NASA SP-7037 (284)
November 1992

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(NASA-SP-7037(284)) AERONAUTICAL ENGINEERING: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 284) (NASA) 261 p

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NASA SP-7037 (284)
November 1992

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

National Aeronautics and Space Administration
Scientific and Technical Information Program
Washington, DC 1992

INTRODUCTION

This issue of *Aeronautical Engineering—A Continuing Bibliography* (NASA SP-7037) lists 974 reports, journal articles, and other documents originally announced in October 1992 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

Accession numbers cited in this issue are:

STAR (N-10000 Series)	N92-28223 — N92-30232
IAA (A-10000 Series)	A92-44895 — A92-49229

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 1992 will be published in early 1993.

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

NASA SPONSORED

ON MICROFICHE

ACCESSION NUMBER → N92-26435*# Notre Dame Univ., IN. ← CORPORATE SOURCE

TITLE → **GAMMA GROUP-THE PALE HORSE: A PROPOSAL IN RESPONSE TO A COMMERCIAL AIR TRANSPORTATION STUDY ORT STUDY Final Design Proposal**

AUTHORS → T. EHLER, J. HAWKINS, J. NEWELL, M. OHARA, KARL SCHUDT, G. SOHA, and S. VANDENBERG May 1991 80 p ← PUBLICATION DATE

Sponsored in part by Boeing Commercial Airplane Co.

CONTRACT NUMBER → (Contract NASW-4435) ← AVAILABILITY SOURCE

REPORT NUMBERS → (NASA-CR-190019;NAS 1.26:190019) Avail: CASI HC A05/MF A01 ← PRICE CODE

A conventional remotely piloted vehicle (RPV) was designed to operate in a fictional 'Aeroworld' as a 30 passenger aircraft. The topics addressed include: economic/cost analysis, aerodynamics, weight and structures, propulsion, stability and control, and performance. Author

TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT

NASA SPONSORED

ACCESSION NUMBER → **A92-13210*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA. ← CORPORATE SOURCE

TITLE → **PROBE SHAPES FOR STREAMWISE MOMENTUM AND CROSS-STREAM TURBULENCE INTENSITY**

AUTHOR → VERNON ROSSOW, J. (NASA, Ames Research Center, Moffett Field, CA) Journal of Aircraft (ISSN 0021-8669), vol. 28, Nov. 1991, p. 741-749. refs ← AUTHORS' AFFILIATION

Copyright ← JOURNAL TITLE

When the highly turbulent flowfields at the edges of jets, in augmentors, and in other jet-mixing devices are surveyed with conventional pitot probes, the values indicated by the instruments may contain a significant increment brought about by the dynamics of the eddies. Although the influence of turbulence on the measurements is usually negligible in streams where the turbulence level is 1 percent or less, the effect of turbulence on static and total pressure measurements can be around 20 percent when the turbulence level exceeds 40 percent. This paper describes a theoretical study that develops probe shapes that directly measure the time-averaged total pressure based on the streamwise component of the velocity vector to obtain a direct measurement of the streamwise momentum. The difference between the time-averaged pressure indicated by such a probe and one that measures the total head based on the entire velocity vector yields the cross-stream turbulence intensity. Author

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 284)

November 1992

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AERONAUTICS (GENERAL)

A92-44895
ASSEMBLING THE FUTURE
DOUGLAS BARRIE Flight International (ISSN 0015-3710), vol. 141, no. 4322, June 10, 1992, p. 50-52.
Copyright

An overview is presented of the expansion work currently in progress to handle final assembly of A321 aircraft, which program has recently been awarded to Deutsche Airbus. Consideration is given to the primary contractors and the major subassemblies of the A321 and how the various sections will be handled to achieve final assembly. R.E.P.

A92-45302
INTERNATIONAL POWERED LIFT CONFERENCE, LONDON, ENGLAND, AUG, 29-31, 1990, PROCEEDINGS
Conference sponsored by Royal Aeronautical Society. London, Royal Aeronautical Society, 1990, 375 p. For individual items see A92-45303 to A92-45325.
(ISBN 0-903409-68-2) Copyright

The present volume on powered lift discusses U.S. Air Force STOVL activities, jet-powered V/STOL aircraft, the Harrier international program, and V/STOL engine design evolution. Attention is given to a remote tip-driven fan-powered supersonic fighter concept, the military utility of medium-speed V/STOL design, ASTOVL flexibility in the 21st century, and a USAF assessment of STOVL fighter options. Topics addressed include the evolution of ASTOVL aircraft design, ASTOVL propulsion systems configuration and concept choice, recent developments at the Shoeburyness STOVL test facility, and configuration effects on the ingestion of hot gas into the engine intake. Also discussed are hot gas ingestion characteristics and flow visualization of a vectored thrust STOVL concept, the progress of the ASTOVL control concept studies under the VAAC program, ASTOVL engine control, small-scale experiments in STOVL ground effects, and numerical simulation of powered-lift flows. C.A.B.

A92-45303
AN OVERVIEW OF US NAVY AND MARINE CORPS V/STOL
LEONARD S. FREEMAN, FRANCIS J. O'BRIMSKI, and LISA J. PFANNESCHLAG (U.S. Navy, Naval Air Systems Command, Washington, DC) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. I.6.1-I.6.14.
Copyright

U.S. Navy and Marine Corps activities with regard to V/STOL aircraft development for military operations are reviewed. Some historical Navy V/STOL programs are discussed, with emphasis on their importance for the progression of the present technical data base. Propulsion technology is the key factor in any V/STOL concept and in current Navy V/STOL activities. The position of the Navy and the Marine Corps in the acquisition process is examined, and the programs involved in this process are highlighted. Attention is also given to maritime unique criteria, in-house studies, flight demo definition, force structure considerations, ground environment testing, and engine programs. C.A.B.

A92-45309
ASTOVL FLEXIBILITY IN THE 21ST CENTURY
RICHARD A. NIKSCH (McDonnell Aircraft Co., Saint Louis, MO) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. II.7.1-II.7.21.
Copyright

This paper addresses the probable conflict scenarios of the 21st century, how an ASTOVL aircraft could be used, and its concepts of operation. The ASTOVL aircraft would complement current conventional take-off and landing aircraft both in Third World conflicts and in the European environment. Additionally, the advantages of an ASTOVL aircraft to the user/operator are illustrated from the perspective of 'lessons learned' from past STVL operations. The pros and cons of the advanced technology features considered in the engineering-design process are addressed. Author

A92-45376
INTERNATIONAL PACIFIC AIR AND SPACE TECHNOLOGY CONFERENCE AND AIRCRAFT SYMPOSIUM, 29TH, GIFU, JAPAN, OCT. 7-11, 1991, PROCEEDINGS
Warrendale, PA, Society of Automotive Engineers, Inc. (SAE P-246), 1991, 931 p. For individual items see A92-45377 to A92-45458.
(SAE P-246; ISBN 1-56091-146-8) Copyright

Various papers on air and space technology are presented. Individual topics addressed include: media selection analysis: implications for training design, high-speed challenge for rotary wing aircraft, high-speed VSTOL answer to congestion, next generation in computational aerodynamics, acrobatic airship 'Acrostat', ducted fan VTOL for working platform, Arianespace launch of Lightsats, small particle acceleration by minirailgun, free-wake analyses of a hovering rotor using panel method, update of the X-29 high-angle-of-attack program, economic approach to accurate wing design, flow field around thick delta wing with rounded leading edge, aerostructural integrated design of forward-swept wing, static characteristics of a two-phase fluid drop system, simplfied-model approach to group combustion of fuel spray, avionics flight systems for the 21st century. Also discussed are: Aircraft Command in Emergency Situations, spectrogram diagnosis of aircraft disasters, shock interaction induced by two hemisphere-cylinders, impact response of composite UHB propeller blades, high-altitude lighter-than-air powered platform, integrated wiring system, auxiliary power units for current and future aircraft, Space Shuttle Orbiter Auxiliary Power Unit status, numerical analysis of RCS jet in hypersonic flights, energy requirements for the space frontier, electrical system options for space exploration, aerospace plane hydrogen scramjet boosting, manual control of vehicles with time-varying dynamics, design of strongly stabilizing controller, development of the Liquid Apogee Propulsion System for ETS-VI. C.D.

A92-45407* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
UPDATE OF THE X-29 HIGH-ANGLE-OF-ATTACK PROGRAM

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GARY TRIPPENSEE (NASA, Flight Research Center, Edwards, CA) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 375-382.
(SAE PAPER 912006) Copyright

The X-29A forward-swept wing flight research aircraft flight envelope was expanded to 66 deg angle-of-attack during 1990. Following this flight envelope expansion, a military utility evaluation was performed to investigate the tactical utility of the X-29 configurations at high-angle -of-attack, slow-speed flight conditions. An overall management view and perspective of the expansion process, the technical problems encountered, and the results obtained when compared to the predictions are presented. R.E.P.

A92-45421
AVIONICS FLIGHT SYSTEMS FOR THE 21ST CENTURY
RICHARD A. PEAL (Boeing Commercial Airplane Group, Seattle, WA) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 513-524.
(SAE PAPER 912033) Copyright

This paper illustrates the need to establish requirements for the 21st century system immediately to support the design and development of the ground and airborne equipment that will provide an economical evolution from existing systems to the post-year 2000 system. Technology limitations are no longer principal constraints to defining the required or desired operation and maintenance of commercial transport aircraft. Rather, the limitation is the ability to develop a total system requirements definition to develop the most cost-effective architecture from today's system. R.E.P.

A92-45699
A NEW MILESTONE IN AUTOMATIC AIRCRAFT CONTROL - FLY-BY-LIGHT SYSTEMS TRANSMIT COMMANDS OPTOELECTRONICALLY
New-Tech News (ISSN 0935-2694), no. 2, 1992, p. 16-20.
Copyright

A fly-by-light (FBL) aircraft control system capable of overcoming strong radio interference and relieving a pilot of a great deal of work is considered. FBL is an extremely stable and reliable system which is important for both military and civil applications of the future generation of helicopters. O.G.

A92-46202
AVIATION, MOTOR, AND SPACE DESIGNS
ALEXANDER BOLONKIN IN: Emerging technology in the Soviet Union: Selected papers with analysis. Falls Church, VA, Delphic Associates, Inc., 1990, p. 32-80.
Copyright

An overview is given of aviation, motor, and space design projects undertaken at the Eastern Siberian Technological Institute in the Soviet Union between 1986 and 1988. The organization of the Institute and its organization of research are briefly reviewed. The designs of supersonic VSTOL, including its passenger and transport versions, are examined. Work done on a rotary combustion engine and on other projects is examined, including a space motor using solar wind, space solar sail, simple space nuclear reactive motors and electric generators run on radioactive substances, hydrotransmission for automobiles, the transformation of light energy into mechanical energy, a ship using wave energy, new noncontact means of transportation, a compact and simple device for creating a strong open continuous electrical field, and the development of electrically neutral plasma. C.D.

A92-47403
COMPOSITES IN MANUFACTURING - CASE STUDIES
A. B. STRONG, ED. (Brigham Young University, Provo, UT) Dearborn, MI, Society of Manufacturing Engineers, 1991, 335 p.
For individual items see A92-47404 to A92-47418.
(ISBN 0-87263-406-X) Copyright

The papers presented in this volume focus on 19 cases of applied technology in composites design and manufacturing, all of them dealing with specific products. Topics covered include design using composite in aerospace, innovative materials and processing, tooling, fasteners and adhesives, finishing, repair, specialty applications of composites. and applications in the automotive industry. Papers are presented on the filament winding of isogrid fuselage structures; design and use of aramid fiber in aircraft structures; resin transfer molding of a complex composite aircraft structure; and field repair of an advanced helicopter vertical fin structure. V.L.

A92-47405
FILAMENT WINDING OF COMPOSITE ISOGRID FUSELAGE STRUCTURES
LARRY J. ASHTON, STEVEN D. HUNTSMAN, MICHAEL G. ALLMAN, A. B. STRONG, and CHRISTOPHER A. ROTZ (Brigham Young University, Provo, UT) IN: Composites in manufacturing - Case studies. Dearborn, MI, Society of Manufacturing Engineers, 1991, p. 19-32. refs
Copyright

The filament winding of composite isogrid fuselage structures is investigated as a cost-effective and high-productivity method of manufacturing large aircraft structures. It is shown that the automated combination of filament winding and tow placement offers a low-cost alternative to the expensive hand-laid prepreg technology. Combination filament winding and tow placement of isogrid have been demonstrated in prototype parts. The testing of these components confirms the theoretical predictions that isogrid is a superior aircraft structure design. The inherent damage tolerance and redundancy of isogrid will allow the use of higher design strain allowables and other design parameters, yielding lighter and stronger structures. V.L.

A92-47407
DESIGN AND USE OF ARAMID FIBER IN AIRCRAFT STRUCTURES
PAUL R. LANGSTON IN: Composites in manufacturing - Case studies. Dearborn, MI, Society of Manufacturing Engineers, 1991, p. 49-77.
Copyright

The use of Kevlar fibers and Nomex honeycomb in aircraft structures is discussed with particular reference to the design, fabrication, and properties of Kevlar/Nomex sandwich structures. The applications discussed include filament-wound pressure vessels and a variety of structural, interior, and systems applications. It is shown that improved composite designs can reduce weight and thus improve fuel efficiency, lower final costs, lower life cycle costs, reduce maintenance, and increase dispatch reliability. V.L.

A92-47410
RESIN TRANSFER MOLDING OF A COMPLEX COMPOSITE AIRCRAFT STRUCTURE
DALE BROSIUS and MARK WADSWORTH IN: Composites in manufacturing - Case studies. Dearborn, MI, Society of Manufacturing Engineers, 1991, p. 111-127.
Copyright

The use of resin transfer molding (RTM) to manufacture the elevator trim tab for the Beech Starship aircraft is discussed. The specific of the process are described, with attention given to the choice of resin and reinforcement, preform technology, part geometry and size, fiber loading and placement, mold conditions, and injection variables. Tooling considerations are examined in detail. The results of the study demonstrate the effectiveness of the RTM process for the manufacture of composite aerospace components. V.L.

A92-47413
THE ROLE OF NONMETALLIC FASTENERS IN AIRCRAFT WINGS AND OTHER COMPOSITE STRUCTURES

IMRE BERECZ (Microdot Aerospace Fastening Systems Corp., Fullerton, CA) IN: Composites in manufacturing - Case studies. Dearborn, MI, Society of Manufacturing Engineers, 1991, p. 167-174.
Copyright

The development and use of fasteners designed specifically for composite structures are discussed. First, some problems associated with the use of metal fasteners for composites are reviewed, and the evolution of composite fasteners is examined. Attention is then given to the use of composite fasteners for the Boeing A-6 wing, fabrication and design concepts for composite fasteners, and some new fastener concepts for the B-1B bomber's tail section. V.L.

A92-47414
USE OF ADHESIVE BONDED ATTACHMENTS FOR A COMPOSITE AIRCRAFT FUEL TANK
ALEXANDER B. CARTER, III (Click-Bond, Inc., Carson City, NV) and MICHAEL W. CASE (Brunswick Corp., Skokie, IL) IN: Composites in manufacturing - Case studies. Dearborn, MI, Society of Manufacturing Engineers, 1991, p. 175-188. refs
Copyright

The use of adhesively bonded attachments as a way of avoiding problems associated with the use of traditional fasteners, such as bolt and rivets, in composite structures is discussed with particular reference to the fabrication of composite aircraft fuel tanks. Several types of adhesive bonded fasteners and their advantages are described, and the importance of proper surface preparation is emphasized. The discussion also covers general installation procedures for adhesive bonded structures and a comparison between riveted and bonded nutplate installations. V.L.

A92-47416
ADVANCED COMPOSITE COMPONENTS IN AIRLINE SERVICE STATUS AND REPAIR
J. KOSHORST (Airbus Industrie, Blagnac, France) IN: Composites in manufacturing - Case studies. Dearborn, MI, Society of Manufacturing Engineers, 1991, p. 207-217. refs
Copyright

The current status of advanced composite applications in aircraft is discussed using the Airbus A310 as an example. In particular, attention is given to design and fabrication concepts for inner airbrakes, rudder, and leg fairings as well as repair considerations, including damage evaluation and details of several repair solutions. An outline of a repair training program is presented. V.L.

A92-47417
A FIELD REPAIR OF ADVANCED HELICOPTER VERTICAL FIN STRUCTURE
MICHAEL J. HOKE IN: Composites in manufacturing - Case studies. Dearborn, MI, Society of Manufacturing Engineers, 1991, p. 219-227.
Copyright

The actual field repair of a carbon fiber structure in a HH-65A helicopter is described. The discussion covers methods for initial damage assessment, including paint removal and plotting of the damage zone using tap testing visual inspection; removal of the damaged material; the development of a new repair procedure; and verification of the repair integrity. The need for standardizing repair materials and techniques for advanced composite structures is emphasized. V.L.

A92-47592
GERMAN-GUS COOPERATION IN CIVIL AVIATION [KOOPERATION DEUTSCHLAND-GUS IN DER ZIVILEN LUFTFAHRT]
MICHAEL HAUGER Luft- und Raumfahrt (ISSN 0173-6264), vol. 13, no. 3, May-June 1992, p. 16-18, 20, 22, 23. In German.
Copyright

German-Russian cooperation in the development of aircraft technologies is discussed. Emphasis is given to plans for a hydrogen-fueled 'cryoplane' and the MTU-CRISP propfan. The economic costs of these developments are addressed. C.D.

A92-47655
RESEARCH OF ENVIRONMENTAL SPECTRUM FOR AIRCRAFT STRUCTURE
XI-YUAN ZHOU and SHU-KUI YU Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 13, no. 3, March 1992, p. A121-A127. In Chinese. refs

The definition of the environmental spectrum for the verification of aircraft structure is presented together with basic methods for designing the spectrum. The total environments for various climate regions and typical flying regions for aircraft are statistically analyzed, and the observed data, including atmospheric temperature, air humidity, solar radiation, sulfur dioxide content, the seawater salinity, and salt fog, are provided. The use of these results for designing a structural integrity test is described. I.S.

A92-47660
OPTIMAL MAINTENANCE PROGRAM OF DAMAGE TOLERANCE STRUCTURE
ZHE WU (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 13, no. 3, March 1992, p. A163-A169. In Chinese. refs

A method for analyzing a damage tolerance structure and for assessing the structure's reliability is described, and the basic concepts involved are discussed. The possible damage and failure states of the damage tolerance structure are defined, and the loss caused by each state is analyzed. The results are used to develop a series of mathematical models for calculating expected costs and losses in the period of the structure remaining life. An example for optimizing a maintenance program for an aircraft substructure is presented. I.S.

A92-47670
ECONOMIC LIFE ANALYSIS FOR REPLACING COMPONENTS
YOU-PING CHEN and CHUAN-YAO CHEN (Huazhong University of Science and Technology, Wuhan, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 13, no. 3, March 1992, p. A214-A218. In Chinese. refs

An economic life analysis for replaceable components, such as hubs on aircraft wheels, was carried out. It was found that the period for economical maintenance and the limits of this period, T(L) and T(U), can be calculated using a quantitative criterion proposed recently by the authors for the evaluation of maintenance economy. It is shown that the economic life, (Te), of a component may be calculated using the relationship Te = min(T(U)Tc), where Tc is the lifetime of the allowable critical damage, which may be estimated by available methods for fatigue lifetime prediction. I.S.

A92-47757
DAWN OF STEALTH
Lockheed Horizons (ISSN 0459-6773), no. 30, May 1992, p. 4-15.
Copyright

An overview is presented of the early development of the F-117 fighter and the evolution of studies to develop fighter aircraft with significantly reduced radar detectability. One significant breakthrough was the concept of reducing the complex shape of a traditional aircraft to a finite set of 2D surfaces, thus facetting, or creating a 3D aircraft, not out of smooth, gracefully curved surfaces, but out of a collection of flat panels. R.E.P.

A92-47758
THE TONOPAH YEARS
Lockheed Horizons (ISSN 0459-6773), no. 30, May 1992, p. 16-27.
Copyright

An overview is presented of the facilities, security arrangements and flight activities at the Tonopah test range in Nevada during the development of the F-117 stealth fighter. For the first six years, the aircraft operated strictly at night, compressing the intensity of realistic combat scenarios into increasingly demanding training missions. Attention is given to evolution of the training program, introduction of flight simulators and the formation of formal USAF operational squadrons. R.E.P.

A92-47774

INDUSTRIAL PRACTICE IN AERONAUTICAL MAINTENANCE [PRATIQUES INDUSTRIELLES EN MAINTENANCE AERONAUTIQUE]

M. C. LECLERCQ and G. MERET (Air France, Direction du Materiel, Orly) (Societe Francaise des Mecaniciens and FIMTM, Journees sur l'Integrite des Structures, Courbevoie, France, Apr. 18, 19, 1991) Revue Francaise de Mecanique (ISSN 0373-6601), no. 1, 1992, p. 45-47. In French.

Copyright

A review is presented covering industry practices in the area of aircraft maintenance. An example is given showing that a 747 aircraft undergoes 16 hours of maintenance for every hour of flight. Maintenance time is broken down into the various hours spent on light maintenance and heavy maintenance for airframe and engines and other major components. R.E.P.

A92-47821

CIS ENGINES. I - THE RANGE REVEALED

KEN FULTON Air International (ISSN 0306-5634), vol. 43, no. 1, July 1992, p. 34-39.

Copyright

A review is presented of the background and development of current production engines being offered by the aerospace industries of Russia and Ukraine. The restructuring of the various principal engine design bureaus, manufacturing plants, and the aggregate plants producing engine fuel and control system components, and other system devices is described. Current gas turbine and piston engines are listed showing maximum takeoff thrust and aircraft applications. R.E.P.

A92-47971

B-1B EXCELS IN CONVENTIONAL ROLE

WILLIAM B. SCOTT Aviation Week and Space Technology (ISSN 0005-2175), vol. 137, no. 4, July 27, 1992, p. 40-42.

Copyright

A report is presented of an observational flight performed in a USAF B-1B to better understand the operational aspects of the aircraft's new conventional bombing mission as an integral element of a multiaircraft tactical strike package. The basic flight plan consisted of a standard takeoff and climb, cruising to the training area at 22,000 ft, descending for a 400 ft low-level run, making two simulated bomb drops, and climbing back to 25,000 ft for the return to base. Attention is given the new/enhanced avionics, the ALQ-161 defensive electronic warfare system and ripple-release Mk. 82 bombing procedures. R.E.P.

A92-48426

NAECON 91; PROCEEDINGS OF THE IEEE NATIONAL AEROSPACE AND ELECTRONICS CONFERENCE, DAYTON, OH, MAY 20-24, 1991. VOLS. 1-3

Conference sponsored by IEEE. New York, Institute of Electrical and Electronics Engineers, Inc., (ISSN 0547-3578), 1991, p. Vol. 1, 509 p.; vol. 2, 492 p.; vol. 3, 398 p. For individual items see A92-48427 to A92-48576.

(ISBN 0-7803-0084-X) Copyright

Various papers on digital control technology and avionics subsystem and weapon technology are presented. The general topics addressed include: VLSI, components, and packaging; signal processing; data transmission; advanced avionics architecture; optical applications; information control and display; data storage; airborne image processing; airborne radar and fire control; navigation; weapon guidance and interface; Kalman filtering; power generation and control; command, control, and communications. C.D.

A92-48587

TRENDS IN COMMERCIAL AIRCRAFT DESIGN - WHAT EVOLUTION FACTORS AND WHAT APPROACH?

JEAN-PIERRE MAREC (ONERA, Chatillon, France) ONERA, TP no. 1992-25, 1992, 40 p. Translation. Previously cited in issue 09, p. 1304, Accession no. A91-26087.

(ONERA, TP NO. 1992-25)

A92-49049#

FLEXIBLE MANUFACTURING IN REPAIR OF GAS TURBINE ENGINE COMPONENTS

KIRK DE PRITER (U.S. Navy, Naval Engine Airfoil Center, Cherry Point, NC), ANDREW N. VAVRECK, ERIC J. LITTLE, LESLIE D. JOHNSON, and BRETT D. SAYLOR (Pennsylvania State University, State College) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 5 p.

(Contract N00039-88-C-0051)

(AIAA PAPER 92-3524) Copyright

The U.S. Naval Engine Airfoil Center has led in the creation of three flexible manufacturing system (FMS) work-cell components. These workcells accomplish gas turbine blade cleaning, metal removal, welding, coating, brazing, and HIP rejuvenation. These functions are further elaborated by connecting the cells with toolrooms and materials supplies, using automated guided vehicles and an automated storage and retrieval system. The ability of an FMS to rapidly adapt to work part-quantities and repair procedures has proven critically important to the Center's handling of its constantly varying workload, especially in the case of small batch sizes. O.C.

N92-28348# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.

LIFE CYCLE COSTS OF THE C-130 ELECTRICAL POWER SYSTEM UPGRADE M.S. Thesis

THEODORE D. SEYMOUR Sep. 1991 141 p

(AD-A246759; AFIT/GLM/LSQ/91S-57) Avail: CASI HC A07/MF A02

This research investigated the life cycle costs of three alternative electrical power systems for a planned electrical system upgrade to the C-130 transport aircraft. Research identified the contractors as Sundstrand, Westinghouse, and Leland. The literature review included discussions on the C-130, electrical power systems and the proposed alternatives, and the elements of life cycle cost analysis. In the discussion on supportability issues, this research evaluated changes in mission capable rates and the needed fleet size to perform the current mission. In estimating Operating and Support costs, this research used the analogy approach. Analogies were based on expert opinions of Air Force and industry engineers. Sensitivity analysis was then performed on these expert's predictions to help in the formation of conclusions. The system performance of all options netted similar results. However, Alternative 3 had the lowest total life cycle costs, making it the most cost effective option. This research concluded the Leland proposal to be the best choice and recommends implementation of the proposal. GRA

N92-28522# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Mechanics Panel.

PILOTED SIMULATION EFFECTIVENESS [L'EFFICACITE DE LA SIMULATION PILOTEE]

Feb. 1992 349 p In ENGLISH and FRENCH Symposium held in Brussels, Belgium, 14-17 Oct. 1991

(AGARD-CP-513; ISBN-92-835-0656-1; AD-A253007) Copyright Avail: CASI HC A15/MF A03

The ability of piloted simulators to represent military and civil aviation operational tasks with ever increasing levels of fidelity is leading to a steady growth in their use for all areas of aviation from new concept studies, through support for development and flight clearance, to training aircrews for complex missions. The papers here present a variety of experience of the effectiveness of simulation for many of the key areas of application. This session focuses on: the use of simulation in aircraft development programs; the use of simulation in developing piloting skills; the use and potential of simulation in full mission training for military roles; and the effectiveness of simulation for a variety of research tasks.

N92-29874# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Helicopter Div.
REPAIR PROCEDURES FOR ADVANCED COMPOSITES FOR HELICOPTERS
HERMANN ESCHBAUMER 1991 25 p Presented at the 17th European Rotorcraft Forum, Berlin, Fed. Republic of Germany, 24-26 Sep. 1991
(MBB-UD-0606-91-PUB; ETN-92-91696) Avail: CASI HC A03/MF A01

Standard repair procedures and the various solutions determined for structural repairs are discussed. Repairs on load introduction areas and extensive damages were rated to require specific repairs and therefore assistance of stress design. Specific repairs are not discussed. Standard repairs applicable for primary and secondary structures are referred to. The differences between 'in house repairs', 'depot and on aircraft repairs', and 'field repairs' are clarified. Suitable nondestructive test techniques for nonstationary inspection are considered and aspects to transfer the required standard repair procedures to maintenance personnel are discussed. ESA

N92-30122*# Northwest Airlines, Inc., Minneapolis, MN.
CURRENT AND FUTURE DEVELOPMENTS IN CIVIL AIRCRAFT NON-DESTRUCTIVE EVALUATION FROM AN OPERATOR'S POINT OF VIEW
JEFF REGISTER *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 279-282 Jul. 1992
Avail: CASI HC A01/MF A04

In June, 1988, the first International Conference on aging aircraft was held to address nondestructive tests (NDT) of aging aircraft and other issues. From this meeting, a research program was initiated and funded by the FAA. As a result of this program, a lot of work has been done to study current NDT practices in the aviation industry and secondly, to research and develop new NDT methods to improve the reliability and efficiency of in-service inspection of aircraft structures and powerplants. The following is an overview of the current and future developments in civil aircraft NDT, as viewed by an air carrier and the concerns for NDT in the future. Author

N92-30232# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Hubschrauber und Flugzeuge.
ACQUISITION OF AN AEROTHERMODYNAMIC DATA BASE BY MEANS OF A WINGED EXPERIMENTAL REENTRY VEHICLE
E. H. HIRSCHEL, H. GRALLERT, J. LAFON, and M. RAPUC 19 Aug. 1991 40 p Sponsored in part by ESA
(MBB/FE202/S/PUB/461; ETN-92-91903) Copyright Avail: CASI HC A03/MF A01

A winged aerothermodynamic experimental reentry vehicle is proposed in order to verify and validate the methods of numerical aerothermodynamics as design tool additional to the classical tools, i.e., the wind tunnel. Experimental hypersonic vehicles are reviewed and the aerothermodynamic characteristic of reentry vehicles and the ground simulation problems are considered. The possible configuration and trajectory of a winged experimental vehicle are discussed, together with the required and possible measurements, and the data management and recovery. Use of the obtained data base in the establishment of the methods of numerical aerothermodynamics as additional design tool is outlined. ESA

02

AERODYNAMICS

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

A92-45263* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HIGH-REYNOLDS-NUMBER TEST REQUIREMENTS IN LOW-SPEED AERODYNAMICS
D. M. BUSHNELL and G. C. GREENE (NASA, Langley Research Center, Hampton, VA) IN: High Reynolds number flows using liquid and gaseous helium. New York, Springer-Verlag, 1991, p. 79-85. refs
Copyright

Research requirements to an ultra-high-Reynolds-number liquid helium facility are reviewed. Aerodynamic research areas under consideration include wave vortex hazard reduction, vortex control and diagnostics for maneuvering fighter aircraft, and performance of high-lift devices. O.G.

