interactions with computational fluid dynamics (as applied not only to deterministic flows but also to the statistical

characteristics of turbulence), while additionally incorporating rigorous comparisons with experiment. The new Computational Aeroacoustics will press forward in two parallel ways. In one of them, CFD will be used to determine aeroacoustic source strengths, the associated radiation being derived by the Acoustic Analogy approach in one of its forms. In the other, a direct Computational Aeroacoustics will apply CFD techniques over a region extending beyond the flow field so as to include at least the beginnings of the acoustic far field. There are some particularly important areas of study, including rotor noise, boundary-layer noise, and the noise of supersonic jets, where it is strongly recommended that use of both methods is continued. On the other hand, important problems of the diffraction of radiation from aeroacoustic sources around complicated aircraft shapes will require the use of comprehensively Computational Aeroacoustics, while Acoustic Analogy methods seem better suited to estimating subsonic jet noise. The study of model problems to allow comparisons with experiment will be valuable in both lines of attack. L.R.R.

N93-13257# Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).
DIAGNOSTICS SYSTEMS FOR THE TBR-E TOKAMAK
M. UEDA, J. L. FERREIRA, Y. ASO, and J. G. FERREIRA 1992 36 p
(INPE-5428-RPQ/662) Avail: CASI HC A03/MF A01

A general view of the several diagnostic systems proposed for the TBR-E tokamak is given. This project is a joint undertaking of INPE, USP and UNICAMP plasma laboratories. The requirements for the measurements of the plasma produced parameters are described. Special attention is given for diagnostics used to investigate new physical issues on a low aspect ratio tokamak such as TBR-E. Author

N93-13762*# General Electric Co., Evendale, OH.
ELECTRO-OPTIC ARCHITECTURE FOR SERVICING SENSORS AND ACTUATORS IN ADVANCED AIRCRAFT PROPULSION SYSTEMS Final Report, Apr. 1988 - Jan. 1989
G. L. POPPEL (General Electric Co., Cincinnati, OH.) and W. M. GLASHEEN (General Electric Co., Cincinnati, OH.) Jun. 1989 98 p
(Contract NAS3-25344)
(NASA-CR-182269; NAS 1.26:182269; GE-R89AEB208) Avail: CASI HC A05/MF A02

A detailed design of a fiber optic propulsion control system, integrating favored sensors and electro-optics architecture is presented. Layouts, schematics, and sensor lists describe an advanced fighter engine system model. Components and attributes of candidate fiber optic sensors are identified, and evaluation criteria are used in a trade study resulting in favored sensors for each measurand. System architectural ground rules were applied to accomplish an electro-optics architecture for the favored sensors. A key result was a considerable reduction in signal conductors. Drawings, schematics, specifications, and printed circuit board layouts describe the detailed system design, including application of a planar optical waveguide interface. Author

N93-14144 California Univ., Los Angeles.
TURBULENCE AND CHAOS IN CLASSICAL AND QUANTUM SYSTEMS Ph.D. Thesis
MITCHELL BEHJAN HAERI 1992 98 p
Avail: Univ. Microfilms Order No. DA9224112

The nonlinear quantum kinetic equation for the interaction of sound waves and Liouville's equation for the kicked rotor are solved via analytic and numerical techniques. In the classical regime sound wave energy cascades to higher frequency (omega) according to the steady state power law omega(exp -3/2). In the quantum limit, the system prefers a reverse cascade of energy which follows the steady state power law omega(exp -6). Above a critical flux, a new type of spectrum appears for the interaction of sound waves which is neither self-similar nor close to equilibrium. This state of nonlinear quantum wave turbulence represents a flow of energy directly from the classical source to the quantum degrees of freedom. The classical kinetic equation is used to examine the locality issue associated with turbulence. In contrast to the Kolmogorov picture of vortex turbulence, we find that the time development of each mode is governed by a nonlocal interaction with the source where energy is injected. The local equations for wave turbulence are used to derive analytically an expression for the minimum flux required to overcome viscous damping and generate a turbulent spectrum. A map of the probability distribution function for the kicked classical rotor is generated by exactly solving Liouville's equation for any arbitrary initial condition and kicking strength. This solution is compared to the analogous quantum mechanical map in an attempt to define chaos in the quantum rotor. In this way we compare two linear partial differential equations. Unlike the standard map generated from the canonical equations of motion, the map of the classical probability distribution function is 'practically' reversible for large values of the kicking potential. In fact, the conditions for reversibility of Liouville's equation are similar to those for Schroedinger's. In all other respects, the solution to Liouville's equation is similar to the standard map. However, there is no metric like Liapunov exponents to quantify chaos in Liouville's equation. Any method used to define chaos in Liouville's equation can be applied to Schroedinger's equation. Dissert. Abstr.