A92-45318
PREDICTION AND MEASUREMENT OF JET FLOWFIELD FEATURES FOR ASTOVL AIRCRAFT
J. MCGUIRK, G. J. PAGE, N. SAKELLARIOU (Imperial College of Science, Technology, and Medicine, London, England), J. E. FLITCROFT, W. ABBOTT, D. R. WHITE (Royal Aerospace Establishment, Pyestock, England), and P. TATTERSALL (Royal Aerospace Establishment, Farnborough, England) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. III.6.1-III.6.9. Research supported by Ministry of Defence Procurement Executive. refs
Copyright

Results from a program of experimental and theoretical research on ASTOVL jet flows are presented. The experimental investigations explore how the supersonic exhaust jet velocities on ASTOVL aircraft affect features of the jet flowfield during landing. The implications for the viability of modeling techniques used to assess the severity of hot-gas ingestion behavior are examined. Flowfield measurements are presented for the ground plane and interjet fountain produced by twin impinging jets, at nozzle pressure ratios up to 4:1. Inlet temperature rise characteristics observed using a two-poster simplified aircraft configuration model, operating with jet conditions up to full ASTOVL powerplant pressures and temperatures, are also discussed. Progress with the development of a transonic flow version is described and demonstrated by comparisons with measurements from the experimental work. C.A.B.

A92-45324
THE EXPERIMENTAL AND COMPUTATIONAL STUDY OF JET IMPINGEMENT FLOWFIELDS WITH REFERENCE TO VSTOL AIRCRAFT PERFORMANCE
A. G. SMITH (S & C Thermofluids, Ltd., Kelston, England), D. N. ING, and P. J. BAILEY (Logico Systems, Ltd., East Horsley, England) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. III.13.1-III.13.15. refs
Copyright

Jet flowfields generated by ASTOVL aircraft in ground effect have been studied experimentally and computationally. The general aspects of single-, twin- and three-jet impingement are described via experimental information obtained using laser sheet and schlieren photography as well as ground and underfuselage surface pressure measurements. The implications for ASTOVL aircraft performance are discussed. The results obtained by the use of two general purpose computational fluid dynamic packages for the prediction of such flowfields are presented and the design capability explored. Author

A92-45385

SPACEPLANE LONGITUDINAL AERODYNAMIC PARAMETER ESTIMATION BY CABLE-MOUNT DYNAMIC WIND-TUNNEL TEST

SHUICHI SASA, MINORU TAKIZAWA, TAKASHI SHIMOMURA, and OSAMU NONAKA (National Aerospace Laboratory, Chofu, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 141-149. refs
(SAE PAPER 911980) Copyright

Cable-mount dynamic wind-tunnel tests were conducted in a low-speed wind tunnel for the purpose of extracting aerodynamic parameters of a 5 percent spaceplane model. The cable-mount dynamic wind-tunnel experiment is described. An identification technique composed of flight path reconstruction and regression analysis and the maximum likelihood method for the identification of the parameters in the linear dynamic system were applied to the wind-tunnel test data. The estimation results for the aerodynamic parameters obtained by the two methods are compared. Author

A92-45386

EXPERIMENTAL STUDIES ON AERODYNAMIC CHARACTERISTICS OF SSTO VEHICLE AT LOW SUBSONIC SPEEDS

YOSHITO MIYAMOTO, TOSHIMI FUJITA, AKIHITO IWASAKI, and HIROTOSHI FUJIEDA (National Aerospace Laboratory, Chofu, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 151-158.
(SAE PAPER 911981) Copyright

For a fully reusable space transportation system of an SSTO of the horizontal takeoff and landing type, experimental studies on low-speed aerodynamic characteristics have been done. Wind tunnel tests were conducted using NAL's gust wind tunnel. Six-component force and moment data were obtained over an angle of attack range from -14 to 44 deg. In this paper, aerodynamic tests results are presented for the low-speed aerodynamics of a generic SSTO configuration. Author

A92-45390* National Aeronautics and Space Administration, Washington, DC.

COMPUTATIONAL AERODYNAMICS - THE NEXT GENERATION

KRISTIN A. HESSENIUS and PAMELA F. RICHARDSON (NASA, Aerodynamics Div., Washington, DC) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 201-215. refs
(SAE PAPER 911988) Copyright

Continued advances in the various elements that comprise the field of computational fluid dynamics (CFD) are promoting a radically different approach to the aerodynamic design and analysis of aerospace vehicles and systems. The elements of CFD generally include numerical algorithm development, transition and turbulence modeling, surface modeling, and grid generation, scientific visualization and validation methodologies. This paper discusses the research progress and prospects for the future in each of these elements within NASA's CFD and Experimental Validation Program. The applicability of computational methods for the purposes of understanding complex flow phenomena, exploring aerodynamic concepts, and providing vehicle-design input is also addressed. Author

A92-45391

THE IMPACT OF CFD ON THE AIRPLANE DESIGN PROCESS - TODAY AND TOMORROW

RONALD L. BENGELINK and PAUL E. RUBBERT (Boeing Commercial Airplane Group, Seattle, WA) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 217-226. refs
(SAE PAPER 911989) Copyright

CFD codes that play a central role in aircraft design are discussed. Requirements and limitations of CFD for high speed airfoil and wing design, landing and takeoff with flaps deployed, and stability and control are addressed. The importance of timely and accurate design is stressed. C.D.

A92-45392

COMPUTATIONAL AERODYNAMICS IN AIRCRAFT DESIGN - CHALLENGES AND OPPORTUNITIES FOR EULER/NAVIER-STOKES METHODS

P. RAJ (Lockheed Aeronautical Systems Co., Burbank, CA) and S. W. SINGER (Lockheed Advanced Development Co., Sunland, CA) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 227-239. Research supported by Lockheed Corp. refs
(SAE PAPER 911990) Copyright

Present capabilities and limitations of the Euler/Navier-Stokes methods are examined to help identify the areas of opportunities and challenges that lie ahead. Solutions obtained using a state-of-the-art 3D Euler/Navier-Stokes Method (TEAM) are presented for four test cases ranging from an airfoil to the complete advanced tactical fighter prototype configuration. Four levels of CFD codes for estimating aerodynamic characteristics of aircraft configurations are discussed. The higher-level CFD methods, which cover a large region of a design space characterized by speed and angle of attack, are found to provide more accurate aerodynamic data over a wider range of flight conditions than the lower-level methods. The challenge lies in enhancing the effectiveness of the Euler/Navier-Stokes methods to be comparable to that of the potential-flow methods. C.A.B.

A92-45393

NUMERICAL SIMULATIONS OF SEPARATED FLOWS AROUND OSCILLATING AIRFOIL FOR DYNAMIC STALL PHENOMENA

SHIGERU ASO, ATSUHIRO SAKAMOTO (Kyushu University, Fukuoka, Japan), and MASANORI HAYASHI (Nishinippon Institute of Technology, Fukuoka, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 241-248. refs
(SAE PAPER 911991) Copyright

A92-45394

COMPUTATIONAL FLUID DYNAMICS APPLICATIONS IN AIRPLANE CABIN VENTILATION SYSTEM DESIGN

FRED ABOOSAIDI, MATTHEW J. WARFIELD (Boeing Co., Seattle, WA), and DIPANKAR CHOUDHURY (Creare, Inc., Hanover, NH) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 249-258. refs
(SAE PAPER 911992) Copyright

Two three-dimensional cabin airflow configurations have been the subject of experimental and analytical testing to establish the validity and role of computational fluid dynamics (CFD) tools in the design of cabin airflow distribution systems. The CFD tools considered here are two separate Navier-Stokes computer codes which have been used for a number of applications, including those in the present study. A correlative study of a detailed air supply nozzle configuration has been examined to further understand its flow characteristics and to establish a procedure for examining cases with large scale differences. The comparison of experimental results with the numerical simulations in the two cases is generally quite good, leading to an increased confidence in the application of CFD methods within the cabin airflow distribution system design arena. Author

A92-45395
WIND TUNNEL INVESTIGATION OF AN IMPROVED UPPER SURFACE BLOWN FLAP TRANSPORT SEMI-SPAN MODEL
HITOSHI TAKAHASHI, MASAHIRO OKUYAMA, HIROTOSHI FUJIEDA, TOSHIMI FUJITA, and AKIHITO IWASAKI (National Aerospace Laboratory, Chofu, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 259-267. refs
(SAE PAPER 911993) Copyright
This paper describes the investigations which have been conducted to improve the aerodynamic characteristics of a subsonic jet transport semi-span model with an Upper Surface Blowing Flap system which has been newly designed using the NAL STOL CAD program. The tests were conducted in the NAL 2 by 2 meter Gust Wind Tunnel and results were obtained for several flap and slat deflections at engine thrust coefficents from 0 to 1.85. Author

A92-45401
RESPONSE CHARACTERISTICS OF A WING IN SUPERSONIC FLOW NEAR FLUTTER BOUNDARY
HIROSHI TORII (Meijo University, Nagoya, Japan) and YUJI MATSUZAKI (Nagoya University, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 309-314. refs
(SAE PAPER 911999) Copyright
The subcritical flutter characteristics of wings in a supersonic flow are examined. Especially the scattering property of the criterion parameters which are used in order to estimate a flutter boundary, is studied. The wing response due to the flow turbulence is expressed by the autoregressive moving-average process through Akaike's estimation procedure. The wing stability is evaluated by applying the Jury's stability determinant method for a discrete system to the estimated time series model. The flutter boundary is predicted by plotting the Jury's stability criterion parameter at several dynamic pressures in the subcritical range. As the dynamic pressure approaches to the flutter boundary, the estimated stability parameter and its scattering monotonically decreases while the damping, the conventional flutter estimation criterion, scattered so much near the flutter boundary. Author

A92-45404
RECENT APPLICATIONS OF THE FNS ZONAL METHOD TO COMPLEX FLOW PROBLEMS
KOZO FUJII and YOSHIAKI TAMURA (Institute of Space and Astronautical Science, Sagamihara, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 341-350. refs
(SAE PAPER 912003) Copyright
A newly developed zonal technique utilizing the interface scheme based on the Fortified Navier-Stokes concept is applied to steady and unsteady flow problems. Two computational results are given as application cases to unsteady flow problems. The results show that this technique alleviates the difficulty of the simulation of complex flow configuration. It is shown that several types of zonal approach including overlaid, overlapped, and multiblock methods are treated in the same manner under this concept, and that the present zonal method can make a conventional program be an effective CFD tool for the analysis of complex flow configuration. R.E.P.

A92-45405
FREE WAKE ANALYSES OF A HOVERING ROTOR USING PANEL METHOD
GIZO HASEGAWA, HIROYUKI NAKAGAWA, TAKASHI SATO, and TOMOARI NAGASHIMA (National Defense Academy, Yokosuka, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 351-364. refs
(SAE PAPER 912004) Copyright
Employing a higher order vortex panel technique, 3D wake analyses are conducted for a rotor in hover. New methods are proposed to incorporate wake deformations due to wake-ground interactions into performance predictions. Numerical results of wake geometries for rotors at close proximity and isolated to inclined ground surface are presented and advantages of the proposed method are discussed. R.E.P.

A92-45408
AN ECONOMIC APPROACH TO ACCURATE WING DESIGN
TUNCER CEBECI and JOHN E. KING (California State University, Long Beach) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 383-392. refs
(SAE PAPER 912008) Copyright
An interactive boundary-layer method is described for computing three-dimensional transonic flows on wing/body configurations. The method combines Euler solutions with viscous flow solutions obtained from an inverse boundary-layer method with an interaction law based on the extension of the Hilbert integral formulation used for two-dimensional flows. Depending on the complexity of the flowfield, two versions of teller's box scheme are used, the regular box scheme in regions of positive crossflow and no separation, and the characteristic box scheme in regions of negative crossflow and flow separation. Preliminary calculations performed for a modern transport wing show good agreement with experimental data and indicate that wing/body configurations in transonic flows can be analyzed with good accuracy with this method at substantial savings of computer time. Author

A92-45409
FLOW FIELD AROUND THICK DELTA WING WITH ROUNDED LEADING EDGE
YOSHIJI NAKAJIMA, YOSHIYUKI NAKAO, YOSHIAKI NAKAMURA, and MICHIRU YASUHARA (Nagoya University, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 393-404. refs
(SAE PAPER 912009) Copyright
A thick delta wing with a rounded leading edge has been experimentally studied. To understand the basic flowfield of such a wing, experiments have been conducted in the low-speed wind tunnel at Nagoya University. Three types of flow visualization: oil flow, smoke wire, and tuft methods are employed, and forces: lift and drag, and pressure distributions were also obtained. The same test has been conducted for a thin delta wing for comparison. The results show the different flowfield of the thick delta wing from those commonly known for delta wings. However, in other properties except for the flow pattern, similarities were observed between the thick delta wing and thin delta wing. Author

A92-45412
NUMERICAL SIMULATION OF A SUPERSONIC JET IMPINGEMENT ON A GROUND
NOBUYUKI TSUBOI, A. K. HAYASHI, TOSHI FUJIWARA (Nagoya University, Japan), KAZUO ARASHI (Churyo Engineering Co., Ltd., Aerodynamics Research Dept., Nagoya, Japan), and MASARU KODAMA (Mitsubishi Heavy Industries, Ltd., Nagoya Aircraft Works, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 421-433. refs
(SAE PAPER 912014) Copyright
The impingement on the ground of underexpanded uniform and nonuniform axisymmetric supersonic jets at atmospheric conditions is simulated numerically using 2D and cylindrically symmetric Euler equations for a perpendicular ground and 3D Euler equations for ground inclined from 0 to 45 deg. The numerical results are compared with those of an experimental study of

underexpanded axisymmetric supersonic N2 jets impinging on a ground which inclines from 0 to 45 deg. The results of experiments showed that the maximum pressure on the inclined ground is larger than that on the perpendicular ground due to the possibility of high pressure recoveries through multiple shock systems. I.S.

A92-45413

AERODYNAMIC CHARACTERISTICS NEAR THE TIP OF A FINITE WING BY A PANEL METHOD

JANGSOO CHOI and YOSHIYUKI SUGIYAMA (Nagoya University, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 435-443. refs

(SAE PAPER 912020) Copyright

The aerodynamic characteristics around a wing tip are investigated with a first order panel method. The geometry chosen for the study is a rectangular wing of aspect ratio 8.43, with RAF6 airfoil of 10 percent thickness ratio. The panel method gives similar aerodynamic characteristics to experimental ones even near the tip, such as a dominant suction pressure distribution present near the trailing edge around the tip, and the increase in the local lift and drag at the very narrow region of the tip. These properties are caused by the strong spanwise velocity component around the wing tip, the inviscid effects of which are described in detail, with respect to pressure coefficient, local lift and drag coefficients, downwash, and vorticity on the wing. Author

A92-45414

AERO-STRUCTURAL INTEGRATED DESIGN OF FORWARD SWEPT WING

JUNICHI MIYAKAWA (Mitsubishi Heavy Industries, Ltd., Tokyo, Japan), TAKESHI OHNUKI, and NOBUHIKO KAMIYA (National Aerospace Laboratory, Chofu, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 445-450. refs

(SAE PAPER 912021) Copyright

Forward swept wing (FSW) is known to have excellent performance relative to aft swept wing. The practical application, however, has been limited due to its structural divergence characteristics. The current progress in materials, especially anisotropic composites has opened up a new future for FSW. This paper describes a design study of FSW for transonic transport looking for high drag divergence performance. Inverse code is applied to FSW aerodynamic design to achieve an isobar design concept. The performance is verified by transonic wind tunnel test. The paper also mentions the development of aero-structural integrated design tool, a combination of aerodynamic analysis code and structural analysis code, which is essential to FSW wing development. Author

A92-45417

EXPERIMENTAL AND NUMERICAL STUDIES OF RADIATION EMISSION FROM HIGH-TEMPERATURE AIR BEHIND 10 KM/S SHOCK WAVES

HIROKI HONMA (Chiba University, Japan) and HIROYUKI IIZUKA (Mitsubishi Atomic Power Industries, Inc., Tokyo, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 471-482. refs

(Contract MOESC-61420021; MOESC-63302022; MOESC-02252105; MOESC-03238105)

(SAE PAPER 912025) Copyright

In order to estimate the exact heat transfer from shock-heated air to the reentering space vehicles, accurate understanding if its radiative characteristics is needed. The 10 km/s shock waves are produced by a free-piston, double-diaphragm shock tube, and the total and spectral-resolved radiation intensities of the shocked air are observed by using an image converter camera and a pair of photomultipliers. The numerical analysis is carried out for 1D steady hypersonic flows with nonequilibrium chemical reactions of hot air, including the evaluation of radiation intensity. The double-peak characteristic of radiation intensity for the shock waves above 10 km/s and the time-lag of radiation peak for different wave length are experimentally observed and qualitatively reproduced in numerical simulation. Author

A92-45418

MULTIDIMENSIONAL EULER/NAVIER-STOKES ANALYSIS FOR HYPERSONIC EQUILIBRIUM GAS

TAKUJI KISHIMOTO (Kawasaki Heavy Industries, Ltd., Gifu Technical Institute, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 483-490. Research supported by NASDA. refs

(SAE PAPER 912026) Copyright

Numerical simulations of hypersonic flow around a 2D cylinder and a 3D complete reentry vehicle have been carried out by solving Euler/Navier-Stokes equations which incorporate the equation of state for an equilibrium gas. The governing equations are solved by an implicit finite volume total variation diminishing upwind scheme using a two-equation turbulence model for a viscous flow. Curve-fits for the thermodynamic and transport properties of an equilibrium air are adopted in order to estimate real gas effects. Convective fluxes are calculated by the Roe's approximate Riemann solver generalized for an equilibrium gas. The results of hypersonic flow analysis using this code suggest that the real gas effects, such as chemical reaction, are not negligible to predict the hypersonic flow characteristics accurately. Author

A92-45419

A CALCULATION OF PENETRATION OF THE JET ISSUING NORMALLY INTO A CROSS FLOW ACROSS A WALL BOUNDARY LAYER

YOSHIYUKI SUGIYAMA (Nagoya University, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 491-500. refs

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An increase in jet penetration due to the wall boundary layer is determined in the flow field, including an aerodynamic interference between the wall boundary layer and the jet. The aerodynamic effect of the wall boundary layer is replaced by that of a secondary vortex filament resulting from vorticity in the wall boundary layer. A differential equation governing the increase in jet penetration is derived using the circulation around the secondary vortex filaments, its induced velocity, and the empirical decay law of the jet axial velocity along the jet centerline. A numerical example of the present analysis shows good agreement with the experiment. This indicates that the vortex flow model used simulates the real flow conditions. Author

A92-45427

SHOCK INTERACTION INDUCED BY TWO HEMISPHERE-CYLINDERS

TETSUYA NAGASHIMA, YOSHIAKI NAKAMURA, MICHIRU YASUHARA, and KIYOSHI TSUBOI (Nagoya University, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 581-589. refs

(SAE PAPER 912043) Copyright

A type IV interaction caused by a shock generated by a large hemisphere cylinder impinging on a blunt body was measured. The stagnation pressure coefficient increased by more than 5.0, or 2.8 times larger than without the interaction. The pressure decrease on the side opposite the shock was more rapid than on the impinging side. The detailed pattern of the interaction was studied using 2D numerical simulations. The results showed that the supersonic jet impinges on the subsonic region and that compression and expansion waves formed. The pressure and heat

transfer distribution along the body surface were eight and four times as large, respectively, as those without the interaction.
C.D.

A92-45428
AERODYNAMIC HEATING IN THREE-DIMENSIONAL SHOCK WAVE TURBULENT BOUNDARY LAYER INTERACTION INDUCED BY SWEPTBACK SHARP FINS IN HYPERSONIC FLOWS
SHIGERU ASO, SHOUZO MAEKAWA (Kyushu University, Fukuoka, Japan), and MASANORI HAYASHI (Nishinippon Institute of Technology, Fukuoka, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 591-598. refs
(SAE PAPER 912044) Copyright
For the fundamental study of aerodynamic heating of winged vehicle and space planes in hypersonic flow, the detailed structure of 3D shock wave/turbulent boundary layer interaction region induced by swept-back sharp fins is investigated by oil flow technique and pressure distribution. The major objectives were to study the effects of the shape of the leading edge of the fin to the flow fields on the body and to study the effects of the sweep angle of the leading edge of the fin to the interaction region. Also, aerodynamic heating phenomena in the flow fields are investigated by using a new technique. For the measurements, a new method of measuring heat flux is used. The new method is based on a new type of thin-film heat transfer gauge with high spatial resolution and fast response. The results suggest the effects of the shape of the leading edge to the flow fields are quite significant and the sweep of the leading edge of the fin to freestream is quite important to reduce the interaction region.
Author

A92-45429
NUMERICAL SIMULATIONS OF HYPERSONIC REAL-GAS FLOWS OVER SPACE VEHICLES
MASAHIRO NAKAO (Mitsubishi Heavy Industries, Ltd., Tokyo, Japan) and KOZO FUJII (Institute of Space and Astronautical Science, Sagamihara, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 599-606. refs
(SAE PAPER 912045) Copyright
Hypersonic flows over simple 3D bodies and a space vehicle are simulated using a real-gas Navier-Stokes code under an equilibrium air assumption. This code is based on 3D upwind flux splitting scheme with generalized Roe's Riemann solver. The real-gas effect is incorporated using the VEG (Variable Equivalent Gamma) method. The equivalent gamma and other thermodynamic properties are calculated using empirical curve fits. Author

A92-45443
OSCILLATION OF OBLIQUE SHOCK WAVES GENERATED IN A TWO DIMENSIONAL ASYMMETRIC NOZZLE
FUMIO HIGASHINO, SHIGERU MATSUO (Tokyo Noko University, Koganei, Japan), and TARO TSUYUKI (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 749-757. Research supported by MOESC. refs
(SAE PAPER 912061) Copyright
The development and the oscillation phenomena of pseudoshock waves in a 2D asymmetric nozzle are investigated experimentally. A shock tube was used to generate supersonic flows in nozzles which consisted of both short and long walls diverging in the flow direction. The oscillation frequencies were determined from pressure measurements by means of a piezo-pressure transducer fixed at different loci. It was found that an oblique shock wave appeared near the turning corner of the diverging section owing to a separation vortex, and then it developed into a pseudoshock wave. The supersonic flow that issued from the duct was not significantly expanded in the flow direction and behaved like an underexpanded jet which was deflected toward the shorter wall of the nozzle. The oscillation frequency was not affected by the initial pressure. When the initial pressure decreased, the oscillation amplitude increased. C.A.B.

A92-45445
NUMERICAL ANALYSIS OF RCS JET IN HYPERSONIC FLIGHTS
YUMIKO INOUE, A. K. HAYASHI, TOSHI FUJIWARA (Nagoya University, Japan), SHO MIYAKE, and TADASHI KATSURAHARA (Mitsubishi Heavy Industries, Ltd., Nagoya Aircraft Works, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 767-774. refs
(SAE PAPER 912063) Copyright
A transversely injected jet into a hypersonic flow is simulated numerically in order to study the flow field of the injection jet in the hypersonic atmosphere, its heat flux on the body surface, and the moments working on the body. The flow field is governed by the 2D Reynolds-averaged full Navier-Stokes equations with an algebraic eddy viscosity model developed by Baldwin-Lomax. The governing equations are solved using the Harten-Yee type TVD and central difference schemes for the convex and viscous terms, respectively. The real gas effect is considered in the numerical analysis. The jets injected across the main flow of Mach 10 and 15 are compared.
Author

A92-45476
AIAA APPLIED AERODYNAMICS CONFERENCE, 10TH, PALO ALTO, CA, JUNE 22-24, 1992, TECHNICAL PAPERS. PTS. 1 & 2
Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. Pt. 1, 520 p.; pt. 2, 533 p. For individual items see A92-45477 to A92-45569.
Copyright
Consideration is given to vortex physics and aerodynamics; supersonic/hypersonic aerodynamics; STOL/VSTOL/rotors; missile and reentry vehicle aerodynamics; CFD as applied to aircraft; unsteady aerodynamics; supersonic/hypersonic aerodynamics; low-speed/high-lift aerodynamics; airfoil/wing aerodynamics; measurement techniques; CFD-solvers/unstructured grid; airfoil/drag prediction; high angle-of-attack aerodynamics; and CFD grid methods. Particular attention is given to transonic-numerical investigation into high-angle-of-attack leading-edge vortex flow, prediction of rotor unsteady airloads using vortex filament theory, rapid synthesis for evaluating the missile maneuverability parameters, transonic calculations of wing/bodies with deflected control surfaces; the static and dynamic flow field development about a porous suction surface wing; the aircraft spoiler effects under wind shear; multipoint inverse design of an infinite cascade of airfoils, turbulence modeling for impinging jet flows; numerical investigation of tail buffet on the F-18 aircraft; the surface grid generation in a parameter space; and the flip flop nozzle extended to supersonic flows. O.G.