N93-14406# Aerospace Medical Research Labs., Wright-Patterson AFB, OH.
EVALUATION OF THREE MODELS USED FOR PREDICTING NOISE PROPAGATED LONG DISTANCES OVERGROUND Interim Report, Aug. 1990 - Sep. 1991
W. R. LUNDBERG Sep. 1991 44 p
(Contract AF PROJ. 7321)
(AD-A255963; AL-TR-1991-0126) Avail: CASI HC A03/MF A01

Pershing 2 missile elimination noise measurements were used as the basis for comparing three noise prediction programs' ground-to-ground propagation modeling approaches. The effects of atmospheric refraction, atmospheric absorption, and ground impedance are considered. The noise models were compared because they are currently in use, in different venues, for environmental noise propagation modeling. The respective strong points of each model are emphasized. The results are used to delineate the needs for development of a model which produces both rapid and physically detailed predictions. GRA

N93-14912# Systems Control Technology, Inc., Arlington, VA.
TILTROTOR AIRCRAFT NOISE: A SUMMARY OF THE PRESENTATIONS AND DISCUSSIONS AT THE 1991 FAA/GEORGIA TECH WORKSHOP Final Report
K. K. AHUJA (Georgia Inst. of Tech., Atlanta.) Jan. 1992 53 p
(Contract DTFA01-87-C-00014)
(DOT/FAA/RD-91/23; SCT-A8924-1) Avail: CASI HC A04/MF A01

Georgia Institute of Technology hosted a workshop in Atlanta on 28 and 29 March 1991 on the noise problems associated with tiltrotors. The workshop had two major objectives: (1) to review the status of research and development in predicting and reducing tiltrotor noise; and, (2) to identify key technical and operational issues and methods to address them. The second objective had both near term and far term implications. In the near term, the goal is to arrive at a level of technical credibility that can support decisions to develop urban and inner city markets. The long term goal is to target resources and actions which will lead to tiltrotor noise abatement and effective control. The opening session of this workshop consisted of an overview and a discussion of the physics of tiltrotor noise mechanisms. A review of the available experimental data followed. A discourse on potential flight operational procedures to minimize noise impacts, and a general presentation of industry and government perspectives concluded the workshop. Subsequent sessions were available for participants to present observations on and experiences with the XV-15 and V-22. Operational experiences included flight tests, wind tunnel tests, and other simulations. Experiences with computational fluid dynamics codes, small-scale model testing, and other related research were shared. This document provides a summary of the

presentations and discussions that took place during the workshop. Author

N93-15116*# United Technologies Research Center, East Hartford, CT.
ELECTRO-OPTIC ARCHITECTURE (EOA) FOR SENSORS AND ACTUATORS IN AIRCRAFT PROPULSION SYSTEMS Final Report, Apr. 1988 - Jan. 1989
W. L. GLOMB, JR. Jun. 1989 250 p
(Contract NAS3-25343)
(NASA-CR-182270; UTRC-R89-927889; NAS 1.26:182270)
Avail: CASI HC A11/MF A03