A92-45477#
NUMERICAL INVESTIGATION INTO HIGH-ANGLE-OF-ATTACK LEADING-EDGE VORTEX FLOW
J. I. VAN DEN BERG, H. W. M. HOEIJMAKERS, and H. A. SYTSMA (National Aerospace Laboratory, Amsterdam, Netherlands) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1-11. Research supported by Netherlands Agency for Aerospace Programs. refs
(AIAA PAPER 92-2600) Copyright
An Euler method is applied to the steady subsonic leading-edge vortex flow about a 65-deg sharp-edged cropped delta wing at incidences close to the incidence at which vortex breakdown is observed in wind tunnel experiments. Above a critical value of the incidence the pseudotime dependent numerical procedure fails to attain a steady-stage solution. The occurrence of this 'solution

breakdown' indicates the limits of the domain of applicability of the steady-flow Euler method for the case of subsonic leading-edge vortex flow. Analysis of the converged solution at incidences just below the critical value reveals that above the aft part of the wind the velocity and vorticity distribution within the vortex core undergoes a remarkable change. Author

A92-45478*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

CRITICAL EFFECTS OF DOWNSTREAM BOUNDARY CONDITIONS ON VORTEX BREAKDOWN

OSAMA KANDIL, HAMDY A. KANDIL (Old Dominion University, Norfolk, VA), and C. H. LIU (NASA, Langley Research Center, Hampton, VA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 12-26. refs
(Contract NAG1-994)
(AIAA PAPER 92-2601) Copyright

The unsteady, compressible, full Navier-Stokes (NS) equations are used to study the critical effects of the downstream boundary conditions on the supersonic vortex breakdown. The present study is applied to two supersonic vortex breakdown cases. In the first case, quasi-axisymmetric supersonic swirling flow is considered in a configured circular duct, and in the second case, quasi-axisymmetric supersonic swirling jet, that is issued from a nozzle into a supersonic jet of lower Mach number, is considered. For the configured duct flow, four different types of downstream boundary conditions are used, and for the swirling jet flow from the nozzle, two types of downstream boundary conditions are used. The solutions are time accurate which are obtained using an implicit, upwind, flux-difference splitting, finite-volume scheme. Author

A92-45479*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EFFECT OF CANARD DEFLECTION ON CLOSE-COUPLED CANARD-WING-BODY AERODYNAMICS

EUGENE L. TU (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 27-40. refs
(AIAA PAPER 92-2602) Copyright

The thin-layer Navier-Stokes equations are solved for the flow about a canard-wing-body configuration at transonic Mach numbers of 0.85 and 0.90, angles of attack from -4 to 10 degrees and canard deflection angles from -10 to +10 degrees. Effects of canard deflection on aerodynamic performance, including canard-wing vortex interaction, are investigated. Comparisons with experimental measurements of surface pressures, lift, drag and pitching moments are made to verify the accuracy of the computations. The results of the study show that the deflected canard downwash not only influences the formation of the wing leading-edge vortex, but can cause the formation of an unfavorable vortex on the wing lower surface as well. Author

A92-45480*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

THE EFFECTS OF NOZZLE EXIT GEOMETRY ON FOREBODY VORTEX CONTROL USING BLOWING

NATHAN M. GITTNER and NDAONA CHOKANI (North Carolina State University, Raleigh) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 41-51. refs
(Contract NCC1-46)
(AIAA PAPER 92-2603) Copyright

An experimental study has been undertaken to examine the influence of the blowing jet geometry on the effectiveness of the aft blowing technique for forebody vortex control. The experiments were conducted with a 3.0 tangent caliber ogive model at subsonic, laminar flow conditions. Asymmetric aft blowing was accomplished using both a single nozzle and a double nozzle configuration. Detailed surface pressure measurements on the model were obtained. The experimental results show that the height and the width of the blowing jet are important parameters that determine the effectiveness of aft blowing; a broad, lowly positioned blowing jet is found to be most effective for the forebody vortex control technique using aft blowing. Author

A92-45482*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

NUMERICAL SIMULATION OF AEROTHERMAL LOADS IN HYPERSONIC ENGINE INLETS DUE TO SHOCK IMPINGEMENT

R. RAMAKRISHNAN (Analytical Services and Materials, Inc., Hampton, VA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 61-71. Research supported by NASA. refs
(AIAA PAPER 92-2605)

The effect of shock impingement on an axial corner simulating the inlet of a hypersonic vehicle engine is modeled using a finite-difference procedure. A three-dimensional dynamic grid adaptation procedure is utilized to move the grids to regions with strong flow gradients. The adaptation procedure uses a grid relocation stencil that is valid at both the interior and boundary points of the finite-difference grid. A linear combination of spatial derivatives of specific flow variables, calculated with finite-element interpolation functions, are used as adaptation measures. This computational procedure is used to study laminar and turbulent Mach 6 flows in the axial corner. The description of flow physics and qualitative measures of heat transfer distributions on cowl and strut surfaces obtained from the analysis are compared with experimental observations. Conclusions are drawn regarding the capability of the numerical scheme for enhanced modeling of high-speed compressible flows. Author

A92-45483#

NAVIER-STOKES AND EULER SOLUTIONS FOR AN UNMANNED AERIAL VEHICLE

BRIAN E. WAKE (United Technologies Research Center, East Hartford, CT), STEPHEN J. OWEN (Sikorsky Aircraft, Stratford, CT), and T. A. EGOLF (United Technologies Research Center, East Hartford, CT) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 72-84. refs
(AIAA PAPER 92-2609) Copyright

Navier-Stokes and Euler solutions have been computed for an unmanned aerial vehicle (UAV). The unmanned aerial vehicle in this study, the Cypher under development by Sikorsky Aircraft, has an unique geometry which consists of propulsive co-axial rotors surrounded by a bluff-body shroud. The flow about this aircraft is highly three-dimensional and demonstrates strong viscous effects. Body forces were used in the flow solver to account for the presence of the rotors. Viscous and inviscid results are presented and compared with experimental data. The need for a Navier-Stokes solver for adequate flow and airloads prediction is demonstated. Calculations are compared with data for several flight conditions, and two different shroud geometries. Considering the present modeling assumptions, the correlation with experimental data is good. Author

A92-45484#

PREDICTION OF ROTOR UNSTEADY AIRLOADS USING VORTEX FILAMENT THEORY

KYUNG M. YOO (Korea Institute of Aeronautical Technology, Seoul, Republic of Korea) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 85-99. refs
(AIAA PAPER 92-2610) Copyright

A procedure using three-dimensional lifting surface method based on vortex filament theory is developed for the prediction of unsteady airloads of multibladed rotors undergoing disturbed dynamic motions. Interblade wake effects due to vortex-phasing phenomena below the rotor blades moving in different phases of motion are numerically simulated by phase control of wake vortices' time-varying memory of each blade. The results show that the amount of lift loss is directly related to the coalescence of unsteady wake below the rotor blades. This abrupt lift loss due to unsteady wake alignment is well predicted by two-dimensional Loewy's lift deficiency function or Peters' finite-state inflow model. However, the present procedure using vortex filament theory, wherein the time-dependent interblade wake vortices are designed to travel along in the prescribed wake geometry, is an improvement over the two-dimensional unsteady rotor aerodynamic theory or the mathematical treatment of wake effect in finite-state model since the present method provides the spanwise distribution of the perturbed airloads as well as the timewise variation in a realistic manner. Author

A92-45485*# National Aeronautics and Space Administration. *Ames Research Center, Moffett Field, CA.*

HIGH SPEED AERODYNAMICS OF UPPER SURFACE BLOWING AIRCRAFT CONFIGURATIONS

LARRY D. BIRCKELBAW (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 100-116. refs

(AIAA PAPER 92-2611) Copyright

An experimental investigation of the high speed aerodynamics of Upper Surface Blowing (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 was used which permitted parametric variations in the number and spanwise location of the nacelles and was powered with two turbofan engine simulators. The tests conducted in the Ames 14 Foot Transonic Wind Tunnel examined 10 different configurations at Mach numbers from 0.5 to 0.775, fan nozzle pressure ratios from 1.1 to 2.1 and angles of attack from -4 to 6 degrees. Measured force data is presented which indicates the cruise drag penalty associated with each configuration and surface pressure contour plots are used to illustrate the underlying flowfield physics. It was found that all of the tested configurations suffered from a severe drag penalty which increased with freestream Mach number, power setting and angle of attack and was associated with the presence of strong shocks and regions of separated flow in the wing/nacelle junction regions. Author

A92-45487#

AN IMPROVED APPROACH FOR THE COMPUTATION OF TRANSONIC/SUPERSONIC FLOWS WITH APPLICATIONS TO AEROSPACE CONFIGURATIONS

RANJIT COLLERCANDY (ONERA, Chatillon, France) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 125-140. Research supported by CNES. refs

(AIAA PAPER 92-2613) Copyright

An improved approach for numerically solving the 3D time dependent Euler equations has been developed. The cell-centered upwind finite volume methods are adopted for the spatial discretizations. Time-stepping to solve the discretized equations is carried out by an explicit three-stage Stetter's predictor-corrector scheme. This technique is found to be robust for the multiblock computations of transonic and supersonic flows. The important feature of this code is that, for transonic flows, there is no need for slope limiters. The validity of the present approach is successfully demonstrated in transonic flow conditions (NACA 0012 airfoil, ONERA M6 wing, GARTEUR F4 wing, turbofan nacelle, Hermes space plane, Hermes space plane atop its launcher Ariane 5). Even though only a limited number of supersonic test cases were computed, these confirmed the robustness and accuracy of the method. Author

A92-45490#

THREE-DIMENSIONAL ORTHOGONAL-TO-SURFACE STRUCTURED GRID GENERATION WITH TRANSONIC NAVIER-STOKES FLOW SOLUTIONS FOR A COMMERCIAL TRANSPORT CONFIGURATION

HOA V. CAO and T. J. KAO (Boeing Commercial Airplane Group, Seattle, WA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 161-171. refs

(AIAA PAPER 92-2616) Copyright

A simple and effective method to numerically generate 3D structured grids is proposed for a commercial transport configuration using the NASA Langley thin-layer Navier-Stokes code. The field grids are computed in such a way that the grid lines intersecting the solid boundaries are always orthogonal to these boundaries and the grid distributions necessary for viscous flow analysis along these grid lines are accurately computed. The method was successfully applied to a transonic commercial transport wing-body configuration and the NASA F16XL wing-body configuration. A grid-quality check code developed to verify the 3D grids generated is described. The orthogonal grids generated by the present method are used to compute transonic thin-layer Navier-Stokes flow solutions using the Johnson-King turbulent model for a typical transport configuration. O.G.

A92-45493*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

COUPLED NUMERICAL SIMULATION OF THE EXTERNAL AND ENGINE INLET FLOWS FOR THE F-18 AT LARGE INCIDENCE

SCOTT M. MURMAN (MCAT Institute, Moffett Field, CA), YEHIA M. RIZK, and LEWIS B. SCHIFF (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 192-200. refs

(Contract NCC2-729)

(AIAA PAPER 92-2621) Copyright

This paper presents a numerical simulation of the external and engine inlet flows for the F-18 aircraft at typical high-angle-of-attack flight conditions. Two engine inlet mass flow rates, corresponding to flight idle and maximum power, were computed. This was accomplished using a structured, overset grid technique to couple the external and internal grid systems. Reynolds-averaged Navier-Stokes solutions were obtained using an implicit, finite-differencing scheme. Results show a strong coupling of the external and engine inlet flows, especially at the maximum power setting. Increasing the mass flow rate through the inlet caused the primary vortex breakdown location to move downstream. This trend is also observed in flight tests performed on the F-18. A reversed flow region upstream of the inlet duct is visible in the faired-inlet and flight-idle computations. This flow reversal is not present in the maximum power setting computation. These large-scale changes in flow structure highlight the importance of simulating inlet conditions in high-angle-of-attack aircraft computations. Author

A92-45494*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

EXPERIMENTAL INVESTIGATION OF THE FLOWFIELD OF AN OSCILLATING AIRFOIL

J. PANDA and K. B. M. Q. ZAMAN (NASA, Lewis Research Center, Cleveland, OH) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 201-218. refs

(AIAA PAPER 92-2622) Copyright

The flow field of an airfoil oscillated periodically over a wide range of reduced frequencies, 0 less than k less than 1.6, is studied experimentally at chord Reynolds numbers of R sub c = 22,000 and 44,000. The NACA0012 airfoil is pitched sinusoidally about one quarter chord between alpha of 5 deg and 25 deg.

Detailed flow visualization and phase averaged vorticity measurements are carried out for k = 0.2 to document the evolution and the shedding of the dynamic stall vortex (DSV). In addition to the DSV, an intense vortex of opposite sign originates from the trailing edge just when the DSV is shed. After being shed into the wake, the two together take the shape of a large 'mushroom' while being convected away from the airfoil. The unsteady circulation around the airfoil and, therefore, the time varying component of the lift is estimated in a novel way from the shed vorticity flux and is found to be in good agreement with the lift variation reported by others. The delay in the shedding of the DSV with increasing k, as observed by previous researchers, is documented for the full range of k. The DSV, for example, is shed nearly at the maximum alpha of 25 deg at k = 0.2, but is shed at the minimum alpha of 5 deg at k = 0.8. At low k, the flowfield appears quasi-steady and the bluff body shedding corresponding to the maximum alpha (25 deg) dominates the unsteady fluctuations in the wake. Author

A92-45495#

BOUNDARY-LAYER MEASUREMENTS DURING A PARALLEL BLADE-VORTEX INTERACTION

J. STRAUS and R. E. MAYLE (Rensselaer Polytechnic Institute, Troy, NY) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 219-229. refs

(AIAA PAPER 92-2623) Copyright

The unsteady effect of a downstream convecting two-dimensional vortex on an airfoil boundary layer is studied experimentally. Surface pressures and boundary layer velocity profiles are measured over several critical portions of a NACA 0012 airfoil during the interaction with the vortex. Results indicated that the response of the boundary layer to the passing vortex was highly dependent upon the initial state of the boundary layer and on the spin orientation of the vortex. Author

A92-45496#

A FAST THREE-DIMENSIONAL VORTEX METHOD FOR UNSTEADY WAKE CALCULATIONS

KIAT CHUA and TODD R. QUACKENBUSH (Continuum Dynamics, Inc., Princeton, NJ) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 230-238. refs

(Contract DE-FG05-91ER-81207; DAAL03-89-C-0004)

(AIAA PAPER 92-2624) Copyright

This paper describes the development of a fast vortex method for the numerical simulation of a three-dimensional, unsteady, vortical flow. Previous simulations using a vortex method rely on a direct summation of the Biot-Savart induced velocity due to all vortices. This approach requires a large computation time which increases quadratically with the number of vortices. The method developed herein uses a multipole expansion and a Taylor series expansion in the treatment of the far-field induced velocity. This results in an enormous improvement in the computational speed with little or no loss in accuracy. Application of the method to a simple flow geometry involving the propagation of an isolated vortex ring, as well as a complete helicopter flow configuration, involving the unsteady wake trailing from a four-bladed rotor and draping over an axisymmetric fuselage, have been carried out and results obtained from the calculations are discussed in the paper. Author

A92-45497#

DYNAMICALLY ENHANCED SUSTAINED LIFT USING OSCILLATING LEADING-EDGE FLAPS

BROOKE C. SMITH (Eidetics International, Inc., Torrance, CA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 239-250. refs

(Contract N00019-91-C-0083)

(AIAA PAPER 92-2625) Copyright

Flow visualization experiments were conducted in Eidetics' water tunnel with a 1/16-scale half-span F/A-18 wing with the objective of increasing, prolonging or sustaining lift dynamically by altering the formation and development of the stall vortex using control surface movements. Oscillation of the leading-edge flap produced a dramatic, time-varying response in the flowfield that indicated the generation of additional sustained lift at a static angle of attack. The angular rate of the leading-edge oscillation was identified as the primary factor in the magnitude of lift enhancement, followed in importance by the frequency and amplitude of the oscillation. To assist interpretation of the flow visualization images, a computer model of the shed vorticity was created. The general agreement of the oscillatory wake predicted by the simulation and the wake recorded in the experiment confirmed the importance of the leading-edge flap deflection rate. A major difference between the potential flow, inviscid simulation and the real flow was the lift-indicative wake contraction. The simple model has no mechanism for predicting this behavior, leading to the conclusion that the contraction is due to higher order, viscous interactions in the flow. Author

A92-45498#

MEASUREMENTS OF THE VELOCITY AND VORTICITY FIELDS AROUND A PITCHING AIRFOIL

H. OSHIMA and B. R. RAMAPRIAN (Washington State University, Pullman) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 251-259. refs

(Contract AF-AFOSR-90-0131)

(AIAA PAPER 92-2626) Copyright

This paper reports the results of measurement of the instantaneous velocity and vorticity field in the 2D flow over an NACA 0015 airfoil pitching at constant angular velocity about its quarter-chord axis. The measurements were made in a specially designed water channel using the technique of particle-image velocimetry. The data correspond to a Reynolds number of 15,000 and a nondimensional pitch rate of 0.072. The results are used to understand the vortex dynamics associated with unsteady lift generation and dynamic stall. The use of the water channel and the selection of the experimental conditions result in good spatial and temporal resolution of the flowfield. The present measurements also provide a reliable database for the development and verification of numerical codes. Author

A92-45499#

NUMERICAL STUDY ON A SUPERSONIC OPEN CAVITY FLOW WITH GEOMETRIC MODIFICATION OF AFT BULKHEAD

YIH N. JENG and TIN-JUEI WU (National Cheng Kung University, Tainan, Republic of China) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 260-267. refs

(Contract NSCRC-80-0401-E006-41)

(AIAA PAPER 92-2627) Copyright

A supersonic open cavity flow is numerically simulated by a third-order up wind TVD scheme. The upper corner of the aft bulkhead of a rectangular cavity is replaced by a ramp with a variety of ramp angles. Numerical results show that a large enough ramp angle can effectively suppress the overall sound pressure level and that the optimal angle of 45 deg is consistent with existing analytical prediction. By examining the flowfields, the modification of the geometry of the cavity is found to change the mechanism inducing the mass exchange from the interaction between the oscillatory shear layer and rectangular cavity's rear corner to the fluctuation of shear layer's impinging point on the ramp surface. Subsequently, the interaction between the free shear layer, vortices and pressure waves within the cavity is reduced. Author

A92-45500#

STATIC AND DYNAMIC FLOW FIELD DEVELOPMENT ABOUT A POROUS SUCTION SURFACE WING

GREGORY A. ADDINGTON (USAF, Wright Laboratory, Wright-Patterson AFB, OH), SCOTT J. SCHRECK (USAF, Frank J. Seiler Research Laboratory, Colorado Springs, CO), and MARVIN W. LUTTGES (Colorado, University, Boulder) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 268-284. refs

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(AIAA PAPER 92-2628)

A passive suction surface was fit to a hollow NACA 0015 wing of otherwise conventional construction. No active forcing was applied to this surface. Static surface pressure measurements indicated that the adverse pressure gradient usually present over the aft portions of this wing was severely attenuated by the addition of the porous surface, and Cp values were generally lower than those experienced by the nonporous surface wing. When these pressure data were combined with flow visualization data, a separated region ornamented with periodic vortical structures became apparent. Using flow visualization and surface pressure measurements taken during constant-rate pitch motions of the porous wing, no evidence of dynamic stall phenomena were observed at low nondimensional pitch rates during circumstances when dynamic stall phenomena are otherwise evident. As nondimensional pitch rates were increased, dynamic stall vortices were observed over the porous surface, but this and other dynamic stall flowfield developments were dramatically altered by surface conditions. A physical model is produced explaining these phenomena. Author

A92-45502*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

COMPUTATIONAL STUDY OF TRANSITION FRONT ON A SWEPT WING LEADING-EDGE MODEL

VENKIT IYER (Vigyan, Inc., Hampton, VA), ROBERT E. SPALL (South Alabama, University, Mobile, AL), and J. R. DAGENHART (NASA, Langley Research Center, Hampton, VA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 304-314. Research supported by University of South Alabama. refs

(Contract NAS1-18585)

(AIAA PAPER 92-2630)

The e(N) method is employed with Navier-Stokes calculations to study 3D supersonic boundary layers at the leading-edge region of swept wings with attention given to the conditions for linear stability. Mean-flow profiles are computed as solutions to the Navier-Stokes equations, and the e(N) method is used to identify the onset of the transition. Specific treatment is given to the identification of parameters which affect the transition such as free-stream Reynolds number, wall cooling, and boundary-layer suction levels. The boundary layer can be stabilized to below $N=10$ levels in all locations by utilizing distributed suction, and enhanced stabilization can also be achieved by employing wall cooling and reduced free-stream Reynolds numbers. This study presents key calculations for corresponding experimental investigations by shedding light on requirements for test conditions and measurement requirements. C.C.S.

A92-45503#

AIRFOIL PRESSURE MEASUREMENTS DURING OBLIQUE SHOCK WAVE-VORTEX INTERACTION IN A MACH 3 STREAM

IRAJ M. KALKHORAN and PASQUALE M. SFORZA (Polytechnic University, Farmingdale, NY) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 315-321. refs

(AIAA PAPER 92-2631) Copyright

An experimental investigation of the interaction of discrete vortices with oblique shock waves was conducted in a Mach 3 blowdown wind tunnel. An instrumented two-dimensional wedge airfoil section was placed downstream of a semi-span wing section so that the trailing tip vortex would interact with the shock wave formed over the downstream test airfoil. The experiments were designed to simulate interaction of streamwise vortices from upstream sections with shock waves formed over aft surfaces as might be encountered in supersonic flight of aircraft and missiles. The influence of vortex strength and vortex-airfoil vertical separation distance on the interaction was examined. The flowfield generated was found to be highly unsteady and a substantial change in the pressure distribution of the downstream airfoil was observed. Furthermore, the interaction of strong vortices with the oblique shock waves over the test airfoil resulted in formation of unsteady detached shock waves far upstream of the airfoil leading edge. Author

A92-45504#

UNSTEADY NAVIER-STOKES SIMULATIONS OF SUPERSONIC FLOW OVER A THREE-DIMENSIONAL CAVITY

YEN TU (USAF, Wright Laboratory, Eglin AFB, FL) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 322-329. refs

(AIAA PAPER 92-2632)

A numerical solution is obtained for a flow with a freestream Mach number of 1.2 and Reynolds number of 2.5 x 10 exp 6 over a three-dimensional cavity with an L/D of 4.5. This is accomplished by integrating the unsteady compressible 3D Reynolds averaged Navier-Stokes equations. Turbulence is modeled via a simple algebraic model. Self-sustained oscillatory motion within the cavity has been observed. Details of the flow field are elucidated in terms of velocity vectors and pressure contours. Calculated results agree well with experimental data. Author

A92-45505*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

PRACTICAL DESIGN OPTIMIZATION OF WING/BODY CONFIGURATIONS USING THE EULER EQUATIONS

J. REUTHER, S. E. CLIFF, R. M. HICKS (NASA, Ames Research Center, Moffett Field, CA), and C. P. VAN DAM (California, University, Davis) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 330-342. refs

(AIAA PAPER 92-2633)

The development of a practical method for the aerodynamic design of isolated wing and wing/body configurations is achieved through the coupling of existing computational fluid dynamics (CFD) analysis codes and a quasi-Newton numerical optimization method. The direct design method is generalized to treat three-dimensional aerodynamic optimization problems subject to inviscid, rotational, compressible flow conditions imposed by the Euler equations. The method couples either the FLO57 or the TEAM flow solver with a modified version of the QNMDIF numerical optimization algorithm. The method is applied, but is not limited, to supersonic design problems. A case study is presented illustrating the method's effectiveness in maximizing the lift-to-drag ratio, subject to a variety of constraints, of selected supersonic configurations at cruise conditions. Author

A92-45506#

AERODYNAMIC SHAPE OPTIMIZATION OF HYPERSONIC CONFIGURATIONS INCLUDING VISCOUS EFFECTS

GEORGE S. DULIKRAVICH and SCOTT G. SHEFFER (Pennsylvania State University, University Park) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 343-351. Research supported by Pennsylvania State University. refs

(AIAA PAPER 92-2635) Copyright

An optimization algorithm is introduced which can be used to study nonaxisymmetric hypersonic configurations in terms of combined aerodynamic wave drag and viscous drag minimization.

Modified Newtonian flow theory and modified boundary-layer approximations are used in the algorithm, and a surface-fitted Fourier series or a point-motion algorithm is used for the shape optimization. The optimal configuration is then determined with a quasi-Newton gradient search for cone, stubby-wing, four-pointed-star, and space-shuttle configurations. The point-motion algorithm is used to fix parameters of the original aircraft such as wing thickness and cabin size, and the coefficient algorithm permits the derivation of optimized shapes for the hypersonic vehicles. C.C.S.

A92-45507#
APPLICATION OF AN UNSTRUCTURED NAVIER-STOKES SOLVER TO MULTI-ELEMENT AIRFOILS OPERATING AT TRANSONIC MANEUVER CONDITIONS
LUCA STOLCIS and LESLIE J. JOHNSTON (University of Manchester Institute of Science and Technology, England) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 352-360. refs
(AIAA PAPER 92-2638) Copyright

The development of a numerical prediction method for the viscous transonic flow around multielement, high-lift aerofoil sections is summarized. The method involves solution of the Reynolds-averaged Navier-Stokes equations using a cell-centered, finite-volume spatial discretization and an explicit multistage scheme to time march to steady-state solutions. The mean-flow equations are solved in conjunction with a two-equation, high-Reynolds number k-epsilon turbulence model, in order to deal adequately with the complex flow physics. The geometric complexity associated with multielement aerofoils is addressed by adopting unstructured computational grids. In this way, fully representative geometries can be handled including blunt trailing edges and sharp-edged cut-outs in flap and slat cove regions. A detailed evaluation is presented of the predictive capability of the resulting method for the SKF 1.1 aerofoil/maneuver flap configuration. Author

A92-45508*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
VORTEX TRAPPING ON A 60 DEGREE DELTA WING
MARK D. BUCHHOLZ and JIN TSO (California Polytechnic State University, San Luis Obispo) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 361-373. refs
(Contract NCC2-730)
(AIAA PAPER 92-2639) Copyright

An experiment was conducted to examine the vortex trapping concept on a 60 deg sweep delta wing at low angles of attack. Using tapered leading edge fences, stable vortices have been successfully trapped. The resulting increase in lift coefficient can be as high as 0.4, which amounts to a 6.5 deg shift in the lift coefficient curve of the delta wing. The corresponding increase in drag coefficient, however, is also significant. Author

A92-45509#
AIRCRAFT SPOILER EFFECTS UNDER WIND SHEAR
M. M. ABDELRAHMAN, M. A. GHAZI, I. A. OLWI, and A. M. AL-BAHI (King Abdulaziz University, Jedda, Saudi Arabia) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 391-401. refs
(AIAA PAPER 92-2642) Copyright

Effects of symmetrical and nonsymmetrical spoiler configurations on an aircraft model under wind shear are experimentally studied. Lift, drag and side forces in addition to pitching, yawing and rolling moments are investigated for various angles of attack, sideslip angles, spoiler deflections and wind shear velocity ratios. The results substantiate that spoiler deflection increases the drastic lift reduction caused by wind shear effect, specially at low angles of attack. Wind shear also tends to intensify the spoiler effect on the side force and yawing moment, while it affects the resulting rolling moment only at high angles of attack. Spoiler deflections, however, have practically no effect on the aircraft stability margin which normally increases by the presence of wind shear. Author

A92-45510*# National Aeronautics and Space Administration, Washington, DC.
A NONLINEAR RELAXATION/QUASI-NEWTON ALGORITHM FOR THE COMPRESSIBLE NAVIER-STOKES EQUATIONS
JACK R. EDWARDS and D. S. MCRAE (North Carolina State University, Raleigh) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 402-409. Research supported by USAF and U.S. Navy. refs
(Contract NAGW-1072)
(AIAA PAPER 92-2643) Copyright

A highly efficient implicit method for the computation of steady, two-dimensional compressible Navier-Stokes flowfields is presented. The discretization of the governing equations is hybrid in nature, with flux-vector splitting utilized in the streamwise direction and central differences with flux-limited artificial dissipation used for the transverse fluxes. Line Jacobi relaxation is used to provide a suitable initial guess for a new nonlinear iteration strategy based on line Gauss-Seidel sweeps. The applicability of quasi-Newton methods as convergence accelerators for this and other line relaxation algorithms is discussed, and efficient implementations of such techniques are presented. Convergence histories and comparisons with experimental data are presented for supersonic flow over a flat plate and for several high-speed compression corner interactions. Results indicate a marked improvement in computational efficiency over more conventional upwind relaxation strategies, particularly for flowfields containing large pockets of streamwise subsonic flow. Author

A92-45513#
SHOCK FITTING WITH A FINITE VOLUME APPROXIMATION TO THE EULER EQUATIONS
SCOTT A. SIBIO (Princeton University, NJ) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 424-432. refs
(AIAA PAPER 92-2646) Copyright

A shock fitting algorithm for use with a finite volume approximation to the Euler equations is presented. The scheme allows the shock wave to cross both families of grid lines in the structured computational grid. Results are shown for various flows over a wedge. Author

A92-45514#
PREDICTIONS OF A TURBULENT BACKWARD-FACING-STEP FLOW WITH A CUBIC PRESSURE-STRAIN MODEL
C. A. LIN (National Tsing Hua University, Hsinchu, Republic of China) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 433-440. refs
(AIAA PAPER 92-2647) Copyright

Three variants of a cubic pressure-strainstress model were applied to a 2D turbulent backward-facing-step flow, and the results were contrasted with the measurements and the predictions by the k-epsilon model and a linear pressure-strain IP stress model. It was found that the inclusion of the turbulence part of the wall-related pressure-strain term in the cubic model would result in a depressed level of shear stresses due to the over-damping of the normal stresses in the direction normal to the wall and consequently an elongation of the predicted reattachment length. The cubic models without the turbulence part of the wall related pressure-strain process were shown to predict a better anisotropic-level of stresses. Overall, one version of the cubic pressure-strain model with a modified epsilon source returns best regarding the reattachment length and the recovery region after the reattachment point. Author

A92-45515#

LAMINAR SEPARATION BUBBLES AND AIRFOIL DESIGN AT LOW REYNOLDS NUMBERS

R. H. LIEBECK (Douglas Aircraft Co., Long Beach; Southern California, University, Los Angeles, CA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 441-456. refs

(AIAA PAPER 92-2735) Copyright

Airfoil design at low Reynolds numbers is distinguished by the requirement that the omnipresent laminar separation bubble needs to be understood. Recently, an experimental investigation on the structure and behavior of the bubble on low Reynolds number airfoils was conducted in the University of Southern California Dryden low turbulence wind tunnel. Significant results include: the laminar portion of the bubble structure is two-dimensional, simple sweep theory describes bubble behavior on infinite swept wings, and the dynamics of the bubble are independent of airfoil shape, angle of attack, and Reynolds number. Application of these results to the design and analysis of low Reynolds number airfoils appears promising. The airfoil design approach at the Douglas Aircraft Company is outlined, and several example low Reynolds number airfoils for a variety of applications are presented. Author

A92-45516#

THE SUBSONIC AND TRANSONIC FLOW AROUND THE LEADING EDGE OF A THIN AIRFOIL WITH A PARABOLIC NOSE

Z. RUSAK and B. E. WEBSTER (Rensselaer Polytechnic Institute, Troy, NY) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 457-463. refs

(AIAA PAPER 92-2649) Copyright

This paper discusses recent asymptotic solutions of the subsonic and transonic flow around the leading edge of a thin airfoil with a parabolic nose. The analyses show that in the subsonic regime the flowfield near the nose is strongly affected by the total circulation around the airfoil, whereas in the transonic regime, it is locally symmetric and dominated by the local shape of the parabolic nose. A possible physical mechanism is suggested to explain the basic differences between the flows in the nose region. A good agreement is found between the asymptotic solutions and refined numerical solutions of the Euler equations. The calculations confirm the analyses prediction abouat the shift of the stagnation point toward the airfoil's leading edge as the Mach number of the oncoming flow is increased from subsonic to transonic. Author

A92-45517*# National Aeronautics and Space Administration, Washington, DC.