Results of a study to design an optimal architecture for electro-optical sensing and control in advanced aircraft and space systems are described. The propulsion full authority digital Electronic Engine Control (EEC) was the focus for the study. The recommended architecture is an on-engine EEC which contains electro-optic interface circuits for fiber-optic sensors on the engine. Size and weight are reduced by multiplexing arrays of functionally similar sensors on a pair of optical fibers to common electro-optical interfaces. The architecture contains common, multiplex interfaces to seven sensor groups: (1) self luminous sensors; (2) high temperatures; (3) low temperatures; (4) speeds and flows; (5) vibration; (6) pressures; and (7) mechanical positions. Nine distinct fiber-optic sensor types were found to provide these sensing functions: (1) continuous wave (CW) intensity modulators; (2) time division multiplexing (TDM) digital optic codeplates; (3) time division multiplexing (TDM) analog self-referenced sensors; (4) wavelength division multiplexing (WDM) digital optic code plates; (5) wavelength division multiplexing (WDM) analog self-referenced intensity modulators; (6) analog optical spectral shifters; (7) self-luminous bodies; (8) coherent optical interferometers; and (9) remote electrical sensors. The report includes the results of a trade study including engine sensor requirements, environment, the basic sensor types, and relevant evaluation criteria. These figures of merit for the candidate interface types were calculated from the data supplied by leading manufacturers of fiber-optic sensors. Author

N93-15430*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
COMPUTATION OF SUPERSONIC JET NOISE UNDER IMPERFECTLY EXPANDED CONDITIONS
CHAN M. KIM, EUGENE A. KREJSA, and ABBAS KHAVARAN (Sverdrup Technology, Inc., Brook Park, OH.) Jan. 1993 11 p Presented at the 31st Aerospace Sciences Meeting and Exhibit, Reno, NV, 11-14 Jan. 1993; Sponsored by AIAA
(Contract RTOP 537-02-23)
(NASA-TM-105961; E-7481; NAS 1.15:105961; AIAA PAPER 93-0735) Avail: CASI HC A03/MF A01

The turbulent mixing noise of supersonic jet under imperfectly expanded conditions is calculated for convergent and convergent-divergent (CD) axisymmetric nozzle geometries. The noise prediction incorporates CFD solution of Navier-Stokes equations. The effect of grid resolution on shock structure computation is demonstrated. Mixing noise spectra predicted from fine and coarse grid solutions exhibit little sensitivity to the grid resolution. A proper grid resolution, however, results in a significant improvement in shock capturing capability and helps predictions agree favorably with experimental data. Good agreement between predicted noise spectra and data shows that the CFD-incorporated noise prediction scheme, which was demonstrated for shock-free conditions, works as well for shock-containing flow conditions. Author

N93-15575*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PROPAGATION OF HIGH FREQUENCY JET NOISE USING GEOMETRIC ACOUSTICS
A. KHAVARAN (Sverdrup Technology, Inc., Brook Park, OH.) and E. A. KREJSA Jan. 1993 18 p Presented at the 31st Aerospace Sciences Meeting and Exhibit, Reno, NV, 11-14 Jan. 1993; sponsored by AIAA
(Contract RTOP 537-02-23)
(NASA-TM-105950; E-7471; NAS 1.15:105950; AIAA PAPER 93-0147) Avail: CASI HC A03/MF A01

Spherical directivity of noise radiated from a convecting quadrupole source embedded in an arbitrary spreading jet is obtained by ray-tracing methods of geometrical acoustics. The six propagation equations are solved in their general form in a rectangular coordinate system. The noise directivity in the far field is calculated by applying an iteration scheme that finds the required radiation angles at the source resulting in propagation through a given observer point. Factors influencing the zone of silence are investigated. The caustics of geometrical acoustics and the exact locations where it forms is demonstrated by studying the variation in ray tube area obtained from transport equation. For a ring source convecting along the center-axis of an axisymmetric jet, the polar directivity of the radiated noise is obtained by an integration with respect to azimuthal directivity of compact quadrupole sources distributed on the ring. The Doppler factor is shown to vary slightly from point to point on the ring. Finally the scaling of the directivity pattern with power -3 of Doppler factor is investigated and compared with experimental data. 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.

A93-14103
ECONOMICAL VIEW ON COMPOSITE STRUCTURES MAINTENANCE
JUERGEN THORBECK (Lufthansa German Airlines, Hamburg, Germany) Jan. 1992 14 p. Society of Manufacturing Engineers, Conference on Composites in Manufacturing '92, Anaheim, CA, Jan. 7, 8, 1992
(SME PAPER EM92-102) Copyright

The question is raised with regard to composites if there is a balance between airframe weight savings and avoidance of corrosion problems on the one side and additional burdens on the other side. This point is assumed to be reached when further substitution of metals with composites in areas where a significant weight reduction and/or a relief in maintenance burdens is achieved. R.E.P.

A93-14338* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COST - THE CHALLENGE FOR ADVANCED MATERIALS AND STRUCTURES
JOHN G. DAVIS, JR., WILLIAM T. FREEMAN, JR. (NASA, Langley Research Center, Hampton, VA), and SHAHID SIDDIQI (Analytical Services and Materials, Inc., Hampton, VA) *In* ICAS, Congress, 18th, Beijing, China, Sept. 20-25, 1992, Proceedings. Vol. 2 Washington American Institute of Aeronautics and Astronautics, Inc. 1992 p. 1489-1496. refs

Information is presented on the cost of various aircraft structures, together with methods for predicting and reducing cost. The need for the development of cost models, and of a comparative cost algorithm which could function as an engineering design tool to evaluate different design concepts, is emphasized. Efforts are underway to develop cost models that establish building-block unit cell elements that represent different material forms, geometric shapes, fabrication processes, and methods of assembly, with the purpose of expressing cost per pound or labor per pound data, with physical design and manufacture variables that a designer can visualize. I.S.

A93-15032
INTRODUCTION TO REGULATORY PROBLEMS FOR SUPERSONIC TRANSPORTS [INTRODUCTION AUX PROBLEMES DE REGLEMENTATION POUR LES AVIONS DE TRANSPORT SUPERSONIQUES]
CLAUDE FRANTZEN (Direction Generale de l'Aviation Civile, Paris, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 141 1990 p. 17-20. In French.
Copyright
An overview is presented of the rules and regulations that have been imposed on Concorde operations as a precursor to those that will affect future supersonic transports. Attention is given to SST airport noise; the sonic boom; surface, atmospheric, and stratospheric air pollution; and ATC operational constraints. R.E.P.

A93-15033
THE OPPORTUNITIES AND RISKS OF THE SUPERSONIC TRANSPORT MARKET - THE LUFTHANSA POINT OF VIEW [LE MARCHE DES GRANDES VITESSES, CHANCES ET RISQUES - LE POINT DE VUE DE LA LUFTHANSA]
K. NITTINGER (Lufthansa German Airlines, Hamburg, Germany) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 141 1990 p. 21-23. In French.
Copyright
A review of SST market analyses conducted and the conclusions drawn regarding future supersonic transport aircraft are presented. Attention is given to market requirements, technical constraints, development costs, operational economics, and the return on investment associated with a future SST. R.E.P.

A93-15035
AIRPORTS, AIR TRAFFIC CONTROL, AND THEIR CLIENTS - REFLECTIONS ON SYSTEM OPTIMIZATION [AEROPORTS, CONTROLE AERIEN ET LEURS CLIENTS - REFLEXIONS SUR L'OPTIMISATION DU SYSTEME]
JEAN-YVES VALIN (Dept. Developpement Aeroports, Paris, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 141 1990 p. 64-70. In French.
Copyright
This paper presents some problems and solutions to the integration of operator and passenger requirements within airports. Attention is given to ATC, the airline operators, air freight, passenger handling and interline convenience, and the economic penalties that may result from infrastructure changes. R.E.P.

N93-12671*# National Aeronautics and Space Administration, Washington, DC.
COORDINATING COUNCIL. FOURTH MEETING: NACA DOCUMENTS DATABASE PROJECT
1991 87 p Meeting held in Arlington, VA, 7 Feb. 1991
(NASA-TM-108017; NAS 1.15:108017) Avail: CASI HC A05/MF A01
This NASA Scientific and Technical Information Coordination Council meeting dealt with the topic 'NACA Documents Database Project'. The following presentations were made and reported on: NACA documents database project study plan, AIAA study, the Optimal NACA database, Deficiencies in online file, NACA documents: Availability and Preservation, the NARA Collection: What is in it? and What to do about it?, and NACA foreign documents and availability. Visuals are available for most presentations. R.L.B.