MULTI-POINT INVERSE DESIGN OF AN INFINITE CASCADE OF AIRFOILS

MICHAEL S. SELIG (Pennsylvania State University, University Park) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 464-476. refs

(Contract NGT-50341)

(AIAA PAPER 92-2650) Copyright

This paper describes a practical method for the design of an infinite cascade in incompressible flow. The method is based on conformal mapping, and as a result it allows for multi-point design. The cascade blade to be determined is divided into a desired number of segments. Over each segment, the velocity distribution is prescribed together with an inlet or outlet flow angle at which this velocity distribution is to be achieved. In this way multi-point design requirements can be met. It is necessary to satisfy several conditions that arise to guarantee compatibility with the inlet and outlet flow as well as closure of the cascade blade. Satisfaction of these conditions does not necessarily result in a cascade with all the desired characteristics. For example, the cascade blades may be bulbous or crossed. Through Newton iteration, however, the desired characteristics may be prescribed by allowing for the adjustment of the design parameters that define the mathematical problem through conformal mapping. Several examples will be illustrated to demonstrate the capability of the method. It will be shown that the method is limited to the design of cascades with solidities of up to one. Author

A92-45518*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

TRANSONIC AIRFOIL AND WING DESIGN USING NAVIER-STOKES CODES

N. J. YU (Boeing Commercial Airplane Group, Seattle, WA) and R. L. CAMPBELL (NASA, Langley Research Center, Hampton, VA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 477-485. refs

(AIAA PAPER 92-2651) Copyright

An iterative design method has been implemented into 2D and 3D Navier-Stokes codes for the design of airfoils or wings with given target pressure distributions. The method begins with the analysis of an initial geometry, and obtains the analysis pressure distributions of that geometry. The differences between analysis pressures and target pressures are used to drive geometry changes through the use of a streamline curvature method. This paper describes the procedure that makes the iterative design method work for Navier-Stokes codes. Examples of 2D airfoil design, and 3D wing design are included. It is demonstrated that the method is highly effective for airfoil or wing design at flow conditions where no substantial separation occurs. Problems encountered in the airfoil design with shock induced flow separations are discussed. Author

A92-45520#

EFFECT OF THROAT CONTOURING ON TWO-DIMENSIONAL CONVERGING-DIVERGING NOZZLES USING URS METHOD

GE-CHENG ZHA and E. BILGEN (Ecole Polytechnique, Montreal, Canada) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 494-502. refs

(AIAA PAPER 92-2659) Copyright

Numerical calculations have been conducted to study the nozzle internal-performance effect of throat contouring, the result of increasing the circular-arc throat radius. Five nonaxisymmetric converging-diverging nozzles at design conditions were calculated by solving the three-dimensional Navier-Stokes equations using Upwind Relaxation-Sweeping (URS) algorithm. Throat contouring resulted in a positive effect on discharge coefficient but showed no significant improvement in internal thrust ratio. All the computational results have been compared with the experiments and they are generally in good agreement. Author

A92-45522#

INVESTIGATION OF SOLUTION OPERATORS FOR THE THREE-DIMENSIONAL EULER EQUATIONS

FRANK A. MANSFIELD (U.S. Navy, Naval Air Warfare Center, China Lake, CA) and DAVID WHITFIELD (Mississippi State University, Mississippi State) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 507-517. refs

(AIAA PAPER 92-2666) Copyright

Various combinations of the implicit left-hand side and explicit right-hand side operators are investigated in terms of stability bounds and convergence rates for subsonic, transonic, and supersonic flows. A method for numerically analyzing the stability of any numerical solution operator based on finite difference or finite-volume formulations for the 3D inviscid Euler equations is used. Three different block solvers - tridiagonal, two-pass, and modified two-pass - are also evaluated. The modified two-pass solver is shown to be the best in terms of stability, convergence, and CPU time. The effects on stability and convergence of different components, such as flux Jacobian formulation and factorization, used in creating a solution equation operator for Euler equations are clearly established. C.A.B.

A92-45523#

AN UNFACTORED IMPLICIT SCHEME FOR 3D INVISCID TRANSONIC FLOWS

STEFANO PAOLETTI, MARCELLO VITALETTI (IBM European Center for Scientific and Engineering Computing, Rome, Italy), and PETER STOW (Rolls-Royce, PLC, Dept. of Theoretical Science, Derby, England) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 518-527. refs

(AIAA PAPER 92-2668) Copyright

An unfactored implicit scheme for the 3D Euler equations is compared with the alternating-direction-implicit (ADI) scheme. Emphasis is on the effect of the factorization error on the convergence to a steady-state solution. The unfactored scheme can achieve a faster convergence by the exploitation of larger time-steps but requires the solution of large sparse systems of equations. The conjugate-gradient-squared iterative algorithm is applied to the unfactored system using the ADI product of block-tridiagonal factors as a preconditioner, and the method was tested on transonic and subsonic test cases. Author

A92-45524# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

A NEW APPROACH FOR THE CALCULATION OF TRANSITIONAL FLOWS

T. W. YOUNG, ERIC S. WARREN (North Carolina State University, Raleigh), JULIUS E. HARRIS (NASA, Langley Research Center, Hampton, VA), and H. A. HASSAN (North Carolina State University, Raleigh) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 528-538. Research supported by USAF and U.S. Navy. refs

(Contract NCC1-22; NAGW-1022; NAGW-1331)

(AIAA PAPER 92-2669) Copyright

In spite of many attempts at modeling natural transition, it has not been possible to predict the streamwise intensities. A procedure is developed which incorporates some results of linear stability theory into one-equation and stress model formulations. The stresses resulting from fluctuations in the transitional region have turbulent, laminar (nonturbulent) and large eddy components. Comparison with Schubauer and Klebanoff's experiments have shown that the nonturbulent and large eddy components have a large influence on the streamwise intensities and little influence on the shear stress. Finally, predictions of the one-equation model were as good as those obtained by the stress model. Author

A92-45525*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DETERMINATION OF AERODYNAMIC SENSITIVITY COEFFICIENTS BASED ON THE THREE-DIMENSIONAL FULL POTENTIAL EQUATION

HESHAM M. ELBANNA and LELAND A. CARLSON (Texas A & M University, College Station) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 539-548. refs

(Contract NAG1-793)

(AIAA PAPER 92-2670) Copyright

The quasi-analytical approach is applied to the three-dimensional full potential equation to compute wing aerodynamic sensitivity coefficients in the transonic regime. Symbolic manipulation is used to reduce the effort associated with obtaining the sensitivity equations, and the large sensitivity system is solved using 'state of the art' routines. Results are compared to those obtained by the direct finite difference approach and both methods are evaluated to determine their computational accuracy and efficiency. The quasi-analytical approach is shown to be accurate and efficient for large aerodynamic systems. Author

A92-45526#

LU-SGS IMPLICIT SCHEME FOR ENTRY VEHICLE FLOW COMPUTATION AND COMPARISON WITH AERODYNAMIC DATA

L. T. TAM (Lockheed Engineering and Sciences Co., Houston, TX) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 549-562. refs

(AIAA PAPER 92-2671) Copyright

A three-dimensional shock-capturing CFD code, IEC3D, has been developed for hypersonic flow computations. An upwind-biased, finite-volume, high-order TVD scheme based on Van Leer MUSCL type flux-vector splitting and Roe characteristic-based flux-difference splitting has been incorporated into the code. The LU-SGS implicit solver originally developed by Jameson and Yoon is considered. Computed pressure distributions, aerodynamic coefficients, shock shapes, and flowfields for both perfect gas and equilibrium gas are compared with available data for three aerospace vehicles at wind tunnel and flight conditions. Satisfactory agreement is noted between the CFD results and the measurements in all cases considered. Author

A92-45528*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

NUMERICAL INVESTIGATION OF TAIL BUFFET ON F-18 AIRCRAFT

YEHIA M. RIZK, GURU P. GURUSWAMY (NASA, Ames Research Center, Moffett Field, CA), and KEN GEE (MCAT Institute, Moffett Field, CA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 573-587. refs

(AIAA PAPER 92-2673) Copyright

Numerical investigation of vortex induced tail buffet is conducted on the F-18 aircraft at high angles of attack. The Reynolds-averaged Navier-Stokes equations are integrated using a time-accurate, implicit procedure. A generalized overset zonal grid scheme is used to decompose the computational space around the complete aircraft with faired-over inlet. A weak coupling between the aerodynamics and structures is assumed to compute the structural oscillation of the flexible vertical tail. Time-accurate computations of the turbulent flow around the F-18 aircraft at 30 degrees angle of attack show the surface and off-surface flowfield details, including the unsteadiness created by the vortex burst and its interaction with the vertical twin tail which causes the tail buffet. The effect of installing a LEX fence on modifying the vortex structure upstream of the tail is also examined. Author

A92-45529#

UNSTEADY PRESSURE AND LOAD MEASUREMENTS ON AN F/A-18 VERTICAL FIN AT HIGH-ANGLE-OF-ATTACK

B. H. K. LEE and F. C. TANG (National Research Council of Canada, Institute for Aerospace Research, Ottawa) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 588-599. Research supported by National Research Council of Canada and DND. refs

(AIAA PAPER 92-2675) Copyright

Tail buffet on a rigid 6-percent scale model of the F/A-18 was investigated in a 1.5 m trisonic blowdown wind tunnel. Strain gauges were installed on the port fin to measure normal-force, root-bending, and torsion moments. The starboard fin was instrumented with 24 fast-response transducers on each surface for unsteady pressure measurements. Static tests at constant angle of attack were performed to compare the loads and moments from the strain-gauged fin with those determined from pressure measurements. The mean angle of attack, amplitude of oscillation, and Mach number were varied to note the effects of delay in LEX vortex burst on the vertical-fin buffet loads. The envelopes of the unsteady force and pressure signals, rms variations with angle of attack, and probability densities were evaluated to study the normal force and pressures fluctuations on the vertical fin. Author

A92-45530*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

ANALYSIS OF A PNEUMATIC FOREBODY FLOW CONTROL CONCEPT ABOUT A FULL AIRCRAFT GEOMETRY

KEN GEE (MCAT Institute, Moffett Field, CA), YEHIA M. RIZK (NASA, Ames Research Center, Moffett Field, CA), SCOTT M. MURMAN (MCAT Institute, Moffett Field, CA), WENDY R. LANSER, LARRY A. MEYN, and LEWIS B. SCHIFF (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 600-613. refs

(AIAA PAPER 92-2678) Copyright

A full aircraft geometry is used to computationally analyze the effectiveness of a pneumatic forebody flow control concept. An overset grid technique is employed to model the aircraft and slot geometry. Steady-state solutions for both isolated forebody and full aircraft configurations are carried out using a thin-layer Navier-Stokes flow solver. A solution obtained using the full aircraft geometry and a flight sideslip condition investigates the effect of sideslip on the leading edge extention vortex burst point. A no-sideslip blowing solution using the isolated forebody at full-scale wind tunnel test conditions is compared with experimental data to determine the accuracy of the numerical method. A solution employing the full geometry and slot blowing at flight conditions is obtained. C.A.B.

A92-45531#

CALCULATION OF HIGH SPEED BASE FLOWS

R. H. NICHOLS, J. R. MAUS, R. L. SPINETTI (Calspan Corp., Arnold AFB, TN), and G. A. MOLVIK (MCAT Corp., Moffett Field, CA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 614-623. refs

(AIAA PAPER 92-2679)

A computational approach for high-speed base flows of reentry shapes is demonstrated. The approach is based on solving the thin-layer Navier-Stokes equations for perfect gas, equilibrium air, or chemical nonequilibrium air. An efficient space-marching algorithm is used whenever possible on the body and in the far wake. A blocked time-marching algorithm is used to calculate the embedded subsonic flow in the base region. A two-equation turbulence model which includes compressibility effects is used to extend the approach to Reynolds numbers above the transition to turbulent flow. Comparisons with data are made for both laminar and turbulent base flows, with good agreement in all cases. Author

A92-45532#

SCALE EFFECTS ON THE FLOW PAST THE MATED SPACE SHUTTLE CONFIGURATION

S. V. RAMAKRISHNAN, C. L. CHEN (Rockwell International Science Center, Thousand Oaks, CA), and D. F. DOMINIK (Rockwell International Corp., Space Systems Div., Downey, CA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 624-632. refs

(AIAA PAPER 92-2680) Copyright

Computation of scale effects for the case of the flow past the mated Space Shuttle configuration in ascent mode is presented. The grid employed in the calculations has enough resolution to bring out some of the global features of the differences in the flow field between the full-scale model and a 3-percent wing-tunnel model. A finer grid is required to capture local details. At the wind-tunnel Reynolds number the surface-pressure distribution is smoother and the effect of the protuberances travel farther upstream as compared to the flight Reynolds number. Author

A92-45534*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AN ADAPTIVE GRID METHOD FOR COMPUTING THE HIGH SPEED 3D VISCOUS FLOW ABOUT A RE-ENTRY VEHICLE

MICHAEL J. BOCKELIE (Computer Sciences Corp., Hampton, VA) and ROBERT E. SMITH (NASA, Langley Research Center, Hampton, VA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 641-650. refs

(AIAA PAPER 92-2685)

An algebraic solution adaptive grid generation method that allows adapting the grid in all three coordinate directions is presented. Techniques are described that maintain the integrity of the original vehicle definition for grid point movement on the vehicle surface and that avoid grid cross over in the boundary layer portion of the grid lying next to the vehicle surface. The adaptive method is tested by computing the Mach 6 hypersonic three dimensional viscous flow about a proposed Martian entry vehicle. Author

A92-45535#

EXPERIMENTAL DEVELOPMENT OF SPANWISE VORTEX MODELS WITH STREAMWISE DECAY DUE TO WALL INTERACTION

MICHAEL MACRORIE and WAYNE R. PAULEY (Pennsylvania State University, University Park) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 651-660. refs

(Contract N00014-89-J-3102)

(AIAA PAPER 92-2688) Copyright

Results of an experimental investigation of the interaction between convecting 2D spanwise vortex structures and a flat plate are presented to provide modeling of convected 2D vortices developing in close interaction with a surface. Vortices of both positive and negative circulation are studied at four generator heights above the test surface. The strength of the vortices is not strongly affected by the interaction with the surface until the vortex core becomes fully embedded in the boundary layer. The streamwise decay of vortices of both sense are studied for a single generator height at five streamwise stations. The core vorticity of the dynamic stall vortices experience an initial decay rate of t exp -1 which is similar to that predicted for an Oseen vortex. Three-dimensional effects should be small in this experiment and do not contribute substantially to the vortex decay. Author

A92-45536#

LDV MEASUREMENTS IN THE THREE-DIMENSIONAL NEAR WAKE OF A STATIONARY AND OSCILLATING RECTANGULAR WIND

Y. ZHENG and B. R. RAMAPRIAN (Washington State University, Pullman) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 661-671. refs

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(AIAA PAPER 92-2689) Copyright

The structure of the 3D flow in the near wake of a NACA 0015 rectangular wing of semiaspect ratio 2 was studied in detail using three-component laser-Doppler velocimetry. Two cases were investigated: stationary wing and wing sinusoidally oscillating in pitch about its c/4 axis. The data obtained include time-mean (in steady flow) and phase-locked (in unsteady flow) properties such as velocity and vorticity. These data show clearly that in the near wake, the quasi-two-dimensional shear layer in the inboard regions of the wake, carrying spanwise vorticity, travels toward the tip where it rolls up into the tip vortex carrying strong axial vorticity. The data are useful in understanding the process of roll-up of the vortex in the near wake. Author

A92-45537*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

LDV MEASUREMENTS ON A RECTANGULAR WING WITH A SIMULATED GLAZE ICE ACCRETION

A. KHODADOUST, M. B. BRAGG, and M. KERHO (Illinois, University, Urbana) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 672-687. Research supported by NASA. refs

(AIAA PAPER 92-2690) Copyright

LDV measurement results are presented for the upper surface of a rectangular semispan wing with and without simulated glaze ice accretion. Inspection of the model centerline flow field indicates that a large region of reverse flow exists aft of the ice horn on the iced model. At alpha = 0 deg, this region extends to 7 percent chord, while at alpha = 4 deg the bubble grows to more than 12 percent chord. At alpha = 8 deg, the time-averaged separation bubble is measured well beyond 50 percent chord. Experimental and computational flow visualization support these findings. The flow in the vicinity of the ice shape contains many of the features of flow over a backward-facing step. C.D.

A92-45538#

COMPARISON OF INTERFEROMETRIC MEASUREMENTS WITH 3-D EULER COMPUTATIONS FOR CIRCULAR CONES IN SUPERSONIC FLOW

T. A. W. M. LANEN and E. M. HOUTMAN (Delft University of Technology, Netherlands) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 688-698. refs

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Dual-reference-beam, plane-wave digital holographic interferometry has been applied to obtain quantitative interferometric data in the 3D supersonic flow over circular cones. The interferometric data is compared on a 2D grid with the postprocessed results from an Euler code which simulates 3D inviscid compressible flows. The comparison involves two different combinations of cone angle and angle of incidence. The maximum deviations between the interferometric data and the numerical data confine themselves to the interval 2.0, + 2.0 percent. Author

A92-45539*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

LDA MEASUREMENTS IN A MACH 2 FLOW OVER A REARWARD FACING STEP WITH STAGED TRANSVERSE INJECTION

J.-A. WANG and C. L. DANCEY (Virginia Polytechnic Institute and State University, Blacksburg) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 699-704. refs

(Contract NAS1-18471)

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Measurements of the mean velocity field and selected turbulence statistics have been obtained via 2D LDA in a Mach 2 flow over a rearward facing step with downstream transverse injection. Axial mean velocity profiles, profiles of the axial and normal RMS levels, and the correlation coefficient between the axial and normal fluctuating components are presented for locations upstream of the step. These data, through comparison with other reported measurements in zero pressure gradient compressible boundary layers indicate that the boundary layers upstream of the step are consistent with 'quasi-equilibrium' turbulent boundary layers with the adiabatic wall boundary condition. Mean velocity field measurements on the symmetry plane of the tunnel are compared to laser induced iodine fluorescence measurements reported in the literature and obtained in the same facility. This comparison demonstrates the quality of the present LDA data set and shows that particle lag is not significant in the LDA measurements despite the complex nature of the downstream flow. Author

A92-45540*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

SPATIAL AND TEMPORAL ADAPTIVE PROCEDURES FOR THE UNSTEADY AERODYNAMIC ANALYSIS OF AIRFOILS USING UNSTRUCTURED MESHES

JOHN R. HOOKER (Purdue University, West Lafayette, IN), JOHN T. BATINA (NASA, Langley Research Center, Hampton, VA), and MARC H. WILLIAMS (Purdue University, West Lafayette, IN) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 705-718. refs

(Contract NAG1-372)

(AIAA PAPER 92-2694) Copyright

An algorithm which combines spatial and temporal adaption for the time integration of the two-dimensional Euler equations on unstructured meshes of triangles is presented. Spatial adaption involves mesh enrichment to add elements in high gradient regions of the flow and mesh coarsening to remove elements where they are no longer needed. Temporal adaption is a time accurate, local time stepping procedure which integrates the flow equations in each cell according to the local numerical stability constraint. The flow solver utilizes a four-stage Runge-Kutta time integration scheme with an upwind flux-split spatial discretization. Results obtained using spatial and temporal adaption indicate that highly accurate solutions can be obtained with a significant savings of computing time over global time stepping. Author

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NAVIER-STOKES ANALYSIS AND EXPERIMENTAL DATA COMPARISON OF COMPRESSIBLE FLOW IN A DIFFUSING S-DUCT

GARY J. HARLOFF (Sverdrup Technology, Inc., Brook Park, OH), BRUCE A. REICHERT (NASA, Lewis Research Center, Cleveland, OH), and STEVEN R. WELLBORN (Iowa State University of Science and Technology, Ames) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 719-727. refs

(Contract NAS3-25266)

(AIAA PAPER 92-2699) Copyright

Full three-dimensional Navier-Stokes computational results are compared with new experimental measurements for the flowfield within a round diffusing S-duct. The present study extends previous computational and experimental results for a similar smaller scale S-duct. Predicted results are compared with the experimental static and total pressure fields, and velocity vectors. Additionally, wall pressures, velocity profiles in wall coordinates, and skin friction values are presented. The CFD results employ algebraic and k-epsilon turbulence models. The CFD computed and experimentally determined separated flowfield is carefully examined. Author

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DESIGN AND ANALYSIS OF VORTEX GENERATORS ON REENGINED BOEING 727-100QF CENTER INLET S-DUCT BY A REDUCED NAVIER-STOKES CODE

PAO S. HUANG, ANTONIO PICCOLO, ANDY SLATER (Dee Howard Co., San Antonio, TX), and BERNHARD H. ANDERSON (NASA, Lewis Research Center, Cleveland, OH) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 728-735. refs

(AIAA PAPER 92-2700) Copyright

This paper describes the application of a three dimensional reduced Navier-Stokes code to perform design and analysis of vortex generators on a reengined Boeing 727-100QF center engine inlet S duct. This computer code with vortex generators modeling is shown to be cost-effective, accurate and easy to use to design the optimal vortex generators installed on a S-duct, predict its aerodynamic performance and provide the detailed flow field information. Author

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COMMERCIAL TURBOFAN ENGINE EXHAUST NOZZLE FLOW ANALYSES USING PAB3D

KHALED S. ABDOL-HAMID (Analytical Services and Materials, Inc., Hampton, VA), K. UENISHI (GE Aircraft Engines, Cincinnati, OH), JOHN R. CARLSON (NASA, Langley Research Center, Hampton, VA), and B. D. KEITH (GE Aircraft Engines, Cincinnati, OH) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 736-745. refs
(AIAA PAPER 92-2701) Copyright

Recent developments of a three-dimensional (PAB3D) code have paved the way for a computational investigation of complex aircraft aerodynamic components. The PAB3D code was developed for solving the simplified Reynolds Averaged Navier-Stokes equations in a three-dimensional multiblock/multizone structured mesh domain. The present analysis was applied to commercial turbofan exhaust flow systems. Solution sensitivity to grid density is presented. Laminar flow solutions were developed for all grids and two-equation k-epsilon solutions were developed for selected grids. Static pressure distributions, mass flow and thrust quantities were calculated for on-design engine operating conditions. Good agreement between predicted surface static pressures and experimental data was observed at different locations. Mass flow was predicted within 0.2 percent of experimental data. Thrust forces were typically within 0.4 percent of experimental data. Author

A92-45544#

PREDICTION OF LAMINAR BOUNDARY LAYER USING CUBIC SPLINES

A. ILINCA and B. S. BASU (Ecole Polytechnique, Montreal, Canada) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 746-752. refs
(AIAA PAPER 92-2702) Copyright

The paper presents a numerical method developed for the computation of laminar boundary layer using cubic spline interpolation in direction normal to the wall and finite difference discretization in direction parallel to the wall. A higher order accuracy is obtained not only for the velocity, but also for their first and second derivatives in normal direction, as required by the boundary layer stability analysis. A comparison with results of similar boundary layer profiles is presented. Author

A92-45545#

VORTEX-IN-CELL ANALYSIS OF WING WAKE ROLL-UP

RENATO S. RIBEIRO and ILAN KROO (Stanford University, CA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 753-763. refs
(AIAA PAPER 92-2703) Copyright

A vortex-in-cell method was coupled with a wing vortex-lattice model to compute steady-state wake roll-up. The vorticity concentrated on the wing and wake vortex-segments is distributed to a Cartesian grid through the application of a spreading function. A subvortex technique is introduced to refine the wake description without altering the number of wing panels. The velocity field induced by the spread vorticity is computed using an infinite domain Fast Poisson Solver. Interpolation provides velocities at any point inside the grid. The vortex-in-cell method is used to compute velocities for a wake relaxation procedure and to correct wing panel circulations. The iterative method developed can be applied to configurations with several wings. The method was tested for various one and two-wing problems, and compared with results from experiments and from other theories, with very good agreement. Detailed descriptions for wake geometry and accurate load distributions were obtained, even for cases where wakes intercepted wings directly. Author

A92-45546#

TRANSONIC UNSTEADY INVISCID AND VISCOUS FLOW'S SIMULATION AROUND 2-D MOVING BODIES

M. P. THOMADAKIS and S. TSANGARIS (Athens, National Technical University, Greece) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 764-774. refs
(AIAA PAPER 92-2704) Copyright

The paper presents a generalized method for the numerical simulation of the unsteady compressible flow around stationary or moving bodies. The unsteady Euler and Reynolds-averaged Navier-Stokes equations are numerically solved using a first or second order time accurate implicit factored scheme. The aim is to investigate the effect that the higher order time accuracy has on the solution, to compare the inviscid and viscous results for the same flow problem and to investigate the influence of the grid refinement on the numerical prediction. It is shown that when a second order time accurate scheme is implemented instead of a first order one, larger time steps can be used and so computer time savings of up to 50 percent can be obtained without destroying the accuracy of the solution. Both the inviscid and viscous solutions predict the same physics of the flow, although differences are observed in the values of the total forces and in the location of the shock waves. Comparison between numerical results and experimental data is quite satisfactory, but reveals that there is a lot to be done in both areas of investigations before the prediction of unsteady compressible flows becomes a routine procedure. Author

A92-45548#

CONCEPTS FOR THE STABILITY ANALYSIS OF NLF-EXPERIMENTS ON SWEPT WINGS

H. BIELER (Deutsche Airbus GmbH, Bremen, Federal Republic of Germany) and G. REDEKER (DLR, Institut fuer Entwurfsaerodynamik, Braunschweig, Federal Republic of Germany) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 785-795. refs
(AIAA PAPER 92-2706) Copyright

The prediction of aircraft aerodynamic performance and the extrapolation of laminar wind tunnel tests necessitates reliable and practicable criteria for the prediction of laminar-turbulent transition. For swept wings designed for laminar flow control in particular, transition criteria of Tollmien-Schlichting and crossflow instabilities have to be developed and tested for wind tunnel as well as flight Reynolds numbers. Here, the physical properties of Tollmien-Schlichting and crossflow instabilities are reviewed and strategies used to obtain significant N-factors and the least amount of computing for 3D basic flows are discussed. C.D.