N93-12672*# National Aeronautics and Space Administration, Washington, DC.
COORDINATING COUNCIL. SIXTH MEETING: WHO ARE OUR KEY USERS?
1991 101 p Meeting held in Arlington, VA, 25 Oct. 1991
(NASA-TM-108021; NAS 1.15:108021) Avail: CASI HC A06/MF A02
This NASA Scientific and Technical Information Program Coordinating Council meeting deals with the topic 'Who are our key users?' Presentations were made on the following subtopics: Key users: Who uses the system the most, Who orders the most documents, Users: What do we know about them?, NASA/DOD Aerospace Knowledge Diffusion research project on 'Potential key users', How we meet the user's needs, and STI Council user requirements update. Summaries of discussions after the presentations are included along with visuals for the presentations. R.L.B.

N93-13368# National Aeronautical Lab., Bangalore (India). Information Centre for Aeronautics.
COMPOSITES: A CATALOGUE OF BOOKS AND CONFERENCE PROCEEDINGS AVAILABLE IN THE NAL LIBRARY
G. SHASHIKALA and V. BHANUMATHI Mar. 1992 15 p
(Contract NAL PROJ. ST-1-166)
(NAL-SP-IC-9201) Avail: CASI HC A03/MF A01
Books and conference proceedings on composite materials held by the National Aeronautical Laboratory in Bangalore, India are listed. Author

N93-13798# Committee on Commerce, Science, and Transportation (U.S. Senate).
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION AUTHORIZATION ACT, FISCAL YEAR 1993
ERNEST F. HOLLINGS Washington GPO 1992 49 p Report on H.R. 4364 presented by the Committee on Commerce, Science, and Transportation, 102d Congress, 2d Session, 10 Aug. 1992
(S-REPT-102-364; GPO-59-010) Avail: CASI HC A03/MF A01; Document Room, Senate, Washington, DC 20510 HC; SOD HC
A report of the Senate Committee on Commerce, Science, and Transportation on a bill to authorize fiscal year 1993 appropriations for NASA is presented along with the budget estimates. A detailed summary of the programs funded by this budget is included. L.R.R.

N93-13799# Committee on Science, Space and Technology (U.S. House).
NASA AUTHORIZATION, 1993, VOLUME 2
Washington GPO 1992 592 p Hearings before the Subcommittee on Space, 102d Congress, 2d Session, No. 137, 19 Feb., 26-27 Feb., 4-5 Mar., and 24 Mar. 1992
(GPO-56-943-VOL-2; ISBN-0-16-038977-1) Avail: CASI HC A25/MF A06; Subcommittee on Space, House of Representatives, Washington, DC 20515 HC; SOD HC
Hearings before a subcommittee of the House Committee on Science, Space, and Technology are presented on NASA's 1993 budget request. All written testimony and submittals for the record are included. L.R.R.

N93-13800# Committee on Commerce, Science, and Transportation (U.S. Senate).
NASA'S FISCAL YEAR 1993 BUDGET
Washington GPO 1992 81 p Hearing before the Committee on Commerce, Science, and Transportation, 102d Congress, 2d Session, 17 Mar. 1992
(S-HRG-102-707; GPO-57-099; ISBN-0-16-038961-5) Avail: CASI HC A05/MF A01; Subcommittee on Science, Technology, and Space, Senate, Washington, DC 20510 HC; SOD HC
Hearings before a subcommittee of the Senate Committee on Commerce, Science, and Transportation are presented on NASA's fiscal year 1993 budget. All written testimony and submittals for the record are included. L.R.R.