A92-45549#

TURBULENT DRAG REDUCTION BY LAMINAR SUBLAYER THICKENING

G. LOEBERT (MBB GmbH, Munich, Federal Republic of Germany) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 796-800. refs
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It is well known that in a boundary layer the turbulent flow region is separated from the stationary wall by a very thin laminar sublayer. The velocity at the inner edge of the turbulent layer is about 40 percent of the freestream velocity. The turbulent layer thus slips on the laminar sublayer with a substantial slip velocity. If the thickness of the laminar sublayer, which is determined by stability criteria, can be increased the slip of the turbulent layer will increase and the fraction drag will decrease. One means of sublayer thickening is to stabilize the laminar flow by a series of longitudinal T-shaped riblets or, equivalently, to allow the sublayer air to flow in a series of square pipes that are partially open to the adjacent turbulent layer. In this paper the flow within and exterior to such a square slip channel is analyzed, and the resultant drag is calculated as a function of the channel Reynolds number and of the slot width. It is found that it should be possible to reduce turbulent drag by at least 15 percent with such a surface structure. Author

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COMPUTATIONAL EVALUATION OF AN AIRFOIL WITH A GURNEY FLAP

CORY S. JANG (California Polytechnic State University, San Luis Obispo), JAMES C. ROSS (NASA, Ames Research Center, Moffett Field, CA), and RUSSELL M. CUMMINGS (California Polytechnic State University, San Luis Obispo) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 801-809. refs
(Contract NCC2-536)
(AIAA PAPER 92-2708) Copyright

A 2D numerical investigation was performed to determine the effect of a Gurney flap on a NACA 4412 airfoil. A Gurney flap is a flat plate on the order of 1 to 3 percent of the airfoil chord length, oriented perpendicular to the airfoil chord line and located at the trailing edge of the airfoil. An incompressible Navier Stokes code, INS2D, was used to calculate the flow field about the airfoil. The fully turbulent results were obtained using the Baldwin-Barth one-equation turbulence model. Gurney flap sizes of 0.5 , 1, 1.25, 1.5, 2, and 3 percent of the airfoil chord were studied. Computational results were compared with experimental results where possible. The numerical solutions show that the Gurney flap increases airfoil lift coefficient with only a slight increase in drag coefficient. Use of a 1.5 percent chord Gurney flap increases the maximum lift coefficient by approximately 0.3 and decreases the angle of attack for a given lift coefficient by more than 3 deg. The numerical solutions exhibit detailed flow structures at the trialing edge and provide a possible explanation for the increased aerodynamic performance. Author

A92-45551#

COMPRESSIBLE NAVIER-STOKES SOLUTIONS FOR A SUCTION BOUNDARY CONTROL AIRFOIL

J. F. SLOMSKI (U.S. Navy, Naval Surface Warfare Center, Bethesda, MD) and W. C. WELTON (Cornell University, Ithaca, NY) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 810-822. refs
(AIAA PAPER 92-2710)

This research examines some details associated with numerical simulation of flow around thick airfoils which use suction as a means of boundary layer control. The 2D, compressible Navier-Stokes equations are solved for flows around a 50 percent thick airfoil with suction slots at about the 70 percent chord location. A five zone C-type grid forms the computational domain. An algebraic turbulence model is used with appropriate modifications to the turbulent length scale in the suction slots and in the wake. Suction was modeled by specification of appropriate velocities along the slot boundary. Solutions were carried out for angles of attack from 0 to 12 degrees, and three different boundary layer suction flow rates. Mach number and Reynolds number based on chord were 0.13 and about 865,000, respectively. All solutions were carried out fully turbulent. Author

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ALLEVIATION OF SIDE FORCE ON TANGENT-OGIVE FOREBODIES USING PASSIVE POROSITY

STEVEN X. S. BAUER (NASA, Langley Research Center, Hampton, VA) and MICHAEL J. HEMSCH (Lockheed Engineering and Sciences Co., Hampton, VA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 823-834. refs
(Contract NAS1-19000)
(AIAA PAPER 92-2711) Copyright

An experimental investigation to determine the effectiveness of porosity for alleviating side forces on forebodies was conducted in the NASA Langley Research Center 7 x 10 ft High-Speed Wind Tunnel. The study consisted of a comparison of experimental force, moment, and surface pressure results obtained on a fineness ratio 5.0 tangent-ogive porous forebody with 0.020 in. hole diameter and 22 percent porosity with results obtained on a solid forebody. The forebodies were tested with cylindrical afterbodies. The solid forebody was tested with transition grit to simulate fully turbulent conditions and without transition grit to simulate free transition conditions. The extent of porosity on the forebody was varied to determine the extent of porosity needed to alleviate side forces. Static longitudinal and lateral-directional stability and surface pressure data were obtained at Mach numbers of 0.2, 0.5, and 0.8. The angle of attack range was from 5 to 45 deg and roll angles from -90 to 180 deg. The solid forebody exhibited large asymmetries at moderate to high angles of attack causing large side forces and yawing moments. The porous forebody exhibited no significant side forces or yawing moments at any angle of attack tested. Author

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A LEX BLOWING TECHNIQUE FOR POST-STALL LATERAL CONTROL OF TRAPEZOIDAL WINGS

DHANVADA M. RAO (Vigyan, Inc., Hampton, VA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 835-843. Research supported by NASA. refs
(AIAA PAPER 92-2714) Copyright

An exploratory low-speed wind-tunnel investigation of a pneumatic technique for LEX-induced lift augmetation on a low-aspect-ratio trapezoidal wing near C sub L, MAX is reported. The technique involved lateral sheet ejection from LEX edge-slots, with emphasis on nonsymmetrical blowing to obtain incremental roll control at high angles of attack when the aileron power is declining. Preliminary experiments on a pressure instrumented semispan wing model followed by force/moment measurements on a full-span LEX-wing configuration confirmed the effectiveness of LEX blowing for lateral control improvement up to an angle of attack of 45 deg and with a momentum coefficient of less than 02. Author

A92-45554#

AN EXPERIMENTAL INVESTIGATION OF THE EFFECT OF LEADING-EDGE EXTENSIONS ON DIRECTIONAL STABILITY AND THE EFFECTIVENESS OF FOREBODY NOSE STRAKES

AN-KUO FU, C. E. LAN (Kansas, University, Lawrence), and LIH-SHYUNG SHYU (Aeronautical Research Laboratory, Taichung, Republic of China) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 844-854. refs
(AIAA PAPER 92-2715) Copyright

A generic configuration with a tangent-ogive forebody and leading edge extensions (LEXs) was tested in a 7 ft by 10 ft wind tunnel at a Reynolds number of 1.67 x 10 exp 6/ft. For the baseline configuration without LEXs, directional instability was mainly caused by the forebody. With the LEXs on, the forebody vortices were depressed toward the body surface by the LEX vortices. Consequently, the forebody was not effective in contributing to directional stability or instability. The latter was mainly induced by the vertical tail immersed in the separated flow field from the wing and the burst LEX vortices. Configurations with both small and large symmetric nose strakes were still directionally unstable; the instability was due to the forebody when LEXs were absent and by the vertical tail with LEXs on. A single nose strake at phi(s) large enough to prevent a second vortex from developing was effective in generating a control yawing moment at high angles of attack. C.D.

A92-45555*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

FOREBODY VORTEX CONTROL FOR SUPPRESSING WING ROCK ON A HIGHLY-SWEPT WING CONFIGURATION

CARLOS J. SUAREZ, BRIAN R. KRAMER, BERT AYERS, and GERALD N. MALCOLM (Eidetics International, Inc., Aeronautics Div., Torrance, CA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 855-868. refs
(Contract NAS2-12989)
(AIAA PAPER 92-2716) Copyright

Free-to-roll tests were conducted in a wind tunnel with a configuration that consisted of a highly-slender forebody and a 78 deg swept delta wing. A limit cycle oscillation was observed for angles of attack between 22 and 30 deg. In general, the main flow phenomena responsible for the wing-body-tail wing rock are the interactions between the forebody and the wing vortices. Various blowing techniques were evaluated as means of wing rock suppression. Blowing tangentially aft from leeward side nozzles near the forebody tip can damp the roll motion at low blowing rates and stop it completely at higher blowing rates. At the high rates, significant vortex asymmetries are created, causing the model to stop at a non-zero roll angle. Forward blowing and alternating right/left pulsed blowing appear to be more efficient techniques for suppressing wing rock. The oscillations can be damped almost completely at lower blowing coefficients, and, apparently, no major vortex asymmetries are induced. Good agreement is observed between this study and previous water tunnel tests on the same configuration. Author

A92-45556#

SURFACE GRID GENERATION IN A PARAMETER SPACE

JAMSHID SAMAREH-ABOLHASSANI and JOHN E. STEWART (Computer Sciences Corp., Hampton, VA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 869-880. refs
(AIAA PAPER 92-2717)

A robust and efficient technique is discussed for surface-grid generation on a general curvilinear surface. This technique is based on a nonuniform parameter space and allows for the generation of surface grids on highly skewed and nonuniform spaced background surface-grids. This method has been successfully integrated into the GRIDGEN software system. Author

A92-45557*# National Aeronautics and Space Administration, Washington, DC.

NUMERICAL SIMULATIONS USING A DYNAMIC SOLUTION-ADAPTIVE GRID ALGORITHM, WITH APPLICATIONS TO UNSTEADY INTERNAL FLOWS

RUSTY A. BENSON, D. S. MCRAE, and JACK R. EDWARDS (North Carolina State University, Raleigh) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 881-894. Research supported by U.S. Navy. refs
(Contract NAGW-1072; F49620-92-J-0189)
(AIAA PAPER 92-2719) Copyright

An investigation into the numerical simulation of unsteady flows is undertaken using a two-stage Runge-Kutta scheme coupled with the dynamic solution-adaptive grid algorithm developed by the authors. The inviscid fluxes are described by a modified Advective Upwind Split Method to eliminate the need for artificial dissipation. A well-documented numerical example containing moving discontinuities is presented that demonstrates the ability of the coupled grid/solver scheme to accurately capture unsteady flowfield phenomena. Applications are to a typical inlet diffuser configuration at Mach 3.0 with excessive back pressure inducing inlet unstart. Author

A92-45558#

A NEW AUTOMATIC GRID GENERATION ENVIRONMENT FOR CFD APPLICATIONS

D. BERTIN (Aerospatiale, Division Avions, Toulouse, France), J. LORDON (Control Data France, Toulouse), and V. MOREUX (Aerospatiale, Division Avions, Toulouse, France) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 895-903. refs
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This new grid generation environment enables the fluid volume around complex shapes to be meshed rather easily and quickly. The resulting mesh is structured multiblock, it can be generated interactively or in replay mode. Overall, the new system makes it possible to decrease the CFD design cycle time. The system principles and practical handling are described. Some examples of meshes around industrial configurations and samples of aerodynamic calculations are detailed and shown. Author

A92-45559#

PRISMATIC GRID GENERATION WITH AN EFFICIENT ALGEBRAIC METHOD FOR AIRCRAFT CONFIGURATIONS

Y. KALLINDERIS and S. WARD (Texas, University, Austin) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 904-918. refs
(Contract AF-AFOSR-91-0022)
(AIAA PAPER 92-2721) Copyright

The development and applications of a new generation method for prismatic semi-structured grids are described. The method combines algebraic and elliptic steps which yield low computation cost and grid smoothness. This technique has been developed for treatment of complex aircraft configurations with emphasis on generation of a suitable grid to cover the thin viscous regions emcountered in high Reynolds number flow simulations. Employment of prismatic elements is a relatively new approach toward 3-D complex geometry numerical simulations of high Reynolds number flows. The developed grid generator also offers direct control of grid orthogonality and spacing along with its generality for treatment of complex 3-D geometries. The efficiency and robustness of the method to handle complex topologies were investigated. A.O.

A92-45560*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

VISCOUS FLOW PAST A NACELLE ISOLATED AND IN PROXIMITY OF A FLAT PLATE

KAMRAN FOULADI (Lockheed Engineering and Sciences Co., Hampton, VA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 919-927. refs
(Contract NAS1-19000)
(AIAA PAPER 92-2723) Copyright

Linearized-theory design procedures have proven to be useful in preliminary design stages of supersonic aircraft configurations. These procedures are impaired, however, by their inability to account for certain nonlinear effects inherent in complicated flows. The present computations are aimed at providing necessary information for correction and improvement of a particular linearized design method. Three-dimensional, viscous, supersonic flows past nacelle and nacelle-flat plate configurations are investigated. The thin-layer Navier-Stokes equations are solved using an implicit, upwind-biased, finite-volume method. A hybrid domain decomposition technique is utilized to ease the grid generation task. Computations were made for an unit Reynolds number of 2.0 million per foot and Freestream Mach numbers of 1.6, 2.0, and 2.3. Author

A92-45561*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

THE FLIP FLOP NOZZLE EXTENDED TO SUPERSONIC FLOWS

GANESH RAMAN (Sverdrup Technology, Inc., Brook Park, OH), MICHAEL HAILYE (Michigan, University, Ann Arbor), and EDWARD J. RICE (NASA, Lewis Research Center, Cleveland, OH) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 928-951. Previously announced in STAR as N92-23269. refs
(AIAA PAPER 92-2724) Copyright

An experiment studying a fluidically oscillated rectangular jet flow was conducted. The Mach number was varied over a range from low subsonic to supersonic. Unsteady velocity and pressure measurements were made using hot wires and piezoresistive pressure transducers. In addition smoke flow visualization using high speed photography was used to document the oscillation of the jet. For the subsonic flip-flop jet it was found that the apparent time-mean widening of the jet was not accompanied by an increase in mass flux. It was found that it is possible to extend the operation of these devices to supersonic flows. Most of the measurements were made for a fixed nozzle geometry for which the oscillations ceased at a fully expanded Mach number of 1.58. By varying the nozzle geometry this limitation was overcome and operation was extended to Mach 1.8. The streamwise velocity perturbation levels produced by this device were much higher than the perturbation levels that could be produced using conventional excitation sources such as acoustic drivers. In view of this ability to produce high amplitudes, the potential for using small scale fluidically oscillated jet as an unsteady excitation source for the control of shear flows in full scale practical applications seems promising. Author

A92-45562#
COMPUTATION OF TURBULENT FLOW ABOUT CONE-DERIVED WAVERIDER
BOR-JANG TSAI, JOHN B. MILES (Missouri-Columbia, University, Columbia), and KAKKATTUKUZHY M. ISSAC (Missouri-Rolla, University, Rolla) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 952-962. Research supported by University of Illinois. refs
(AIAA PAPER 92-2726) Copyright

The paper presents the results of a computational fluid dynamics study of the three-dimensional, turbulent, supersonic flowfield about the forebody of a conical waverider at zero angle of attack. The numerical method uses the flux difference splitting algorithm, as embodied in the Navier-Stokes code entitled CFL3D, developed by NASA-Langley Research Center, and the Baldwin-Lomax algebraic turbulence model is employed. The grid selected and overall correctness of the turbulent flow computations are validated by comparison to counterpart flat plate results. The obtained turbulent flow results about the waverider are compared to previously reported results by the authors for the laminar flow about the same configuration, as well as to available experimental and analytical results. Author

A92-45563#
ACTIVE CONTROL OF VORTEX STRUCTURES IN A SEPARATING FLOW OVER AN AIRFOIL
J. A. LOVATO (USAF, Frank J. Seiler Research Laboratory, Colorado Springs, CO) and T. R. TROUTT (Washington State University, Pullman) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 963-970. refs
(Contract F49620-90-C-0076; AF-AFOSR-90-0131)
(AIAA PAPER 92-2728)

The effect of tangential-pulsed air control on dynamic separation is investigated for a NACA-0015 airfoil. Forcing frequencies are coupled with the predetermined static poststall fundamental frequencies associated with free shear layer vortex generation. For all cases studied the airfoil is pitched at a constant rate corresponding to an alpha(+) of 0.05. Results confirm that the active control alters the nature of the unsteady separating boundary layer. The leading edge vortex characteristic to unsteady airfoil flows is attenuated up to 30 deg angle of attack, and upper surface velocity magnitudes are significantly increased over the natural case. In addition, the active forcing appears to create or enhance development of numerous flow regions on the upper airfoil surface. Author

A92-45564#
VISUALIZATION OF STOPPING FLOW OVER AIRFOILS
HAUKE BUSCH and PETER FREYMUTH (Colorado, University, Boulder) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 971-981. refs
(AIAA PAPER 92-2730) Copyright

The vortical patterns of nearly impulsively stopped steady flow over airfoils with NACA 0015 profile have been visualized and their development are described. Dependence of pattern development on angle of attack and on Reynolds number have been explored. In case of detached flow vortex pairs or mushrooms developed near the leading edge of the airfoil and for the higher angles of attack also near the trailing edge. In case of attached flow which occurred at low angles of attack, not greater than 10 deg, and even then at sufficiently high Reynolds numbers only, a leading edge and a trailing edge stopping vortex carrying the circulation of the airfoil were observed simultaneously. Author

A92-45565#
EXPERIMENTAL INVESTIGATION OF VORTEX DYNAMICS ON DELTA WINGS
G. GUGLIERI (CNR, Turin, Italy) and F. B. QUAGLIOTTI (Torino, Politecnico, Turin, Italy) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 982-989. refs
(AIAA PAPER 92-2731) Copyright

Delta wing vortex dynamics was investigated by extensive wind tunnel testing of a 65 degree delta wing. At moderate angles of attack the leeward flow field is dominated by organized vortical flow structures from the leading edge. At high angles of attack vortex breakdown leads to changes in the aerodynamic coefficients which affect wing performance. Vortex breakdown was studied using tests on the delta wing under static and dynamic conditions with forced oscillatory motions. Varying angles of attack and Reynolds numbers were used to determine factors which influence vortex breakdown. Results indicate that the position of breakdown is determined by the pressure gradient along the vortex, initial axial core velocity and slideslip angle. Flow visualization techniques were effective in visualization of vortical flow and breakdown in dynamic conditions. The correlation of pressure gradients with force measurements and flow visualizations at varying attack and sideslip angles under static and dynamic conditions, and to different oscillation frequencies for dynamic conditions are presented. The data acquisition system, pressure measurement system, and flow visualization method are described. A.O.

A92-45566#
DYNAMIC LEX/FOREBODY VORTEX INTERACTION EFFECTS
L. E. ERICSSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 990-996. refs
(AIAA PAPER 92-2732) Copyright

Laminar subscale tests and full-scale flight of the F/A-18 aircraft showed wing rock. This was not observed during wind tests at an intermediate Reynolds number. An analysis of recent experimental results and a separation flow hypothesis which offers an explanation of these observations are presented. Results indicate that dynamic simulation of self-excited oscillations in susbscale tests is not possible unless the full-scale Reynolds number is simulated. The present analysis indicates that even in the presence of moving wall effects analytic extrapolation to full-scale vehicle dynamics from subscale tests may be possible. A.O.

A92-45567#
TIME ACCURATE COMPUTATION OF UNSTEADY TRANSONIC FLOWS AROUND AN AIRFOIL WITH OSCILLATING FLAP ON DYNAMIC GRID
CHANGJU KIM and DONGHO LEE (Seoul National University, Republic of Korea) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 997-1004. Research supported by Korea Science and Engineering Foundation. refs
(AIAA PAPER 92-2733) Copyright

The time accurate delta(k)-correction iterative scheme has been applied to calculate the unsteady flow around an airfoil with an oscillating plain flap or an oscillating slotted-flap. An efficient generation method of the dynamic grid has been developed and the topology of the present dynamic blocked-grid generation has its base on the structured initial grid with nearly continuous metric distribution across boundaries of the blocked-grid. Therefore, the numerical algorithm has no dependency on the regenerated dynamic grid and can be easily programmed and vectorized. Also, to reduce the geometrically induced error by volumetric variations of the grid system, the Geometric Conservation Law (GCL) proper to the Roe's flux difference splitting scheme and the Matsuno's delta(k)-C time-integration have been derived in the uniform flow condition and applied to the oscillating NACA0012 airfoil resulting in good agreement. Also, the numerical computations are carried out for B-type shock motion around a NACA64A010 airfoil with an oscillating plain flap and unsteady flow around an NLR7301 supercritical airfoil with an oscillating slotted flap. The usefulness and the efficiency of the present blocked dynamic-grid generation method are found for the unsteady transonic flowfields due to the oscillating control surface. Author

A92-45568*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NAVIER-STOKES COMPUTATION OF WING LEADING EDGE TANGENTIAL BLOWING FOR A TILT ROTOR IN HOVER
IAN FEJTEK and LEONARD ROBERTS (Stanford University, CA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1006-1015. refs
(Contract NCC2-55)
(AIAA PAPER 92-2608) Copyright

The effect of a thin tangential jet located at the leading edge of the wing of a tilt rotor configuration in hover is computed using the thin-layer Navier-stokes equations. Computations showed that leading edge tangential blowing is effective in reducing the download caused by the impingement of the rotor download caused by the impingement of the rotor downwash on the wing. Results from the numerical model support previous experimental findings that download reduction is due mainly to a decrease in upper surface pressure and not an increase in pressure on the lower surface. The numerical solution clearly shows that because of the three-dimensionality of the flow field, the download could be reduced further by allowing a spanwise variation in blowing strength. Author

A92-45569#
PREDICTION OF THE VISCOUS TRANSONIC AERODYNAMIC PERFORMANCE OF SUPERCRITICAL AEROFOIL SECTIONS
LESLIE J. JOHNSTON (University of Manchester Institute of Science and Technology, England) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 1016-1025. refs
(AIAA PAPER 92-2653) Copyright

A recently-developed computational method is used to predict the aerodynamic performance of the CAST 7 supercritical aerofoil section over a wide range of transonic conditions, from fully-subcritical flow to supercritical flow with shock-induced separation. The method is based on a finite-volume spatial discretization of the compressible Reynolds-averaged Navier-Stokes equations. Reynolds stresses appearing in the governing mean-flow equations are modeled via the eddy viscosity concept, in conjunction with a one-equation turbulence model. This latter model involves the solution of an additional modeled transport equation for the turbulent kinetic energy. Solutions are obtained by time-marching the unsteady flow equations to the steady-state using an explicit multi-stage scheme. Results are presented for the CAST 7 aerofoil, covering incidence angle sweeps at freestream Mach numbers of 0.70 and 0.76, and a Mach number sweep at constant incidence angle. Comparisons with experimental measurements indicate that the general features of the surface pressure distribution and trends for the integrated loads are reasonably well-predicted. Author

A92-45570#
COMPUTATIONS OF HYPERSONIC FLOWS AROUND A THREE-DIMENSIONAL CONCAVE/CONVEX BODY
SURESH MENON, ALAN MUELLER (Quest Integrated, Inc., Kent, WA), JIM L. WONG (TRW, Inc., San Bernardino, CA), and JAMIE KRIEBEL (USAF, Washington, DC) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 14 p. refs
(AIAA PAPER 92-2606)

A numerical scheme was developed for computing steady-state flowfields around a complex concave/convex shaped vehicle in a turbulent hypersonic flow. The numerical scheme used a multistage, multigrid approach with a second-order total variation diminishing scheme to resolve the strong bowshock. The code was used to simulate the flowfield around the concave/convex vehicle at various angles of attack. A complex embedded shock structure was found at the inflection location of the expansion/compression surface. Due to the interaction between the bowshock and the secondary embedded shock, a shear layer was created and the transmitted shock impinged on the surface at an axisymmetrical flow generated high local heating and pressure. This shear layer formed a jetlike flow at the angle of attack, which could cause substantial damage downstream at its reattachment location. I.S.

A92-45571#
A TRANSONIC/SUPERSONIC/HYPERSONIC CFD ANALYSIS OF THE ENTRY SPACE SHUTTLE ORBITER
EDWARD C. MA (Lockheed Engineering and Sciences Co., Houston, TX) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 14 p. refs
(AIAA PAPER 92-2614)

Numerical simulations of the STS-28 reentry trajectory have been performed using in-house Euler solver E3D. The 3D Euler equations are integrated by means of a time marching finite volume shock capturing method, based on cell centered and upwind evaluation of the cell face fluxes with van Leer or Roe's flux-splitting techniques. Computed pressure coefficients at several Mach numbers 0.95, 1.4, 2.0, 2.5, 3.5, and 5.0 are compared with STS-28 flight data and OA146 airloads data base over a wide range of angles of attack (7-30 deg) in order to determine the applicability of the code for different flight regimes. Solutions are in good agreement with available experimental data. It is demonstrated that the E3D Euler code is capable of accurately predicting surface properties for entry Orbiter configuration. Author

A92-45572#
TRANSONIC CALCULATIONS FOR WINGS WITH DEFLECTED CONTROL SURFACES
VINCENT D. CHIN (Douglas Aircraft Co., Long Beach, CA) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 13 p. refs
(AIAA PAPER 92-2617) Copyright

This paper describes a method for predicting transonic flows about wing/body configurations with deflected control surfaces. A multi-zone capability was added to an existing wing/body Euler code for structured meshes and then coupled to a finite difference interactive boundary-layer method to simulate viscous effects. Solutions about a configuration with a deflected aileron show good correlation when compared to experimental data. Author

A92-45574*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

SURFACE AND FLOW FIELD MEASUREMENTS IN A SYMMETRIC CROSSING SHOCK WAVE/TURBULENT BOUNDARY LAYER FLOW

D. O. DAVIS and W. R. HINGST (NASA, Lewis Research Center, Cleveland, OH) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 19 p. refs
(AIAA PAPER 92-2634) Copyright

Results of an experimental investigation of a symmetric crossing shock/turbulent boundary layer interaction are presented for a Mach number of 3.44 and deflections angles of 2, 6, 8 and 9 deg. The interaction strengths vary from weak to strong enough to cause a large region of separated flow. Measured quantities include surface static pressure and flowfield Pitot pressures. Pitot profiles in the plane of symmetry through the interaction region are shown for various deflection angles. Oil flow visualization and the results of a trace gas streamline tracking technique are also presented. Author

A92-45575*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

SEPARATION CONTROL ON HIGH REYNOLDS NUMBER MULTI-ELEMENT AIRFOILS

JOHN C. LIN, STEPHEN K. ROBINSON, ROBERT J. MCGHEE (NASA, Langley Research Center, Hampton, VA), and WALTER O. VALAREZO (Douglas Aircraft Co., Long Beach, CA) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 17 p. refs
(AIAA PAPER 92-2636)

Small surface-mounted vortex generators were investigated as means for the control of a boundary-layer separation on a 2D single-flap three-element high-lift system at near-flight Reynolds numbers and in landing configurations. Wind-tunnel results obtained for small vane-type vortex generators mounted on a multielement airfoil showed that vortex generators as small as 0.18 percent of total chord can effectively reduce or eliminate boundary-layer separation on the flap at approach conditions. It was found that both the outerrotating and the corotating streamwise vortices were effective in reducing flow separation. I.S.

A92-45576*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

EXPLORATORY INVESTIGATION OF A SPANWISE BLOWING CONCEPT FOR TIP-STALL CONTROL ON CRANKED-ARROW WINGS

DHANVADA M. RAO (Vigyan, Inc., Hampton, VA) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 10 p. Research supported by NASA.
(AIAA PAPER 92-2637) Copyright

A novel blowing concept aimed at controlling the tip-panel stall of 'cranked-arrow' type wings was experimentally investigated. A spanwise-directed jet sheet tangential to the upper surface, blown from a chordwise slot located at the crank, interacts obliquely with the external flow to generate a powerful and highly controllable vortex, substantially covering the tip panel. The incremental suction due to this jet vortex, coupled with its flow stabilization effect improves the tip-panel maximum lift and stall characteristics, leading to pitch-up alleviation and lateral control augmentation. Low-speed wind tunnel flow visualizations, pressure measurements and force/moment results are presented validating the flow-control concept and illustrating its potential on a generic crank-arrow wing model. Author

A92-45578#

A NUMERICAL STUDY OF CONTROL SURFACE BUZZ USING COMPUTATIONAL FLUID DYNAMIC METHODS

DENNIS F. FUGLSANG, LARRY O. BRASE, and SHREEKANT AGRAWAL (McDonnell Aircraft Co., Saint Louis, MO) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 13 p. refs
(Contract N00019-84-C-0240)
(AIAA PAPER 92-2654) Copyright

The control-surface rudder buzz recorded during the development of the T-45A Goshawk aircraft was investigated using computational fluid dynamics methods in conjunction with results of aircraft flight tests. The buzz was attributed to a forced oscillation caused by unstable shock wave motion and shock-induced separation. The onset of buzz is believed to be a result of inviscid unsteady shock wave motion; however, separation of the boundary layer at higher oscillation amplitudes is crucial for sustaining and moderating the control-surface motion. Steady-state Navier-Stokes calculations were performed, using the TLNS3D code, to verify the existence of shock waves and flow separation. I.S.