N93-15170# Ministry of Defence, London (England). Procurement Executive.
ROYAL AIR FORCE EXPERIENCE OF THE HARRIER INFORMATION MANAGEMENT SYSTEM [ERFAHRUNGEN DER ROYAL AIR FORCE MIT DEM INFORMATIONS-MANAGEMENT-SYSTEM DES HARRIER-FLUGZEUGES]
R. P. BOOKHAM *In* DLR, Proceedings of the 16th Symposium on Aircraft Integrated Monitoring Systems p 341-360 Jan. 1992

(Contract AE12A/159)
Avail: CASI HC A03/MF A06; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Germany, HC

The Harrier Information Management System (HIMS), part of the Harrier Engine Monitoring System (EMS), is considered. The EMS consists of a number of sensors and transducers feeding data into an Engine Monitoring Unit (EMU). The data is then passed from the EMU via an extraction unit, the Data Retrieval Unit (DRU), to the HIMS ground station, either directly or via a bulk data cassette recorder dependent upon whether the aircraft is on or off base. The data which is part processed in the EMU is further processed in the HIMS with the inclusion of external data about the aircraft flight fed into the system manually by aircraft tradesmen. Once fully processed the data has a number of outputs onto a VDU screen and a printer. The following are discussed: EMU functionality, HIMS functionality, HIMS deployment, system problems and solutions, HIMS performance, HIMS data analysis, possible system enhancements, and lessons learnt. ESA

N93-15637# Naval Postgraduate School, Monterey, CA.
UPGRADE AND EXTENSION OF THE DATA ACQUISITION SYSTEM FOR PROPULSION AND GAS DYNAMIC LABORATORIES M.S. Thesis
RICHARD A. WENDLAND Jun. 1992 207 p
(AD-A256836) Avail: CASI HC A10/MF A03

The goal of the present work was to upgrade the data acquisition system (DAS) in the high-speed building of the Turbopropulsion Laboratory (TPL) and to develop a high speed acquisition capability for pressure measurements for both TPL and the new Gas Dynamics Laboratory (GDL). Using the Hewlett Packard HP9000 Series 300 Computer as the system controller, a 96-channel high-speed pressure DAS was developed using Scanivalve ZOC-14 modules and a CALSYS2000 calibrator. The system allowed acquisition times for current wind-tunnel experiments to be revised from four minutes to eleven seconds. Also, new software was written to acquire data from existing rotary pneumatic Scanivalves and HP-IB compatible instrumentation so that all other existing acquisition capabilities were maintained in both laboratories. GRA

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GENERAL

A93-16854
THE PIONEERS OF THERMOPULSIVE NOZZLES [LES PIONNIERS DES TUYERES THERMOPROPULSIVES]
PHILIPPE RICCO (Centre d'Essais en Vol, Istres, France) L'Aeronautique et l'Astronautique (ISSN 0001-9275) no. 153 1992 p. 13-18. In French.
Copyright

A review is presented of the early research and development work performed in France leading to experimental flight tests of ramjets and pulsejet engines. A paper by R. Lorin published in 1913 outlines the principles of ramjet propulsive applications. R.E.P.

A93-17271
LAMINAR FLOW RESEARCH IN THE 1940-1950S - A PERSONAL RECOLLECTION
E. J. RICHARDS (Southampton Univ., United Kingdom) *In* Boundary layer transition and control; Proceedings of the Conference, Univ. of Cambridge, United Kingdom, Apr. 8-12, 1991 London Royal Aeronautical Society 1991 p. 34.1-34.13. refs
Copyright

An autobiographical account is given of the development history of British research in the fields of aircraft boundary flow laminarization through passive design and active control methods. Attention is given to the development of suction-surfaced wing research, the relationships established between suction quantities and the effective drag coefficient, the laminar flow instability associated with surface concavities, the 'China clay' method of transition indication, and the results of thick wing Griffith tests. O.C.