A92-45582#

COMPARISON OF TWO FLUX SPLITTING SCHEMES FOR CALCULATION OF OGIVE-CYLINDER AT M = 3.5 AND ALPHA = 18 DEG

T. HSIEH and A. B. WARDLAW, JR. (U.S. Navy, Naval Surface Warfare Center, Silver Spring, MD) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 16 p. refs
(AIAA PAPER 92-2667)

Comparisons are presented of Navier-Stokes solutions for an ogive cylinder at M = 3.5 and alpha = 18 deg using the Roe's flux-difference splitting and Van Leer's flux vector splitting schemes. This problem features massive crossflow separation which forms vortices on the leeside of the cylinder. Solutions are computed for laminar and turbulent cases using H and C grids. It was found that Roe's scheme is less robust and requires more computing time. The difference in the predicted flowfield is small, typically less than 1 percent in lift coefficient. For engineering applications, convergence with respect to lift instead of the residual is the criterion used to determine steady state. For reason not fully understood, the laminar solution is, overall, in better agreement with the turbulent experiment than is the turbulent solution. Author

A92-45583*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

FOREBODY FLOW CONTROL ON A FULL-SCALE F/A-18 AIRCRAFT

WENDY R. LANSER and LARRY A. MEYN (NASA, Ames Research Center, Moffett Field, CA) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 12 p. refs
(AIAA PAPER 92-2674) Copyright

A full-scale F/A-18 was tested in the 80- by 120-Foot Wind Tunnel at NASA Ames Research Center to measure the effectiveness of pneumatic forebody vortex control devices. By altering the forebody vortex flow, yaw control can be maintained to angles of attack greater than 50 deg. Two forebody vortex control devices were tested: a discrete circular jet and a tangential slot. The tests were conducted for angles of attack between 25 and 50 deg, and angles of sideslip from 0 to +/- 15 deg. The Reynolds number based on wing mean aerodynamic chord ranged from 4.5 x 10 exp 6 to 12.0 x 10 exp 6. The time-averaged side forces and yawing moments, along with both time-averaged and time-dependent pressures on the forebody of the aircraft are presented here for various configurations. Of particular interest was the results that the tangential slot blowing had a greater effect on the yawing moment than the discrete circular jet. Additionally, it was found that blowing very close to the radome apex was not as effective as blowing slightly farther aft on the radome, and that a 16-inch slot was more effective than either an 8- or 48-inch long slot. Author

A92-45584*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

FULL-SCALE HIGH ANGLE-OF-ATTACK TESTS OF AN F/A-18

LARRY A. MEYN, WENDY R. LANSER (NASA, Ames Research Center, Moffett Field, CA), and KEVIN D. JAMES (Sterling Federal Systems, Inc., Palo Alto, CA) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 13 p. refs
(AIAA PAPER 92-2676) Copyright

This paper presents an overview of high angle-of-attack tests of a full-scale F/A-18 in the 80- by 120-Foot Wind Tunnel of the

National Full-Scale Aerodynamic Complex at NASA Ames Research Center at Moffett Field, California. A production aircraft was tested over an angle-of-attack range of 18 to 50 deg and at wind speeds of up to 100 knots. These tests had three primary test objectives. Pneumatic and mechanical forebody flow control devices were tested at full-scale and shown to produce significant yawing moments for lateral control of the aircraft at high angles of attack. Mass flow requirements for the pneumatic system were found to scale with freestream density and speed rather than freestream dynamic pressure. Detailed measurements of the pressures buffeting the vertical tail were made and spatial variations in the buffeting frequency were found. The LEX fence was found to have a significant effect on the frequency distribution on the outboard surface of the vertical fin. In addition to the above measurements, an extensive set of data was acquired for the validation of computational fluid dynamics codes and for comparison with flight test and small-scale wind tunnel test results. Author

A92-45585#
PREDICTION OF LEADING-EDGE VORTEX BREAKDOWN ON A DELTA WING OSCILLATING IN ROLL
X. Z. HUANG and E. S. HANFF (National Research Council of Canada, Institute for Aerospace Research, Ottawa) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 14 p. Research supported by USAF and DND. refs
(AIAA PAPER 92-2677) Copyright

A method for the prediction of leading-edge vortex breakdown on a 65 deg delta wing at high incidence is proposed. The approach, based on the swirl parameter, takes into account quasi-steady as well as unsteady effects, allowing it to predict breakdown with reasonable accuracy both for static as well as roll oscillation conditions. Author

A92-45588#
QUANTIFICATION OF CANARD AND WING INTERACTIONS USING SPATIAL CORRELATION VELOCIMETRY
P. A. FAWCETT, R. B. FUNK, and N. M. KOMERATH (Georgia Institute of Technology, Atlanta) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 14 p. Research supported by NSF. refs
(Contract DAAL03-88-C-0003)
(AIAA PAPER 92-2687) Copyright

An experiment where a canard moves slowly in close proximity to a wing is used to develop the SCV technique for quantifying complex unsteady velocity fields. A dual-camera system removes previous limitations on flow velocity, and improves spatial resolution. Using laser sheet videography, both flow visualization and velocity measurements are performed while the test configuration is changed through a range of test conditions in a short time. The need to hold the configuration steady at each setting is removed. Automated postprocessing uses parallel computer algorithms to perform iterative analysis of the velocity field. Moving-window averaging, predictive correlation, pixel interpolation, and multiple-peak searching techniques are discussed. Sequences of flow visualization and velocity field images are presented for various configurations with the canard and wing showing attached and separated flows. Velocity variations over the wing show the expected acceleration and deceleration profiles, which are greatly modified by canard interaction. Velocity profiles across the flow show the jetlike flow between the canard and the wing, as well as the wake of the canard. Outstanding problems and sources of error are discussed. Author

A92-45590#
A COMPACT HIGHER ORDER EULER SOLVER FOR UNSTRUCTURED GRIDS WITH CURVED BOUNDARIES
D. W. HALT and R. K. AGARWAL (McDonnell Douglas Research Laboratories, Saint Louis, MO) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 10 p. Research sponsored by McDonnell Douglas Corp. refs
(AIAA PAPER 92-2696) Copyright

A new method is presented for solving the Euler equations on unstructured grids with improved efficiency using compact higher order polynomials. The method uses a characteristic-based approach within a cell-centered finite volume framework. Mutually orthogonal polynomials are used to represent the conservation variables over each cell. Solutions are presented for several 2D and 3D cases including the flow over a sinusoidal bump, an NLR 7301 airfoil with supercritical flow, a NACA 0012 airfoil with a shock and the ONERA M6 wing with a lambda shock. Solutions are shown from first order to fourth order spatial accuracy. Comparisons are shown with a hodograph solution for the supercritical airfoil and with available data for the NACA 0012 airfoil. Comparisons made with CFL2D demonstrate an order of magnitude improvement in accuracy and efficiency for the sinusoidal bump. Author

A92-45592#
AN UNSTRUCTURED APPROACH TO THE DESIGN OF MULTIPLE-ELEMENT AIRFOILS
DON W. KINSEY (USAF, Wright Laboratory, Wright-Patterson AFB, OH) and BRUCE A. JOLLY (Sverdrup Technology, Inc., Eglin AFB, FL) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 9 p. refs
(AIAA PAPER 92-2709) Copyright

This paper describes a design procedure for multiple-element airfoils. A robust, semiinverse geometry modification technique was combined with an unstructured Euler solver and a 'spring analogy' technique for grid movement. In theory, the resulting code may be used to determine the geometry of any number of arbitrary bodies from a given pressure distribution. A description of the techniques used and the results for two and three element airfoils are presented in this paper. Author

A92-45593#
SEPARATION PATTERNS AND FLOW STRUCTURES ABOUT A HEMISPHERE-CYLINDER AT HIGH INCIDENCES
K. C. WANG (San Diego State University, CA) and T. HSIEH (U.S. Navy, Naval Surface Warfare Center, Silver Spring, MD) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 18 p. refs
(AIAA PAPER 92-2712)

Navier-Stokes solutions for an incompressible flow over a hemisphere-cylinder at incidence of 10, 30 and 50 deg are obtained. The computed surface pressure distribution and the separated flow structure over the body surface as well as the meridional planes and the cross-planes are presented. The separation trend vs. incidence is compared with experimental flow visualizations in good agreement. Author

A92-45595#
ON THE AERODYNAMICS/DYNAMICS OF STORE SEPARATION FROM HYPERSONIC AIRCRAFT
GARY NEWMAN, KAREN FULCHER (Textron Defense Systems, Wilmington, MA), ROBERT RAY (General Applied Science Laboratories, Inc., Ronkonkoma, NY), and MARK PINNEY (USAF, Wright Laboratory, Wright-Patterson AFB, OH) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 12 p. refs
(AIAA PAPER 92-2722) Copyright

First order effects of flowfield nonuniformities associated with hypersonic shock layers and wakes on the dynamics and aerodynamics of a store deployed from a hypersonic vehicle were studied. Aerodynamic coefficients for the calculation of store trajectories were determined from an 'embedded' hypersonic impact theory methodology which has been validated by comparison with experimental data. Trajectories were computed using a 6 DOF dynamics code. Effects of deployment location, ejection velocity, initial pitch angle and pitch rate of the store on its trajectory and on the stability of its trajectory were studied. Author

A92-45596*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AN INVESTIGATION OF PASSIVE CONTROL METHODS FOR SHOCK-INDUCED SEPARATION AT HYPERSONIC SPEEDS
R. RALLO, M. WALSH (NASA, Langley Research Center, Hampton, VA), and BRAM VAN LEER (Michigan, University, Ann Arbor) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 17 p. refs
(AIAA PAPER 92-2725) Copyright
The effectiveness of several passive control techniques on shock-induced boundary-layer separation at hypersonic speed was investigated. Two approaches for alleviating the turbulent separation losses were examined: porous surface mass transfer and surface grooving. A total of four perforated surfaces with varying porosities were evaluated, and three groove orientations with respect to the freestream direction were studied. A comparison of the results from passive control techniques with those from an 'uncontrolled' shock impingement showed that the porous surface with the greatest porosity provided the greatest reduction in the pressure rise across the oblique shock wave. The grooved surface tested were found to be not effective; each of the grooved configurations examined increased the peak pressure value. I.S.

A92-45597#
AERODYNAMICALLY BLUNT AND SHARP BODIES
W. H. MASON and JAEWOO LEE (Virginia Polytechnic Institute and State University, Blacksburg) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 7 p. refs
(AIAA PAPER 92-2727) Copyright
Computational fluid dynamics studies at supersonic and hypersonic speeds have resulted in an improved understanding of the meaning of aerodynamically, as opposed to geometrically, sharp and blunt shapes. An analytic investigation using Newtonian theory was conducted to support the computational results. Based on this work, a new criteria for the definition of an aerodynamically sharp shape is proposed. Defining the power law shape to be the relevant gauge function, bodies with n greater than 2/3 are classified aerodynamically sharp, even though the initial body slope, dr/dx, is 90 deg. The paper provides a description of the analysis that resulted in the new sharp and blunt shape criteria for aerodynamics. Author

A92-45598*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MEASUREMENTS OF THE UNSTEADY VORTEX FLOW OVER A WING-BODY AT ANGLE OF ATTACK
BENOIT DEBRY, NARAYANAN M. KOMERATH, SHIUH-GUANG LIOU, J. CAPLIN, and JASON LENAKOS (Georgia Institute of Technology, Atlanta) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 12 p. refs
(Contract NAG1-1278)
(AIAA PAPER 92-2729) Copyright
Measurements of the unsteady vortex flow over a wing-body at high angles of attack were carried out on a generic test model of a pointed body of revolution with double-delta wings. Vortex patterns and trajectories were quantified from digitized laser sheet video images. The velocity-field measurements showed the jetlike flow in the unburst vortex, unsteady secondary structures below the primary core, and then the reversed flow in the burst vortex. Results of hot-film anemometry revealed the presence of peak frequencies in the velocity spectra over the wing and near the trailing edge, which varied linearly with freestream speed and increased as the measurement point moved upstream. Good Strouhal correlation was found with previous results obtained for a smaller generic wing-body model. I.S.

A92-45827
CALCULATION OF POTENTIAL FLOW AROUND AIRFOILS USING A DISCRETE VORTEX METHOD
GEORGE GIANNAKIDIS (Imperial College of Science, Technology, and Medicine, London, England) AIAA Journal (ISSN 0001-1452), vol. 30, no. 7, July 1992, p. 1689, 1690. Abridged. Research supported by Department of Trade and Industry of England. refs
Copyright
A discrete vortex method for calculating the potential flow around arbitrary 2D airfoils is presented, in which the Kutta-Joukowski condition is introduced as an extra equation and the final overdetermined linear system of equations is solved using Gaussian elimination with partial pivoting to remove the redundancy (instead of dropping one equation as was done in previous methods). A comparison of the present scheme with the widely used methods of Smith and Hess (1966) and Kennedy and Marsden (1976) showed that the present method offers higher accuracy for the same computational cost. I.S.

A92-45828
NONUNIFORM MOTION OF LEADING-EDGE VORTEX BREAKDOWN ON RAMP PITCHING DELTA WINGS
J. J. MIAU, R. C. CHANG, J. H. CHOU (National Cheng Kung University, Tainan, Republic of China), and C. K. LIN (Chung-Shan Institute of Science and Technology, Taichung, Republic of China) AIAA Journal (ISSN 0001-1452), vol. 30, no. 7, July 1992, p. 1691-1702. refs
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Vortex flow characteristics on ramp pitching delta wings of sweep angles from 59 to 70 deg were studied by flow visualization and LDA measurement. Experimental observations indicate that the movement of the breakdown point is strongly dependent on the sweep angles and the pitching rates. The moving behavior of the breakdown point can be characterized by the occurrence of two delays. The first delay is due to the fact that the flow initially takes a length of time comparable to C/U(infinity) to respond to the pitching motion. The second delay exists only for specific sweep angles and occurs in the course of pitching-up motion. It is characterized by the phenomenon that the breakdown point is moving slowly or even standing still above the wing surface for a certain length of time. The chordwise location corresponding to this occurrence shifts upstream as the pitching rate increases. This delay diminishes as the sweep angle increases. The LDA data obtained further reveal that both delays are associated with the underdevelopment of the primary vortex. Author

A92-45829
AERODYNAMIC CHARACTERISTICS OF HOAR FROST ROUGHNESS
R. J. KIND and M. A. LAWRYSYN (Carleton University, Ottawa, Canada) AIAA Journal (ISSN 0001-1452), vol. 30, no. 7, July 1992, p. 1703-1707. Research supported by NSERC. Previously cited in issue 06, p. 801, Accession no. A91-19413. refs
Copyright

A92-45839
VISCOUS HIGH-SPEED FLOW COMPUTATIONS BY ADAPTIVE MESH EMBEDDING TECHNIQUES
F. GRASSO, M. MARINI, and M. PASSALACQUA (Roma I, Universita, Rome, Italy) AIAA Journal (ISSN 0001-1452), vol. 30, no. 7, July 1992, p. 1780-1788. Previously cited in issue 07, p. 969, Accession no. A91-21381. refs
Copyright

A92-45840* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AEROTHERMODYNAMICS OF A 1.6-METER-DIAMETER SPHERE IN HYPERSONIC RAREFIED FLOW
V. K. DOGRA (Vigyan Research Associates, Inc., Hampton, VA), R. G. WILMOTH, and J. N. MOSS (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 30, no. 7, July 1992, p. 1789-1794. Previously cited in issue 06, p. 803, Accession no. A91-19462. refs
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A92-45845* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
STREAMLINES, VORTICITY LINES, AND VORTICES AROUND THREE-DIMENSIONAL BODIES

LESLIE A. YATES (Eloret Institute, Palo Alto, CA) and GARY T. CHAPMAN (California, University, Berkeley) AIAA Journal (ISSN 0001-1452), vol. 30, no. 7, July 1992, p. 1819-1826. Previously cited in issue 06, p. 802, Accession no. A91-19439. refs
(Contract NCC2-583)
Copyright

A92-45858
SEPARATED HIGH ENTHALPY DISSOCIATED LAMINAR HYPERSONIC FLOW BEHIND A STEP - PRESSURE MEASUREMENTS
S. L. GAI (Australian Defence Force Academy, Campbell, Australia) AIAA Journal (ISSN 0001-1452), vol. 30, no. 7, July 1992, p. 1915-1918. refs
Copyright

Results are presented of pressure measurements at three flow conditions, conducted under conditions similar to those described by Gai et al. (1989) (i.e. with velocities and enthalpies near those experienced during the flight of an aeroassisted space transfer vehicle). It is shown that general features of the hypervelocity laminar dissociated flow behind a step are qaualitatively similar to those of an undissociated flow at moderate Mach numbers. The distinguishing feature of the present flow is the appearance of a thick shear layer behind the step, which shows very little curvature, resulting in a gradual rise of pressure behind the step, especially postreattachment. I.S.

A92-45859
NEW METHOD OF SWIRL CONTROL IN A DIFFUSING S-DUCT
P. F. WENG and R. W. GUO (Nanjing Aeronautical Institute, People's Republic of China) (CUSAE '91; Proceedings of the 1st China-USSR Seminar on Aero Engines, Nanjing, People's Republic of China, Apr. 15-20, 1991, p. 5-14) AIAA Journal (ISSN 0001-1452), vol. 30, no. 7, July 1992, p. 1918, 1919. Previously cited in issue 11, p. 1718, Accession no. A92-29710. refs
Copyright

A92-46264* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DISCRETE MODES AND CONTINUOUS SPECTRA IN SUPERSONIC BOUNDARY LAYERS
P. BALAKUMAR and M. R. MALIK (High Technology Corp., Hampton, VA) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 239, June 1992, p. 631-656. refs
(Contract NAS1-18240)
Copyright

The disturbance field induced due to a harmonic point source consists of discrete eigenmodes and a continuous spectrum; these are studied by using generalized Fourier transform techniques. For a supersonic boundary layer, there exist seven branches of the continuous spectrum in the complex wavenumber space, four of which (two acoustic waves, one vorticity wave and one entropy wave) contribute to the flowfield downstream of the source. The discrete eigenmodes spring off from these branches at some critical Reynolds numbers. The results for Mach 2 and 4.5 boundary layers show that the receptivity coefficients for the stable discrete modes are much larger than that for the unstable mode. Therefore, the flow very near the source is dominated by the continuous spectrum and the stable discrete modes. However, the unstable mode takes over sufficiently far away from the source. It is shown that it is only necessary to consider the first few discrete modes to construct the solution. Calculations also show that, in a supersonic boundary layer, upstream influence from a localized disturbance is minimal. Author

A92-46431* National Aeronautics and Space Administration, Washington, DC.
WAVES AND THERMODYNAMICS IN HIGH MACH NUMBER PROPULSIVE DUCTS
R. J. STALKER (Queensland, University, Brisbane, Australia) IN: High-speed flight propulsion systems. Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1991, p. 237-264. Research supported by Australian Research Grants Scheme. refs
(Contract NAGW-674)
Copyright

The propulsive effects of waves in ducts, especially at high Mach numbers, are investigated, focusing on drag and thrust and on the conversion of heat into waves which produce thrust. It is shown that essentially all of the work done by an expanding fluid passing through a duct at high Mach number is delivered in the form of waves, and that duct surface angles exist that are optimum for the production of thrust from a wave. The effects of wave phenomena on drag and thrust are considered by extending the concept of a Busemann biplane into that of a 'Busemann scramjet, taking 'off-design' performance into account. An idealized model of a streamtube with heat addition is developed, and flow mechanisms involved in generating thrust by the expansion of this streamtube in an exhaust nozzle are examined. C.D.

A92-46441
THE INVISCID COMPRESSIBLE GOERTLER PROBLEM IN THREE-DIMENSIONAL BOUNDARY LAYERS
ANDREW DANDO (Manchester, Victoria University, England) Theoretical and Computational Fluid Dynamics (ISSN 0935-4964), vol. 3, no. 5, May 1992, p. 253-265. Research supported by SERC. refs
Copyright

Numerical solutions for the growth rates of Goertler vortices in a compressible three-dimensional flow in the inviscid limit of a large Goertler number are investigated. A range of Mach numbers are examined and find that there are three different types of behavior for the mode growth-rate, corresponding to whether the flow is incompressible, has a Mach number small enough so that temperature-adjustment-layer modes do not appear in the two-dimensional case, or has a Mach number large enough so that they do. It is found that it takes a considerably greater crossflow to destroy the Goertler vortices for moderate Mach numbers than it did in the incompressible case looked at by Bassom and Hall (1991). From this it is believed that Goertler vortices may well still be a cause of transition for many practical compressible inviscid three-dimensional flows. Author

A92-46519
EFFECT OF A FAN OF RAREFACTION WAVES ON THE DEVELOPMENT OF DISTURBANCES IN A SUPERSONIC BOUNDARY LAYER [O VLIIANII VEERA VOLN RAZREZHENIIA NA RAZVITIE VOZMUSHCHENII V SVERKHZVUKOVOM POGRANICHNOM SLOE]
S. A. GAPONOV, A. D. KOSINOV, A. A. MASLOV, and S. G. SHEVEL'KOV PMTF - Prikladnaia Mekhanika i Tekhnicheskaia Fizika (ISSN 0044-4626), no. 2, Mar.-Apr. 1992, p. 52-55. In Russian. refs
Copyright

Experiments were conducted in a supersonic wind tunnel in order to study the boundary layer stability during its interaction with a fan of rarefaction waves. The results indicate that the nonuniformity generated by flow turning in the supersonic boundary layer is the cause of the disturbances. Acoustic waves in the nonuniform region that are external to the boundary layer generate vortex disturbances. B.J.

A92-46626
SMOOTH SOLUTIONS FOR TRANSONIC GASDYNAMIC EQUATIONS [GLADKIE RESHENIIA URAVNENII TRANSZVUKOVOI GAZODINAMIKI]
NIKOLAI A. LAR'KIN Novosibirsk, Russia, Izdatel'stvo Nauka, 1991, 144 p. In Russian. refs
(ISBN 5-02-029345-8) Copyright

New results of the mathematical theory of the asymptotic equations of transonic gas dynamics are presented. Statements of boundary value problems for stationary and nonstationary equations modeling Laval nozzle flows are examined from the standpoint of their unique solvability and qualitative behavior of the solution. The nonlinear stability of stationary solutions and stabilization of nonstationary solutions at infinity are analyzed. In addition to classical forms of transonic flow equations, consideration is also given to mathematical models allowing for the effects of viscosity and heat conductivity. V.L.

A92-46778

UNSTEADY AERODYNAMICS OF A WORTMANN WING AT LOW REYNOLDS NUMBERS

H.-T. LIU (Quest Integrated, Inc., Kent, WA) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 532-539. Research sponsored by Quest Integrated, Inc. refs

(Contract N00014-85-C-0214)

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The unsteady effects of turbulence and gusts on the performance of a full-scale Wortmann FX 63-137 wing for remotely piloted vehicle applications were studied by conducting experiments in the atmospheric boundary layer. The wing, which had an aspect ratio of 6, was mounted on an instrumented truck equipped for force/moment and wind measurements. The vehicle remained stationary, and the wing was aligned with the prevailing wind. The wing experienced predominantly a plunging rather than a pitching motion, together with sweeping and longitudinal oscillations, due to the unsteady three-dimensional wind field. The chord Reynolds number ranged from 250,000 to 450,000, and the turbulence intensity ranged from 8 to about 20 percent. From the spectra of the wind components, the reduced frequencies experienced by the wing may be up to 0.1 or higher, indicating that unsteady effects are important. The results show significant lift overshoot, resulting in an increase in the maximum lift coefficient and stall angle. The aerodynamic coefficients do not show pronounced hysteresis loops. A significant reduction of the minimum drag coefficient was also observed, consistent with the theory of a rigid-wing plate undergoing plunging oscillation. It was concluded that the fluctuating wind field significantly improved the wing's maneuverability and endurance. Author

A92-46781

FLOW OVER A TWIN-TAILED AIRCRAFT AT ANGLE OF ATTACK. II - TEMPORAL CHARACTERISTICS

N. M. KOMERATH, R. J. SCHWARTZ, and J. M. KIM (Georgia Institute of Technology, Atlanta) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 553-558. refs

(Contract F09063-85-G-3104)

Copyright

Hot-film anemometry was used to study the frequency content of the fluctuation field over scale models of the F-15 aircraft at high angles of attack. Fluctuations upstream of the wing are found to be mostly broadband with high-frequency humps. The spectra over the wing show the development of a narrow-band peak. A dominant spectral peak occurs upstream, inboard, and outboard of the top of the vertical tails; the dominant frequency is linear with free-stream velocity at a fixed angle of attack. The frequency of the peak and the shape of the spectra change with aircraft angle of attack, with multiple peaks observed at angles of attack above 30 deg. V.L.

A92-46782

ESTABLISHING A DATABASE FOR FLIGHT IN THE WAKES OF STRUCTURES

J. V. HEALEY (U.S. Naval Postgraduate School, Monterey, CA) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 559-564. Research supported by U.S. Navy. refs

The NASA Ames 'Shipboard Simulator' seems to have been the sole serious attempt to model flight in the wake of a structure. This simulator is based on a faulty airwake database that was established with a uniform velocity profile and very low turbulence. The present study attempts to correct this situation by making three-dimensional hot-wire anemometer measurements of the airwake properties of a stationary 1/141-scale model ship in a simulated atmospheric boundary layer. The measurements included velocities, turbulence intensities, and spectra at 17 points along typical helicopter glide paths, within one ship-length of the touch down location. These data provide a preliminary single-point database for simulation of helicopter flight in the wake of the real ship. The results for one path only are presented. In general, the velocities and the root mean square values of their fluctuations decrease as the ship is approached. No correlation is found with the database in the NASA simulator. There is some doubt about the accuracy of certain measurements close to the ship because of very low mean velocities. Author

A92-46783* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

NAVIER-STOKES PREDICTIONS FOR THE F-18 WING AND FUSELAGE AT LARGE INCIDENCE

RUSSELL M. CUMMINGS, YEHIA M. RIZK, LEWIS B. SCHIFF, and NEAL M. CHADERJIAN (NASA, Ames Research Center, Moffett Field, CA) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 565-574. Previously cited in issue 08, p. 1100, Accession no. A90-22165. refs

Copyright

A92-46785

PREDICTION OF INVISCID SUPERSONIC/HYPERSONIC AIRCRAFT FLOWFIELDS

A. VERHOFF and D. STOOKESBERRY (McDonnell Aircraft Co., Saint Louis, MO) (ICAS, Congress, 17th, Stockholm, Sweden, Sept. 9-14, 1990, Proceedings. Vol. 2, p. 1394-1404) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 581-587. Previously cited in issue 09, p. 1309, Accession no. A91-24443. refs

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A92-46786* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

NAVIER-STOKES COMPUTATIONS ON SWEPT-TAPERED WINGS, INCLUDING FLEXIBILITY

GURU P. GURUSWAMY (NASA, Ames Research Center, Moffett Field, CA) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 588-597. Previously cited in issue 11, p. 1605, Accession no. A90-29364. refs

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A92-46787* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EXPERIMENTAL STUDY OF VORTEX FLOWS OVER DELTA WINGS IN WING-ROCK MOTION

T. T. NG, GERALD N. MALCOLM, and LIANE C. LEWIS (Eidetics International, Inc., Torrance, CA) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 598-603. Previously cited in issue 21, p. 3280, Accession no. A89-47648. refs

(Contract NAS2-12787)

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A92-46790

FLIGHT DECK AERODYNAMICS OF A NONAVIATION SHIP

M. M. RHOADES and J. V. HEALEY (U.S. Naval Postgraduate School, Monterey, CA) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 619-626. Research supported by U.S. Navy. refs

The nature of the flow patterns over the aft flight deck of a typical nonaviation scale-model ship is investigated in a simulated atmospheric boundary layer, and three-dimensional hot-wire measurements of the flow at four points around the locus of a helicopter blade tip are made for six ship yaw angles. Extreme levels of velocity gradients and turbulence intensities are found to exist over the flight deck. The results of the study will be used as a preliminary data base for the analysis of the blade strike problem and comparison with future computational fluid dynamics predictions. V.L.

A92-46791* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

PREDICTED PRESSURE DISTRIBUTION ON A PROP-FAN BLADE THROUGH EULER ANALYSIS

MAKOTO KOBAYAKAWA (Kyoto University, Japan), RYOJI TAKAKI (National Aerospace Laboratory, Chofu, Japan), YOSHIFUMI KAWAKAMI (Sumitomo Precision Products, Ltd.,

Amagasaki, Japan), and FREDERICK B. METZGER (Hamilton Standard, Windsor Locks, CT) (ICAS, Congress, 17th, Stockholm, Sweden, Sept. 9-14, 1990, Proceedings. Vol. 2, p. 2073-2081) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 627-631. Research supported by NASA. Previously cited in issue 09, p. 1311, Accession no. A91-24514. refs
Copyright

A92-46793
SIMULATION OF TRANSONIC FLOW OVER TWIN-JET TRANSPORT AIRCRAFT
S. RILL and K. BECKER (Deutsche Airbus GmbH, Bremen, Federal Republic of Germany) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 640-646. Previously cited in issue 07, p. 968, Accession no. A91-21342. refs
Copyright

A92-46797
DESIGN LOAD PREDICTIONS ON A FIGHTER-LIKE AIRCRAFT WING
S. AGRAWAL, P. J. MALLOY, and D. F. FUGLSANG (McDonnell Douglas Corp., Saint Louis, MO) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 665-670. refs
Copyright

Numerical solutions for a transonic design condition have been obtained for a fighterlike aircraft wing geometry using Euler and Navier-Stokes equations. Both rigid and flexible wings are considered. Effects of viscosity and static aeroelasticity on the component loads such as shear, bending moment, and torsion, as well as hinge moments on the flaps and ailerons, are predicted. The flexible wing solutions are obtained by coupling the flow solvers with a simple NASTRAN model. Effects of fuselage and horizontal tail have also been obtained for the rigid wing case using Euler equations. The computed results are compared to available flight test data. It is found that the static aeroelasticity has only a minor role, whereas the effect of viscosity is very pronounced. Comparison with the flight test data is found to be best when viscous effects are included. Author

A92-46798* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
FOREBODY VORTEX CONTROL USING SMALL, ROTATABLE STRAKES
T. T. NG (Toledo, University, OH) and GERALD N. MALCOLM (Eidetics International, Inc., Torrance, CA) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 671-678. Previously cited in issue 06, p. 800, Accession no. A91-19386. refs
(Contract NAS2-13155)
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A92-46804
UNSTEADY CROSSFLOW ON A DELTA WING USING PARTICLE IMAGE VELOCIMETRY
C. MAGNESS, O. ROBINSON, and D. ROCKWELL (Lehigh University, Bethlehem, PA) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 707-709. Research supported by USAF. refs
Copyright

Particle image velocimetry was used to characterize the unsteady flow structure past a pitching delta wing and to identify new features of the flow structure during pitch-up and pitch-down maneuvers. It is shown that the particle image technique makes it possible to identify the instantaneous nature of both the coherent vortical structure and the structure of regions of gross stall on the pitching of a delta wing. The occurrence of these extreme classes of flow structure is linked to the dynamic hysteresis of vortex breakdown location on the wing. V.L.