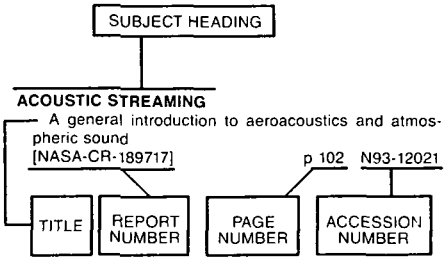
A93-17275
ENGINEERING ASPECTS OF LAMINAR FLOW RESEARCH AT HANDLEY PAGE
A. A. BLYTHE (British Aerospace/Commercial Aircraft/, Ltd., Hatfield, United Kingdom) *In* Boundary layer transition and control; Proceedings of the Conference, Univ. of Cambridge, United Kingdom, Apr. 8-12, 1991 London Royal Aeronautical Society 1991 p. 42.1-42.10. refs
Copyright

A development history is presented for the engineering aspects of research into distributed-suction boundary flow laminarization which was conducted at a British aeronautical research establishment in the period 1949-1966. Attention is given to the engineering aspects of the laminar-flow fins of Lancaster bomber and Vampire fighter test-flight aircraft, whose composite leading edges were slotted, and to the precautions that had to be taken against insect and dust ingestion by the suction surfaces, which led to clogging. O.C.

A93-17326
THE START OF THE LABORATORY - THE BEGINNINGS OF THE MIT INSTRUMENTATION LABORATORY
WILLIAM G. DENHARD (Charles Stark Draper Lab., Inc., Reading, MA) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985) vol. 7, no. 10 Oct. 1992 p. 6-13. refs
Copyright

History of the MIT Instrumentation Laboratory is reviewed with particular attention given to the activities of its leader, Charles Stark Draper. It is noted that the laboratory contributed to the quality of the instruments and systems which made possible the Fleet Ballistic Missiles, MX, and Apollo flights to the moon. O.G.

Typical Subject Index Listing



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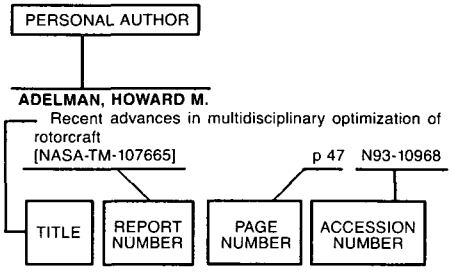

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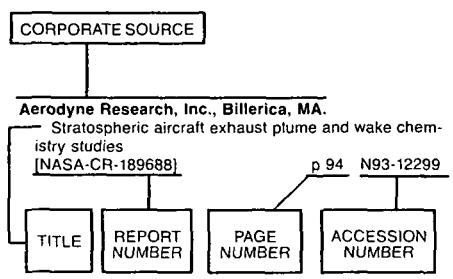

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Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
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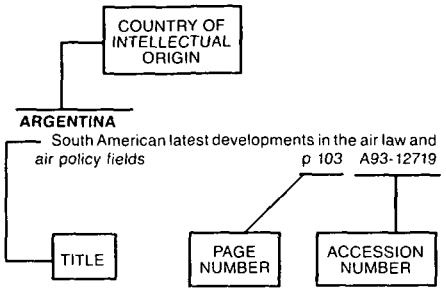

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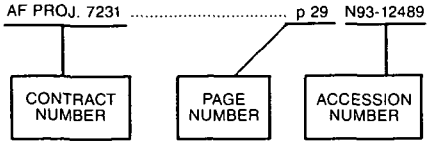

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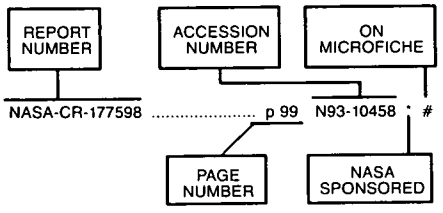

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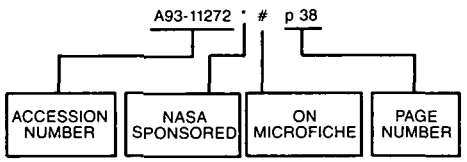

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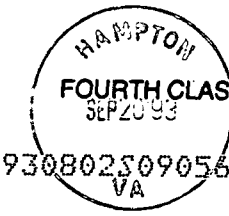

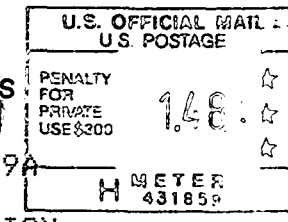

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