A92-46805
TIME-AVERAGE LOADING ON A TWO-DIMENSIONAL AIRFOIL IN A LARGE AMPLITUDE MOTION
G. M. GRAHAM and M. ISLAM (Ohio University, Athens) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 709-712. refs
(Contract AF-AFOSR-87-0312)
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NACA 0015 dynamic section lift data are presented for conditions under which time-average lift values of A(L) = 1.5 and above were measured. It is shown, in particular, that most of the dynamic augmentation in lift occurs before flow separation and increases only slightly beyond this point. Consequently, the time-average lift during pull-up displays the same behavior. The lift-force data during the ramp-down motion indicate that for large angles of attack the lift forces are significantly reduced below their ramp-up values. It is also found that the average lift generally increases with pitch rate during ramp-up and decreases during ramp-down. V.L.

A92-46808
MINIMIZING SUPERSONIC WAVE DRAG WITH PHYSICAL CONSTRAINTS AT DESIGN AND OFF-DESIGN MACH NUMBERS
JEN-FU CHANG (Aeronautical Research Laboratory, Taichung, Republic of China) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 716-718. refs
Copyright

A new computer program has been developed for the design of optimum aircraft area distribution for minimum supersonic wave drag with physical constraints. Being capable of dealing with many physical constraints and providing for a fully automated design process, the program outperforms the Harris code. Wind tunnel data for a conformal tank design demonstrate that the program not only gives the lowest drag throughout the Mach numbers of interest but also meets the objective of least drag increment at the design Mach number. V.L.

A92-46811
THIN-AIRFOIL CORRECTION FOR PANEL METHODS
J. CARTER and P. S. JACKSON (Auckland, University, New Zealand) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 723-725. refs
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A simple modification to a conventional panel method is proposed which accounts for the main effect of the singularity appearing at a sharp edge and significantly improves the accuracy. The correction is easily incorporated into standard panel methods without compromising their usual panel and control point configurations. It provides good agreement between the drag force calculated from forces acting directly on the body and those inferred from a lifting line that terminates the wake, thus allowing a simple self-checking procedure for the drag. V.L.

A92-46814
WING DESIGN FOR HANG GLIDERS HAVING MINIMUM INDUCED DRAG
TAKESHI SUGIMOTO (Tokyo, University, Japan) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 730, 731. refs
Copyright

The optimum wing design for hang gliders with minimum induced drag is analyzed in the context of lifting line theory. The analysis accounts for the bending moment at the wing root. Optimum solutions are presented. V.L.

A92-46816
STATISTICAL PREDICTION OF MAXIMUM BUFFET LOADS ON THE F/A-18 VERTICAL FIN
B. H. K. LEE and S. DUNLAVY (Institute for Aerospace Research, Ottawa, Canada) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 734-736. refs
Copyright

The application of Gumbel's (1954) asymptotic theory of extreme values to the prediction of buffet loads on the vertical fin is discussed. Wind-tunnel examples of peak buffet loads on the F/A-18 vertical fin demonstrate that Gumbel's third asymptotic distributions accurately predict the extreme values. The short time period of 1.56 s is shown to be sufficient to estimate maximum peak load for long operating times. This approach is particularly useful for testing in blowdown wind tunnels where operating costs can be cut down for short runs. V.L.

A92-46818
EFFECT OF A NOSE-BOOM ON FOREBODY VORTEX FLOW
T. T. NG (Toledo, University, OH) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 738-741. refs
Copyright

The effect of the nose-boom on the forebody vortex flow was investigated experimentally in a water tunnel using four different models. The wake flow of a nose-boom is found to be similar to that of highly slender cylindrical bodies. The wake consists of symmetric vortices at moderate angles of attack, asymmetric vortices at high angles of attack, and unsteady vortex shedding at very high angles of attack. In most situations, the nose-boom has a dominating effect on the forebody vortex asymmetry. Conditions under which the nose-boom would increase or decrease the zero-sideslip asymmetric sideforce are determined. V.L.

A92-46820
COMMENT ON 'CANARD-WING INTERACTION IN UNSTEADY SUPERSONIC FLOW'
ERWIN H. JOHNSON, WILLIAM P. RODDEN (MacNeal-Schwendler Corp., Los Angeles, CA), P. C. CHEN (Zona Technology, Inc., Mesa, AZ), and D. D. LIU (Arizona State University, Tempe) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992. refs
Copyright

A92-46882* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
INTERACTION BETWEEN CROSSING OBLIQUE SHOCKS AND A TURBULENT BOUNDARY LAYER
N. NARAYANSWAMI, D. KNIGHT (Rutgers University, Piscataway, NJ), S. M. BOGDONOFF (Princeton University, NJ), and C. C. HORSTMAN (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 30, no. 8, Aug. 1992, p. 1945-1952. Previously cited in issue 06, p. 801, Accession no. A91-19394. refs
(Contract AF-AFOSR-86-0266; AF-AFOSR-89-0033)
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A92-46883
SIMPLIFIED LINEAR STABILITY TRANSITION PREDICTION METHOD FOR SEPARATED BOUNDARY LAYERS
PAOLO DINI (Carleton College, Northfield, MN), MICHAEL S. SELIG, and MARK D. MAUGHMER (Pennsylvania State University, University Park) AIAA Journal (ISSN 0001-1452), vol. 30, no. 8, Aug. 1992, p. 1953-1961. Previously cited in issue 23, p. 4003, Accession no. A91-53785. refs
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A92-46886
NUMERICAL METHOD FOR PREDICTING TRANSITION IN THREE-DIMENSIONAL FLOWS BY SPATIAL AMPLIFICATION THEORY
TUNCER CEBECI and HSUN H. CHEN (California State University, Long Beach) AIAA Journal (ISSN 0001-1452), vol. 30, no. 8, Aug. 1992, p. 1972-1979. Previously cited in issue 17, p. 2851, Accession no. A91-40778. refs
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A92-46887* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TEMPORAL ADAPTIVE EULER/NAVIER-STOKES ALGORITHM INVOLVING UNSTRUCTURED DYNAMIC MESHES
W. L. KLEB, J. T. BATINA (NASA, Langley Research Center, Hampton, VA), and M. H. WILLIAMS (Purdue University, West Lafayette, IN) AIAA Journal (ISSN 0001-1452), vol. 30, no. 8, Aug. 1992, p. 1980-1985. Previously cited in issue 16, p. 2486, Accession no. A90-38778. refs
(Contract NAG1-372)
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A92-46889
COMPACT HIGHER ORDER CHARACTERISTIC-BASED EULER SOLVER FOR UNSTRUCTURED GRIDS
D. W. HALT and R. K. AGARWAL (McDonnell Douglas Research Laboratories, Saint Louis, MO) AIAA Journal (ISSN 0001-1452), vol. 30, no. 8, Aug. 1992, p. 1993-1999. Research supported by McDonnell Douglas Corp. Previously cited in issue 23, p. 4000, Accession no. A91-53751. refs
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A92-46890
JOINT COMPUTATIONAL/EXPERIMENTAL AERODYNAMICS RESEARCH ON A HYPERSONIC VEHICLE. I - EXPERIMENTAL RESULTS
WILLIAM L. OBERKAMPF and DANIEL P. AESCHLIMAN (Sandia National Laboratories, Albuquerque, NM) AIAA Journal (ISSN 0001-1452), vol. 30, no. 8, Aug. 1992, p. 2000-2009. Previously cited in issue 07, p. 971, Accession no. A91-21447. refs
(Contract DE-AC04-76DP-00789)
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A92-46891
JOINT COMPUTATIONAL/EXPERIMENTAL AERODYNAMICS RESEARCH ON HYPERSONIC VEHICLE. II - COMPUTATIONAL RESULTS
MARY M. WALKER and WILLIAM L. OBERKAMPF (Sandia National Laboratories, Albuquerque, NM) AIAA Journal (ISSN 0001-1452), vol. 30, no. 8, Aug. 1992, p. 2010-2016. Previously cited in issue 07, p. 972, Accession no. A91-21458. refs
(Contract DE-AC04-76DP-00789)
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A92-46892* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HYPERSONIC RAREFIED FLOW ABOUT A DELTA WING - DIRECT SIMULATION AND COMPARISON WITH EXPERIMENT
M. C. CELENLIGIL (Vigyan Research Associates, Inc., Hampton, VA) and JAMES N. MOSS (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 30, no. 8, Aug. 1992, p. 2017-2023. Previously cited in issue 18, p. 3050, Accession no. A91-43387. refs
Copyright

A92-46894* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PARALLEL COMPUTING STRATEGIES FOR BLOCK MULTIGRID IMPLICIT SOLUTION OF THE EULER EQUATIONS
YORAM YADLIN and DAVID A. CAUGHEY (Cornell University, Ithaca, NY) AIAA Journal (ISSN 0001-1452), vol. 30, no. 8, Aug. 1992, p. 2032-2038. Research supported by NSF. refs
(Contract NAG2-665)
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A multigrid diagonal implicit algorithm has been developed to solve the three-dimensional Euler equations of inviscid compressible flow on block-structured grids. An improved method of advancing the multigrid cycle has been examined with respect to convergence rates, accuracy, and efficiency. In this method, the multigrid cycle is advanced independently in each of the blocks, and the information exchange between the blocks is done using buffer arrays, allowing for the asynchronous updating of interface boundary conditions. This updating scheme is used to eliminate the convergence problems found in a previous implementation of the algorithm while retaining its potential for efficient parallel execution. Results are computed for transonic flows past wings and include pressure distributions to verify the accuracy of the scheme and convergence histories to demonstrate the efficiency of the method. Efficiencies that were obtained using a modest number of processors in parallel are also presented and discussed. Author

A92-46895
TWO-STREAM, SUPERSONIC, WAKE FLOWFIELD BEHIND A THICK BASE. I - GENERAL FEATURES
V. A. AMATUCCI (Sandia National Laboratories, Albuquerque, NM), J. C. DUTTON (Illinois, University, Urbana), D. W. KUNTZ (Sandia National Laboratories, Albuquerque, NM), and A. L. ADDY (Illinois, University, Urbana) AIAA Journal (ISSN 0001-1452), vol. 30, no. 8, Aug. 1992, p. 2039-2046. Previously cited in issue 08, p. 1105, Accession no. A90-22450. refs
(Contract DAAL03-87-K-0010; DAAL03-90-G-0021)
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A92-46897* National Aeronautics and Space Administration, Washington, DC.
COMPUTATION OF TURBULENT, SEPARATED, UNSWEPT COMPRESSION RAMP INTERACTIONS
T. A. MARSHALL and D. S. DOLLING (Texas, University, Austin) AIAA Journal (ISSN 0001-1452), vol. 30, no. 8, Aug. 1992, p. 2056-2065. Research supported by NASA and U.S. Navy. refs
(Contract AF-AFOSR-86-0112)
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Examination of the literature shows that the comparison between experiment and computation for highly separated unswept compression ramp flows is generally poor, irrespective of the turbulence model used. In general, the upstream influence is not correct, the wall pressure rise through separation is too steep, and the pressures under the separated shear layer are too high. In the current study, the objective is to determine if these discrepancies might be attributed more to other factors such as flowfield unsteadiness or three-dimensionality, rather than to inadequate turbulence modeling. To examine this possibility, multichannel wall pressure fluctuations were measured under the unsteady separation shock wave in a 28-deg unswept compression ramp flow at Mach 5. The results show that the large scale, low frequency separation shock unsteadiness controls the distribution of time-averaged surface properties and that neglect of the unsteadiness is probably the primary cause of the discrepancy between experiment and computation. Author

A92-46899* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MULTIPLE SHOCK-SHOCK INTERFERENCE ON A CYLINDRICAL LEADING EDGE
ALLAN R. WIETING (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 30, no. 8, Aug. 1992, p. 2073-2079. Previously cited in issue 17, p. 2860, Accession no. A91-42598. refs
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A92-46900
EFFECT OF MODEL COOLING ON PERIODIC TRANSONIC FLOW
S. RAGHUNATHAN, F. ZARIFI-RAD (Belfast, Queen's University, Northern Ireland), and D. G. MABEY (Royal Aerospace Establishment, Bedford, England) AIAA Journal (ISSN 0001-1452), vol. 30, no. 8, Aug. 1992, p. 2080-2086. Previously cited in issue 17, p. 2857, Accession no. A91-42562. refs
Copyright

A92-46901
EXPERIMENTAL INVESTIGATION OF THE PARALLEL VORTEX-AIRFOIL INTERACTION AT TRANSONIC SPEEDS
IRAJ M. KALKHORAN (Polytechnic University, Farmingdale, NY) and DONALD R. WILSON (Texas, University, Arlington) AIAA Journal (ISSN 0001-1452), vol. 30, no. 8, Aug. 1992, p. 2087-2092. Previously cited in issue 18, p. 2755, Accession no. A89-42061. refs
(Contract DAAG29-84-K-0131)
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A92-46902* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
GORTLER INSTABILITY AND SUPERSONIC QUIET NOZZLE DESIGN
FANG-JENG CHEN (NASA, Langley Research Center, Hampton, VA), MUJEEB R. MALIK (High Technology Corp., Hampton, VA), and IVAN E. BECKWITH (George Washington University, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 30, no. 8, Aug. 1992, p. 2093, 2094. Abridged. Previously cited in issue 16, p. 2484, Accession no. A90-38727. refs
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A92-46903
MEASUREMENT OF SHOCK-WAVE/BOUNDARY-LAYER INTERACTION IN A FREE-PISTON SHOCK TUNNEL
C. H. B. STACEY and J. M. SIMMONS (Queensland, University, St. Lucia, Australia) AIAA Journal (ISSN 0001-1452), vol. 30, no. 8, Aug. 1992, p. 2095-2098. Research supported by Australian Research Grants Scheme. Previously cited in issue 09, p. 1281, Accession no. A89-25374. refs
Copyright

A92-46913
OUTFLOW BOUNDARY CONDITIONS USING DUHAMEL'S EQUATION
DAVID NIXON (Nielsen Engineering & Research, Inc., Mountain View, CA) AIAA Journal (ISSN 0001-1452), vol. 30, no. 8, Aug. 1992, p. 2156-2158. Abridged. Previously cited in issue 21, p. 3292, Accession no. A90-45937. refs
(Contract F49620-88-C-0006)
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A92-46934
THE UNSTEADY INTERACTION OF A 3-DIMENSIONAL VORTEX FILAMENT WITH A CYLINDER
H. AFFES and A. T. CONLISK (Ohio State University, Columbus) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 37-1 to 37-11. Research supported by U.S. Army. refs

The interaction of a 3D vortex filament with a cylinder is considered. The problem is a simplified model of the interaction between a tip-vortex shed from a helicopter rotor and the fuselage. The motion of the filament indicates that a strong interaction between the vortex and the cylinder will take place as the vortex approaches the cylinder. Numerical calculations indicate that a large adverse pressure gradient develops under the vortex on the wall causing a rapid drop in the pressure there; large variations in the curvature of the vortex are not observed. Author

A92-46935* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A STUDY OF ROTOR WAKE DEVELOPMENT AND WAKE/BODY INTERACTIONS IN HOVER
A. BAGAI, J. G. LEISHMAN, and D. K. SAMAK (Maryland, University, College Park) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 41-1 to 41-17. Research supported by University of Maryland. refs
(Contract DAAL03-88-C-0002; NAG2-607)

Experiments were conducted to document the wake geometry and interactional effects between a hovering rotor and a body representing a simplified helicopter fuselage. The wide-field shadowgraph technique was used to visualize the rotor wake vortices and to obtain quantitative information on the wake trajectories, with and without the presence of the body. Particular attention was paid to visualizing and quantifying the wake geometry during the direct impingement of tip vortices on the body surface. The rotor performance with and without the fuselage is also discussed. Author

A92-46944

ACTIVE CONTROL OF BLADE VORTEX INTERACTION

J. V. R. PRASAD, T. BOWLES, and D. VANDEKERCKHOVE (Georgia Institute of Technology, Atlanta) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 52-1 to 52-7. refs

During operation, a rotor blade must encounter the vortices of preceding blades. The interaction of an airfoil with a vortex is characterized by a large pressure pulse at the leading edge of the airfoil. This pressure pulse causes the well known 'blade slap' of helicopter rotors in certain flight conditions. This paper investigates the possibility of reducing this pressure pulse with the aid of a flap at the trailing edge of the airfoil. It is shown that with a pressure sensor on the leading edge and a flap at the trailing edge, a feedback control scheme can be formulated to reduce the vortex induced pressure pulse. Author

A92-46947

INTERACTION BETWEEN A ROTOR TIP VORTEX AND A SEPARATED FLOWFIELD

NARAYANAN M. KOMERATH, JAI-MOO KIM, and SHIUH-GUANG LIOU (Georgia Institute of Technology, Atlanta) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 23-1 to 23-9. refs
(Contract DAAL03-88-C-0003)
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The experimental study of separated flow effects in rotorcraft interaction aerodynamics is presently approached by way of a qualitative study of the interaction between the vortex system of a two-bladed rotor in forward flight and an axisymmetric, backward-facing step. Phase-averaged surface pressure measurements are made downstream of the step. The results obtained indicate the presence of natural shear layer oscillations in the absence of the rotor, with a characteristic frequency that is of the same order as the rotor frequency used in later experiments. Under forcing by the rotor flowfield, the free shear layer rolls up around the tip vortex. The effect of blade passage and the suction due to tip-vortex interaction are seen in the pressure signal below the recirculating region. O.C.

A92-46948

EXPERIMENTAL AND NUMERICAL STUDY OF FLOW AROUND HELICOPTER ROTOR BLADE TIPS

B. BENCHERIFA and J. MARCILLAT (Institut de Mecanique des Fluides, Marseille, France) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 24-1 to 24-13. Research supported by ONERA. refs

The main results of experimental and numerical studies of flow around blade tips presented emphasize aerodynamic coefficients or limiting flow at a two-surface wall, about new shapes simulated by semispan wings placed in an $M = 0.6$ wind tunnel. Some numerical results obtained through an FIDAP code using a finite element method to solve the Navier-Stokes equations are also presented. Two examples of unsteady, 2D, incompressible viscous flows with separation are presented at 15 and 34 deg, for Re of 1000. Author

A92-46949

FLOW VISUALISATION OF A SMALL DIAMETER ROTOR OPERATING AT HIGH ROTATIONAL SPEEDS WITH BLADES AT SMALL PITCH ANGLES

OSVALDO M. QUERIN (Sydney, University, Australia) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 25-1 to 25-6. refs

Flow visualization experiments were carried out on a four-bladed model rotor with blades set at low pitch angles. Two flow conditions were investigated, the tip vortices were tracked, and their paths were plotted. Analysis of the wake showed that: (1) rotors with substantial axial flow produce very stable wakes; (2) near-hovering flow conditions produce unstable wakes where the tip vortex coordinates flip between two equilibrium positions at different locations in their paths; and (3) these vortex paths cross each other axially and radially. Author

A92-46950

A UNIFIED PROCEDURE FOR SOLVING ROTOR FLOWFIELD, PERFORMANCE AND INTERFERENCE

R. G. RAJAGOPALAN (Iowa State University of Science and Technology, Ames) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 26-1 to 26-13. Research supported by Iowa State University of Science and Technology. refs

The performance and global flow characteristics of helicopter rotors and their interference are presently determined by means of a novel finite-difference procedure which treats the flow through the rotor as composed of two regions: that closest to the rotating blades, and that which extends from the outer boundaries of the inner region to the rest of the flowfield, including the far wake. This approach allows different levels of accuracy to be prescribed for the two regions despite their implicit connection. The usefulness of the method is demonstrated by computing the flowfield of a rotor in descent, including the vortex ring state. O.C.

A92-46951* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

EFFICIENT HIGH-RESOLUTION ROTOR WAKE CALCULATIONS USING FLOW FIELD RECONSTRUCTION

TODD R. QUACKENBUSH (Continuum Dynamics, Inc., Princeton, NJ), DONALD B. BLISS (Duke University, Durham, NC), and C. G. LAM (Continuum Dynamics, Inc., Princeton, NJ) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 27-1 to 27-15. refs
(Contract NAS1-19023)

Recent computational studies of helicopter flowfields for acoustic applications has led to the development of exceptionally efficient analysis methods for carrying out Lagrangian simulations of the vortex wake. The capabilities of these methods are demonstrated here through calculations involving a variety of wake/rotor interactions associated with both main rotor and tail rotor flowfields. These methods incorporate a flowfield reconstruction approach efficiently to compute vortex wake interactions within arbitrary regions located near the main rotor. This paper summarizes the development of the reconstruction approach and outlines some of its potential uses, while focusing primarily on its application to rotor noise calculations. The development of the nearfield velocity corrections used in the analysis of close vortex interactions is described, and the overall structure of the current reconstruction approach is discussed. Author

A92-46952* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

AN EULERIAN/LAGRANGIAN METHOD FOR COMPUTING BLADE/VORTEX IMPINGEMENT

JOHN STEINHOFF (Tennessee, University; Flow Analysis, Inc., Tullahoma), HEINRICH SENGE (Tennessee, University, Tullahoma), and WENREN YONGHU (Tennessee, University; Flow Analysis, Inc., Tullahoma) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 28-1 to 28-10. refs
(Contract NAS2-13079)

A combined Eulerian/Lagrangian approach to calculating helicopter rotor flows with concentrated vortices is described. The method computes a general evolving vorticity distribution without any significant numerical diffusion. Concentrated vortices can be accurately propagated over long distances on relatively coarse grids with cores only several grid cells wide. The method is demonstrated for a blade/vortex impingement case in 2D and 3D where a vortex is cut by a rotor blade, and the results are compared to previous 2D calculations involving a fifth-order Navier-Stokes solver on a finer grid. Author

A92-46953* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

THREE-DIMENSIONAL BLADE VORTEX INTERACTIONS

FARHAD DAVOUDZADEH, RICHARD C. BUGGEIN, STEPHEN J. SHAMROTH (Scientific Research Associates, Inc., Glastonbury, CT), and CAHIT KITAPLIOGLU (NASA, Ames Research Center, Moffett Field, CA) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 29-1 to 29-11. refs

(Contract NAS2-12635)

A three-dimensional time dependent Navier-Stokes analysis was applied to the rotor blade vortex interaction problem. The numerical procedure is an iterative implicit procedure using three point central differences to represent spatial derivatives. A series of calculations were made to determine the time steps, pseudo-time steps, iterations, artificial dissipation level, etc. required to maintain a nondissipative vortex. Results show the chosen method to have excellent non-dissipative properties provided the correct parameters are chosen. This study was used to set parameters for both two- and three-dimensional blade vortex interaction studies. The case considered was the interaction between a vortex and a NACA0012 airfoil. The results showed the detailed physics during the interaction including the pressure pulse propagating from the blade. The simulated flow physics was qualitatively similar to that experimentally observed. The BVI phenomena is the result of the buildup and violent collapse of the shock waves and local supersonic pockets on the blade surfaces. The resulting pressure pulse build-up appears to be centered at the blade leading edge. Author

A92-46954* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EXPERIMENTAL AND COMPUTATIONAL STUDIES OF HOVERING ROTOR FLOWS

M. NSI MBA (Institut de Mecanique des Fluides, Marseille, France), K. RAMACHANDRAN (Flow Analysis, Inc.; NASA, Ames Research Center, Moffett Field, CA), and F. X. CARADONNA (U.S. Army, Aviation Systems Command; NASA, Ames Research Center, Moffett Field, CA) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 30-1 to 30-17. refs

(Contract DRET-89-1433)

HELIX-I, an essentially standard full-potential CFD helicopter rotor code, is unique in its use of the Clebisch kinematical flow description to specify a freely convecting wake and its capacity for predicting hover performance. A study is presently performed to assess the method's sensitivity to grids and solution-starting techniques. The effects of these parameters on thrust, power, load distribution, and wake geometry are ascertained and compared with an extensive rotor data base. The use of a fairly accurate starting solution yields no obvious advantage over the use of a novel starting method which employs a succession of diminishing artificial flows. O.C.

A92-46955

NUMERICAL SIMULATION OF MULTIZONE TWO-DIMENSIONAL TRANSONIC FLOWS USING THE FULL NAVIER-STOKES EQUATIONS

J. C. NARRAMORE (Bell Helicopter Textron, Inc., Fort Worth, TX) and L. N. SANKAR (Georgia Institute of Technology, Atlanta) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 31-1 to 31-11. refs

A new aerodynamic tool has been developed that computes the fluid flow characteristics and forces on multielement two-dimensional aerodynamic configurations. The code solves the two-dimensional, compressible, fully Reynolds-average Navier-Stokes equations in multiple H-grid topology zones and can analyze up to five separate elements. Because it is a Navier-Stokes solver, it can handle high angle-of-attack and Mach number conditions unsuitable for potential flow solvers that historically have been used to evaluate multielement airfoils. Several examples of the application of this code to practical aerodynamic problems are given. This new code provides a significant increase in the analysis capability for complex two-dimensional configurations. Author

A92-46956

INITIAL VALIDATION OF AN UNSTEADY EULER/NAVIER-STOKES FLOW SOLVER FOR HELICOPTER ROTOR AIRLOADS IN FORWARD FLIGHT

BRIAN E. WAKE and T. A. EGOLF (United Technologies Research Center, East Hartford, CT) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 32-1 to 32-14. refs

An unsteady, three-dimensional, Navier-Stokes/Euler solver (NSR3D) has been applied to a helicopter rotor in forward flight for several advance ratios. For the wake influence, the flow solver is coupled with a lifting-line free-wake method. Unsteady blade loads computed by the solver are compared with experimental data and lifting-line/free-wake results. The three-dimensional analysis, performed on the massively parallel Connection Machine (CM-2), was advanced around the rotor azimuth until a periodic solution was produced. Preliminary Navier-Stokes results have been computed without the wake effects. Unsteady blade loading from the Euler analysis demonstrates relatively good correlation with experimental blade airloads at low speed and fair correlation at higher flight speeds. These results demonstrate the feasibility of a 'Numerical Rotor Test Facility' in the near term. Author

A92-46957* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

EFFECTS OF LEADING AND TRAILING EDGE FLAPS ON THE AERODYNAMICS OF AIRFOIL/VORTEX INTERACTIONS

AHMED A. HASSAN (McDonnell Douglas Helicopter Co., Mesa, AZ), L. N. SANKAR (Georgia Institute of Technology, Atlanta), and H. TADGHIGHI (McDonnell Douglas Helicopter Co., Mesa, AZ) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 33-1 to 33-14. refs

(Contract NAS1-19136)

A numerical procedure based on the unsteady 2D full potential equation is presently used to simulate the effects of leading-edge and trailing-edge flaps on the aerodynamics of airfoil-vortex interactions. Attention is given to unsteady flap-motion effects, which alleviate those interactions at sub- and supercritical onset flows. For subcritical interactions, the results obtained indicate that trailing-edge flaps can be used to alleviate the impulsive loads experienced by the airfoil; for supercritical interactions, a leading- rather than trailing-edge flap must be used to alleviate the interaction. O.C.

A92-46958

A NEW INTEGRAL EQUATION FOR POTENTIAL COMPRESSIBLE AERODYNAMICS OF ROTORS IN FORWARD FLIGHT

M. GENNARETTI, O. MACINA, and L. MORINO (Roma I, Universita, Rome, Italy) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 34-1 to 34-8. Research supported by ASI. refs

The Gennaretti (1989) boundary integral equation methodology for the analysis of unsteady, compressible potential flows around helicopter rotors in hover and forward flight was extended by Macina (1990) to the case of arbitrary motion. Novel numerical results have been obtained by these means for isolated rotors in both hover and forward flight. These results were derived through the application of a zeroth-order boundary-element discretization of the integral equation for the velocity potential. O.C.

A92-46959* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AERODYNAMIC PARAMETRIC STUDIES AND SENSITIVITY ANALYSIS FOR ROTOR BLADES IN AXIAL FLIGHT

Y. D. CHIU (Lockheed Engineering and Sciences Co., Hampton, VA) and DAVID A. PETERS (Georgia Institute of Technology, Atlanta) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 35-1 to 35-15. Previously announced in STAR as N91-22078. refs
(Contract NAS1-19000)

The analytical capability is offered for aerodynamic parametric studies and sensitivity analyses of rotary wings in axial flight by using a 3D undistorted wake model in curved lifting line theory. The governing equations are solved by both the Multhopp Interpolation technique and the Vortex Lattice method. The singularity from the bound vortices is eliminated through the Hadamard's finite part concept. Good numerical agreement between both analytical methods and finite differences methods are found. Parametric studies were made to assess the effects of several shape variables on aerodynamic loads. It is found, e.g., that a rotor blade with out-of-plane and inplane curvature can theoretically increase lift in the inboard and outboard regions respectively without introducing an additional induced drag. Author

A92-46985*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

A PARAMETRIC ANALYSIS OF RADIATIVE STRUCTURE IN AEROBRAKE SHOCK LAYERS

ROBERT B. GREENDYKE (Vigyan, Inc., Hampton, VA) AIAA, Plasmadynamics and Lasers Conference, 23rd, Nashville, TN, July 6-8, 1992. 12 p. refs
(Contract NAS1-19237)
(AIAA PAPER 92-2970)

A broad-spectrum version of the NEQAIR code was modified to account for self-absorption and applied to AFE flowfields calculated by the LAURA code with a variety of kinetic models. The resulting radiative fluxes were obtained in a decoupled fashion from the flowfield solver along the vehicle's stagnation streamline. The radiative flux obtained was broken down by causative process to study the radiative structure of the AFE's flowfield for the various kinetic models. In addition, the radiative fluxes for several points on a typical AFE trajectory were analyzed to examine how the radiative structure changes as the vehicle completes its aeropass. Only two radiative processes dominated the stagnation radiative flux, and the flow field conditions near the wall were found to exert considerable influence over the radiative flux to the wall. Author

A92-46986*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

DECOUPLED PREDICTIONS OF RADIATIVE HEATING IN AIR USING A PARTICLE SIMULATION METHOD

IAIN D. BOYD and ELLIS E. WHITING (Eloret Institute, Palo Alto; NASA, Ames Research Center, Moffett Field, CA) AIAA, Plasmadynamics and Lasers Conference, 23rd, Nashville, TN, July 6-8, 1992. 10 p. refs
(Contract NCC2-582)
(AIAA PAPER 92-2971)

A particle simulation technique with decoupled radiation is used to estimate the radiative emission along the stagnation streamline and the radiative heating at the stagnation point of a blunt-nosed vehicle entering the earth's atmosphere at hypersonic speed. The direct simulation Monte Carlo (DSMC) method is used to compute the fluid mechanics of the weakly ionized flow. The radiative emission is computed using the NEQAIR computer code with the radiation decoupled from the flowfield solution. It is concluded that the new models make it possible to decrease the predicted total radiative heating at the stagnation point of the vehicle by a factor of 15. A comparison of the DSMC approach with a continuum flow model shows that the total predicted radiative heating estimates agree within a factor of 2. O.G.

A92-47038

MESH ADAPTION FOR 2D TRANSSONIC EULER FLOWS ON UNSTRUCTURED MESHES

R. RICHTER and P. LEYLAND (Lausanne, Ecole Polytechnique Federale, Ecublens, Switzerland) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 27-39. refs
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Shock fitting for transonic flows is investigated via successive refinement techniques on unstructured triangular meshes. The relative mesh dependency is also studied using respectively a centered explicit scheme, with artificial viscosity and an upwind, approximate Riemann solver type scheme, without local refinement. A semi-interactive graphics package is incorporated to make a workstation feasibility of such codes. The advantages of unstructured meshes, and their flexibility of localized refinements, retain an optimal solution for a minimal number of mesh points. The first scheme is a standard Jameson type centered scheme with artificial dissipation of second and fourth order, based on a Galerkin approximation on dual control volumes rather than cell vertex ones. The artificial dissipation terms are based on bisegment flux control. The approximate Riemann solver is based on Osher's scheme with implicit time-stepping. Only convergence of steady state is considered here. Author

A92-47041

MESH ADAPTIVITY WITH THE QUADTREE METHOD

A. EVANS, M. J. MARCHANT, J. SZMELTER, and N. P. WEATHERILL (Swansea, University College, Wales) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 67-78. Research supported by Royal Aerospace Establishment and CEC. refs
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In this paper, a data structure, loosely based around a quadtree, is introduced and developed to manage an adaptive point enrichment technique for structured quadrilateral meshes. The technique allows the interfaces between enriched regions to be easily detected and transitional interface elements constructed. The approach is applied to the adaptive solution of the inviscid Euler equations for two dimensional transonic flows. Author

A92-47042 National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

UNSTRUCTURED AND ADAPTIVE MESH GENERATION FOR HIGH REYNOLDS NUMBER VISCOUS FLOWS

D. J. MAVRIPLIS (ICASE; NASA, Langley Research Center, Hampton, VA) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 79-91. Previously announced in STAR as N91-20063. refs
(Contract RTOP 505-90-52-01; NAS1-18605)
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A method for generating and adaptively refining a highly stretched unstructured mesh suitable for the computation of high-Reynolds-number viscous flows about arbitrary two-dimensional geometries was developed. The method is based on the Delaunay triangulation of a predetermined set of points and employs a local mapping in order to achieve the high stretching rates required in the boundary-layer and wake regions. The initial mesh-point distribution is determined in a geometry-adaptive manner which clusters points in regions of high curvature and sharp corners. Adaptive mesh refinement is achieved by adding new points in regions of large flow gradients, and locally retriangulating; thus, obviating the need for global mesh regeneration. Initial and adapted meshes about complex multi-element airfoil geometries are shown and compressible flow solutions are computed on these meshes. Author

A92-47045* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

GRID ADAPTATION TO MULTIPLE FUNCTIONS FOR APPLIED AERODYNAMIC ANALYSIS

S. P. PAO (NASA, Langley Research Center, Hampton, VA) and KHALED S. ABDOL-HAMID (Analytical Services and Materials, Inc., Hampton, VA) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 119-129. refs

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A fast and robust method of grid adaptation to multiple functions has been developed for flow analysis in 3D space. It is based on the equidistribution principle and the alternate direction adaptation method. The grid adaptation algorithm has been fully integrated with a space marching flow solver as contained within a 3D Navier-Stokes code and PAB3D-v2. The grid adaptation strategy, details of numerical implementation, examples of application, and potential extensions of the current method are presented in this paper. Author

A92-47054

SINGLE BLOCK MESH GENERATION FOR A FUSELAGE PLUS TWO LIFTING SURFACES

TIMOTHY J. BAKER (Princeton University, NJ) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 261-272. refs

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A procedure is presented for generating a single block H-H mesh around an aerodynamic configuration consisting of a fuselage plus two lifting surfaces. The lifting surfaces may assume any orientation relative to each other. It is therefore possible to create single block meshes for aircraft shapes that have either a wing and a tail or a wing and a canard. The method uses a sequence of mappings to reduce the configuration to a simple generic shape followed by the interpolation of coordinate surfaces that conform with all boundaries. After reversing the mapping sequence one obtains a single block, boundary conforming mesh in physical space. Author

A92-47057

GRID SENSITIVITY IN LOW REYNOLDS NUMBER HYPERSONIC CONTINUUM FLOWS

WALTER H. RUTLEDGE (Sandia National Laboratories, Albuquerque, NM) and KLAUS A. HOFFMANN (Wichita State University, KS) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 301-313. Previously announced in STAR as N91-25118. refs

(Contract DE-AC04-76DP-00789)

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A computational scheme is presented to solve the unsteady Navier-Stokes equations over a blunt body at high altitude, high Mach number atmospheric reentry flow conditions. This continuum approach is directed to low Reynolds/low density hypersonic flows by accounting for non-zero bulk viscosity effects in near frozen flow conditions. A significant difference from previous studies is the inclusion of the capability to model non-zero bulk viscosity effects. The grid definition for these low Reynolds number, viscous dominated flow fields is especially important in terms of numerical stability and accurate heat transfer solutions. Author

A92-47060

MULTI-BLOCK GRID GENERATION AROUND WING-BODY-ENGINE-PYLON CONFIGURATIONS

C.-C. ROSSOW and A. RONZHEIMER (DLR, Institut fuer Entwurfsaerodynamik, Braunschweig, Federal Republic of Germany) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 357-368. refs

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An approach for mesh generation of block-structured, body-fitted grids around wing-body-engine-pylon configurations is described. In this approach geometry definition and the calculation of intersection lines is achieved using Coons patches. Point distributions on lines, surface grids, and field grids are mainly obtained by solving a system of Poisson equations. In order to determine the source terms occurring in the Poisson equations the concept of target points has been applied. Together with a proper scaling of the corrections to the source terms during the iterative solution, accurate control of the desired grid properties was achieved, and elliptic field grid generation is performed within a couple of minutes on modern supercomputers. The presented grid generation system provides grids around twin engine transport aircraft configurations for the calculation of inviscid flows. Different types of engines can be treated. Results of the application of an Euler code to the generated meshes are also presented. Author

A92-47061

3-D NUMERICAL GRID GENERATION FOR THE TRANSONIC FLOW ANALYSIS ABOUT MULTI-BODIES

U. GULCAT and H. R. KUL (Istanbul Technical University, Turkey) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 369-375. refs

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An algebraic grid generation scheme suitable for transonic flow analysis about multi-bodies is presented. In the grid generation process the flow domain external to the bodies are divided into blocks and each block is discretized with finite volumes for which the conservation laws are satisfied using Euler's equations. These blocks are matched together in such a way that the Finite Volume Method can handle the slip surfaces properly. The proposed technique is applied to generate a grid around a wing with an external body attached to the wing with a pylon. The numerical results obtained for a 2D flow past the wing section at free stream Mach number of 0.95, to simulate a transonic maneuver, is presented in terms of surface pressure distribution. Author

A92-47064

INTERACTIVE ALGEBRAIC MESH GENERATION FOR TWIN JET TRANSPORT AIRCRAFT

K. BECKER (Deutsche Airbus GmbH, Bremen, Federal Republic of Germany) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 455-466. Research supported by CEC. refs

Copyright

The fundamental elements of the DA mesh generation system INGRID and the Euler solver MELINA are described. The numerical validation experiments show that this system is able to accurately simulate inviscid flow about complex configurations like wing or body mounted engine cases. As INGRID uses only explicit techniques, it is fast enough to be run on a workstation in interactive mode. Thus it provides a flexible and cheap mesh generation facility. Author

A92-47079

NEW CONCEPTS FOR MULTI-BLOCK GRID GENERATION FOR FLOW DOMAINS AROUND COMPLEX AERODYNAMIC CONFIGURATIONS

S. P. SPEKREYSE, J. W. BOERSTOEL (National Aerospace Laboratory, Amsterdam, Netherlands), and P. L. VITAGLIANO (Alenia S.p.A., Gruppo Aerei da Trasporto, Naples, Italy) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 719-730. Research supported by Netherlands Agency for Aerospace Programs, Aeritalia, National Aerospace Laboratory, et al. refs

Copyright

A multiblock grid generation procedure is described which is suitable for constructing multiblock grids in numerical simulations of flows around complex aerodynamic configurations. Novel aspects of the procedure are its use of topology and geometry of block decomposition specified first by an interactive domain modeler, compound edges and faces, grid embedding, grid lines which are C-deg-continuous only over block faces, and a biharmonic solver for grid generation in faces. C.D.

A92-47090

GENERATION OF UNSTRUCTURED GRIDS WITHIN A HYBRID MULTI-BLOCK ENVIRONMENT

P. N. CHILDS (Aircraft Research Association, Ltd., Bedford, England) and N. P. WEATHERILL (Swansea, University College, Wales) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 899-911. Research supported by Royal Aerospace Establishment. refs

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It is demonstrated how a local region of embedded unstructured grid may be used to extend the range of application of the multiblock approach. It is shown that techniques for surface and field grid generation are amenable to a large degree of automation within the unstructured region. Robust procedures are developed to maintain boundary integrity and to enable structured and unstructured grids to be interfaced. C.D.

A92-47096

ORTHOGONAL GRIDS FOR MULTIPLE AIRFOILS

G. MORETTI (GMAF, Inc., Freeport, NY) and F. MARCONI (Grumman Aerospace Corp., Bethpage, NY) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 965-973. refs

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A technique to generate orthogonal meshes around multiple airfoils (typically, a main airfoil with a flap and a slat) is described. Conformal mappings, based on powers, bilinear equations and a novel interpretation of the Theodorsen technique are used to transform the region outside the three airfoils into seven blocks, each one of which is covered by an orthogonal grid, with coordinate lines running along the boundaries, so that the coordinate lines can be made to match across the seams. The final result is an orthogonal grid of the C-type. Author

A92-47100

ANALYSIS OF MOTION OF AIRFOIL FLYING OVER WAVY-WALL SURFACE (LIFTING SURFACE METHOD)

SHIGENORI ANDO (Tokushima Bunri University, Japan), TETSU SAKAI, and KYOKO NITTA (Nagoya University, Japan) Japan Society for Aeronautical and Space Sciences, Transactions (ISSN 0549-3811), vol. 35, no. 107, May 1992, p. 27-38. refs

A 2D motion of a thin airfoil flying over and in proximity to a wavy-wall surface in incompressible and inviscid flow is analyzed. The problem is reduced to a version of the lifting surface problem. It is found that about ten times the airfoil chord length may be satisfactory with sufficient margin. Results agree well with those obtained with the finite difference method. Examples of computation are presented for two problems: a forced vibration problem and seaworthiness for a wing-in-ground effect vehicle. O.G.

A92-47153

A FINITE DIFFERENCE SOLUTION OF THE EULER EQUATIONS ON NON-BODY-FITTED CARTESIAN GRIDS

KOJI MORINISHI (Kyoto Institute of Technology, Matsugasaki, Japan) (Japan - Soviet Union Joint Symposium on Computational Fluid Dynamics, 2nd, Tsukuba, Japan, Aug. 27-31, 1990) Computers & Fluids (ISSN 0045-7930), vol. 21, no. 3, July 1992, p. 331-344. refs

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A finite difference solution on non-body-fitted Cartesian grids has been developed for the two-dimensional compressible Euler equations. The solution is based on the method of lines. The spatial derivatives of the Euler equations are first discretized by finite difference approximations on stretched grids. The rational Runge-Kutta scheme is used as the time-stepping scheme. Accurate numerical boundary conditions are introduced at the body surfaces where the coordinate lines do not generally fit the boundaries. A series of numerical experiments are carried out to validate the present solution. Numerical results obtained for transonic flows over single-element airfoils agree well with reliable results obtained for the same flows on body-fitted grids. Typical numerical results are also obtained for transonic flows over bi-NACA0012 airfoils. The present solution is confirmed to be easily tractable even for multielement flowfields. Author

A92-47155

NUMERICAL EXPERIMENTS ON UNSTEADY SHOCK REFLECTION PROCESSES USING THE THIN-LAYER NAVIER-STOKES EQUATIONS

SHIGHERU ASO (Kyushu University, Fukuoka, Japan) and MASANORI HAYASHI (Nishinippon Institute of Technology, Fukuoka, Japan) (Japan - Soviet Union Joint Symposium on Computational Fluid Dynamics, 2nd, Tsukuba, Japan, Aug. 27-31, 1990) Computers & Fluids (ISSN 0045-7930), vol. 21, no. 3, July 1992, p. 369-375. refs

Copyright

Processes of shock reflection by a ramp are simulated by solving the thin-layer Navier-Stokes equations using the TVD scheme in the convective terms. Calculations were performed to study viscous effects in unsteady aerodynamic heating and weak Mach reflections. Unsteady aerodynamic heating due to the impingement and the Mach stem and slip layer in shock reflection at higher Ms values were calculated numerically. In addition, Mach reflections at lower Ms are calculated numerically to investigate the viscous effects on weak shock reflection by a ramp. Significant changes in the reflection patterns with Re were observed. L.M.

A92-47684

THE CALCULATION OF THREE-DIMENSIONAL COMPRESSIBLE BOUNDARY LAYER STABILITY ON SWEPT WINGS

DENG-BIN TANG (Nanjing Aeronautical Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 13, no. 1, Jan. 1992, p. A1-A7. In Chinese. refs

The boundary layer stability on swept wings is investigated computationally by using 3D compressible laminar stability theory. For a 3D disturbance wave in a 3D boundary layer, an eigenvalue of an eighth-order system of compressible stability equations is computed by highly efficient correlative two-steps method. The analytical solutions of equations at the outer edge of boundary layers are derived. Examples of the laminar-flow-control wing and the natural-laminar-flow wing are given and used to study typical stability problems of Tollmien-Schlichting type disturbance and crossflow disturbance on the swept wing. The results are quite consistent with available calculations. Author

A92-47686

THE NUMERICAL SIMULATION OF COMPRESSIBLE FLOW AROUND AN AIRFOIL AT HIGH ANGLE OF ATTACK

FENG LI, YI-YUN WANG, and ER-JIE CUI (Beijing Institute of Aerodynamics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 13, no. 1, Jan. 1992, p. A17-A22. In Chinese. refs

Compressible flow around an NACA 0012 airfoil at high angle of attack is numerically simulated by solving the 2D Navier-Stokes equations in a body-fitted system. The Baldwin-Lomax turbulent model is used to simulate the formation of the leading edge separation bubble, the convection of vortex along the airfoil surface, and unsteady phenomena of the vortex at high angle of attack. For some Mach numbers and angles of attack, the NACA 0012 airfoil turbulent solutions are periodic. The results agree with experiments and results obtained by other methods. Author

A92-47690
A TIME MARCHING METHOD IN FINITE VOLUME FOR TRANSONIC DIFFUSER TURBULENT FLOWS
SHU-CHENG ZHANG and XI-JUN HUANG (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 13, no. 1, Jan. 1992, p. A42-A47. In Chinese. refs

A time marching method in finite volume is presented and applied to time dependent, Reynolds-averaged Navier-Stokes equations for transonic diffuser turbulent flows. A two-layer algebraic turbulent model, proposed by Baldwin-Lomax is used for the eddy viscosity function. An explicit, two-step time-marching method is presented. In the predicting step, downwind difference is used in the streamwise direction and central difference in the transverse direction. In the correcting step, upwind difference in the streamwise direction and central difference in the transverse direction are applied. The method is first-order in time and second-order in space. The results of the calculation are in good agreement with experiments. Author

A92-47691
A NEW METHOD FOR PREDICTING THE END WALL BOUNDARY LAYERS AND THE BLADE FORCE DEFECTS INSIDE THE PASSAGE OF AXIAL COMPRESSOR CASCADES
HU WU, FU-QUN CHEN, SONG-LING LIU, and ZHI-TAO HUANG (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 13, no. 1, Jan. 1992, p. A48-A56. In Chinese. refs

A new method is presented for calculating the end-wall boundary layers and the blade force defects inside the passage of axial compressor cascades based on associating boundary layer theory with secondary flow analysis. An integral equation of the boundary layer is used to calculate the longitudinal flow. Two layers of velocity modes are established to predict the transverse flow. An elliptic outer layer transverse flow associated with the secondary vorticity is computed by using the differential method. The calculation is performed inside the cascade passage and conducted alternatively between the longitudinal flow and the transverse flow. The S-type transverse flow profiles are predicted automatically and accurately. Compared with experimental results, the predictions by this method show better agreement for two examples of heavily loaded cascades. It is apparent that this method is both practical and reliable. The bases are established for predicting the end wall boundary layers in multistage axial compressors. Author

A92-47694
AN IMPROVED MULTIPLE LINE-VORTEX METHOD FOR SIMULATION OF SEPARATED VORTICES OF SLENDER WINGS
WEN-HAI GUO (Chinese Academy of Sciences, Institute of Mechanics, Beijing, People's Republic of China), DING-DING XING, and FENG-GAN ZHUANG (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 13, no. 1, Jan. 1992, p. A87-A90. In Chinese. refs

An improved vortical lines method has been made to simulate separated vortices slender wings. The idea of the method is to merge free vortical lines into cores so that chaotic motion of vortical lines can be avoided. The strength and position of vortical cores and lines can iteratively be obtained by satisfying boundary conditions. Numerical results show that the convergent quality of the method is good. The results are basically consistent with experimental results. The vortical flow of slender wings can be satisfactorily simulated by the method. Author

A92-47695
AERODYNAMIC SENSITIVITIES FOR SUBSONIC LIFTING-SURFACE
MING-CHU XU and WEN-YING GU (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 13, no. 1, Jan. 1992, p. A91-A95. In Chinese. refs

The aerodynamic sensitivity for a subsonic lifting-surface with an arbitrary curved leading edge is evaluated by the kernal function method. The expression of the generalized force coefficients and the corresponding sensitivity derivatives are derived into very concise forms by means of an appropriate series representation for load distribution and the calculation of upwash velocity in the Trefftz plane. Illustrative calculations for the elliptic, rectangular, and sweptback wings show that the force coefficient result of the sensitivity derivative method is actually identical to that of the direct kernel function method within the accuracy of lifting-surface theory. The partial derivatives obtained hereby can be used for multidisciplinary optimization by decomposition for aircraft design. Author

A92-47782
TOTAL LOSSES IN TURBULENT FLOWS INSIDE CONICAL DIFFUSERS [STRATY CALKOWITE PRZEPLYWU TURBULENTNEGO W DYFUZORACH STOZKOWYCH]
KRZYSZTOF J. JESIONEK (Wroclaw Technical University, Poland) and ARKADII E. ZARIANKIN (Moskovskii Energeticheskii Institut, Moscow, Russia) Politechnika Slaska, Zeszyty Naukowe, Mechanika (ISSN 0434-0817), no. 107, 1992, p. 173-180. In Polish. refs

A method of calculation of a diffuser flow boundary layer is presented that ensures a high concurrence of theoretical results with experimental investigation findings. A general equation is given, and an adequate detailed expression for the conical diffusers is obtained. The presented method does not require the use of additional, experimental correction coefficients. Author

A92-47839#
CALCULATION OF HYPERSONIC, VISCOUS, NON-EQUILIBRIUM FLOWS AROUND REENTRY BODIES USING A COUPLED BOUNDARY LAYER/EULER METHOD
CH. MUNDT (MBB GmbH, Munich, Federal Republic of Germany) AIAA, Thermophysics Conference, 27th, Nashville, TN, July 6-8, 1992. 15 p. refs
(AIAA PAPER 92-2856) Copyright

The objective of the present paper is to present a new and efficient method for the calculation of hypersonic, viscous flows in chemical nonequilibrium. The solution is obtained by using a coupled second order boundary layer/Euler method, thus making it possible to account for important hypersonic effects, such as entropy layer swallowing. Applications are presented for two-dimensional flow fields to validate the method and to analyze various physical and chemical effects. As a three-dimensional application, flows past the nose of the Hermes vehicle are calculated, and show suitability of the method for these applications is demonstrated. Author

A92-47856#
COMPUTATION OF HYPERSONIC FLOWFIELDS IN THERMAL AND CHEMICAL NONEQUILIBRIUM
ESWAR JOSYULA and JOSEPH S. SHANG (USAF, Wright Laboratory, Wright-Patterson AFB, OH) AIAA, Thermophysics Conference, 27th, Nashville, TN, July 6-8, 1992. 15 p. refs
(AIAA PAPER 92-2874) Copyright

Hypersonic flows past hemisphere cylinders at zero incidence in chemical and thermal nonequilibrium are investigated for a range of Mach numbers from 10 to 18. The numerical code is successfully validated for surface pressure and heat transfer prediction with recent experiments conducted in a shock tunnel. The numerical code is also successfully validated for stagnation point heat flux predictions at altitudes of 22 km and 37 km with a set of earlier experiments. Numerical solutions with the vibrational equilibrium model are compared with those of multi-temperature nonequilibrium. The stagnation point heat transfer is 10 to 23 percent higher for the nonequilibrium solutions in the Mach number range of 12 to 18. The importance of a multi-temperature model for accurate prediction of stagnation properties, particularly the heat transfer, is noted. The variation in computed shock-standoff distance substantiates that the Mach number independence principle applicable to ideal gases does not hold for dissociating flows. Over the range of Mach numbers, the noticeable influence of vibrational relaxation on the temperature distributions and mass concentrations in the vicinity of shocks is shown in the present study. Author

A92-47858#

COMPUTATION OF 3-D HYPERSONIC FLOWS IN CHEMICAL NON-EQUILIBRIUM INCLUDING TRANSPORT PHENOMENA

S. MENNE, C. WEILAND, and M. PFITZNER (MBB GmbH, Munich, Federal Republic of Germany) AIAA, Thermophysics Conference, 27th, Nashville, TN, July 6-8, 1992. 12 p. refs

(AIAA PAPER 92-2876) Copyright

An algorithm for the simulation of 3D hypersonic flows in chemical nonequilibrium is presented. The basic flow solver is based on a quasi-conservative formulation of the Euler or Navier-Stokes equations. The Jacobi matrices are split according to the sign of their eigenvalues. The derivatives of the conservative variables are split accordingly. A third-order upwind space discretization is used in conjunction with an optimized three-stage Runge-Kutta explicit time stepping scheme. The chemistry source terms are treated point-implicitly. For inviscid flow, the code is applied to the complete HERMES 1.0 configuration. The influence of mesh resolution is studied by comparing a fine grid with a coarse grid solution. For viscous flow, the flow about generic configurations (double-ellipse, hemisphere-cylinder-flare, hyperbola-flare) is investigated by performing grid sensitivity studies as well as by comparing different transport models. Author

A92-47860#

NUMERICAL SIMULATION OF CHEMICAL AND THERMAL NONEQUILIBRIUM FLOWS BEHIND COMPRESSION SHOCKS

G. BRENNER and U. PRINZ (DLR, Institut fuer Theoretische Stroemungsmechanik, Goettingen, Federal Republic of Germany) AIAA, Thermophysics Conference, 27th, Nashville, TN, July 6-8, 1992. 12 p. Research supported by DFG and CNES. refs

(AIAA PAPER 92-2879) Copyright

In this paper the influence of the thermal and chemical relaxation on the flow behind the bow shock of blunt and pointed bodies is investigated. Several models using different descriptions for high-temperature nitrogen and air are used. Special attention is payed to the influence of the modeling of nonequilibrium effects on surface heat fluxes and other properties of engineering interest. To shed some light on the relaxation behind shock/shock and shock/boundary layer interactions, as they occur, e.g., at the body-elevon junction of hypersonic vehicles, the flow past an axisymmetric approximation of the windward side of a generic Hermes geometry with body flap is simulated. The numerical method used in this investigation is a finite-difference upwind-TVD scheme. For comparison, alternative numerical methods were used to verify the present results. Author

A92-47872*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

LAMINAR HYPERSONIC FLOW OVER A COMPRESSION USING THE HANA CODE

JOHN F. FAY (Sverdrup Technology, Inc., Huntsville, AL) and JAY SAMBAMURTHI (NASA, Marshall Space Flight Center, Huntsville, AL) AIAA, Thermophysics Conference, 27th, Nashville, TN, July 6-8, 1992. 12 p. refs

(Contract NAS8-37814)

(AIAA PAPER 92-2896) Copyright

A hypersonic blunt-body code, HANA (Hypersonic Analysis for Aerobrakes), has been used to model the flow with compression corner angles of 15 and 24 degrees. A comparison is made between experimental flow data and numerical results of previous investigations which include surface pressures, skin friction coefficients, heat transfer rates, and flow field geometries. O.G.

A92-47873*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

ENHANCEMENTS TO VISCOUS-SHOCK-LAYER TECHNIQUE

ROOP N. GUPTA (NASA, Langley Research Center, Hampton, VA), KAM-PUI LEE (Vigyan, Inc., Hampton, VA), and ERNEST V. ZOBY (NASA, Langley Research Center, Hampton, VA) AIAA, Thermophysics Conference, 27th, Nashville, TN, July 6-8, 1992. 16 p. refs

(AIAA PAPER 92-2897) Copyright

A solution procedure is presented which considerably improves the computational efficiency of the viscous-shock-layer technique, especially for long slender bodies. The 'predictor-corrector' procedure suggested for obtaining the shock shape beyond the nose region requires only a single global pass. The accuracy of the present method is demonstrated by comparison with globally iterated results over the entire body and with ground- and flight-test data. A good comparison of the results computed with the two methods is shown for different flowfield chemistry models and axisymmetric body shapes. The new procedure results in computer run times 1/3 to 1/2 of the times required for the full-body global iteration procedure. Further, the algebraic expressions used to specify the initial shock shape eliminate the need for a shock shape generated by external means and permit immediate introduction of the full viscous-shock-layer equations. Finally, the present method of solution for the VSL equations provides to the aerothermal designer a very efficient and accurate tool for detailed flowfield as well as future technology studies. Author

A92-47875#

LOW DENSITY HEAT TRANSFER PHENOMENA

K. S. NAGARAJA (USAF, Wright Laboratory, Wright-Patterson AFB, OH) AIAA, Thermophysics Conference, 27th, Nashville, TN, July 6-8, 1992. 10 p. refs

(AIAA PAPER 92-2899)

A molecular flow equation (BGK equation) is applied to the classical Rayleigh problem to evaluate the transition characteristics between free molecule and continuum flows. Data obtained show that the heat transfer reaches a peak at a Knudsen number which is within the range of transition flow conditions under which similar peaks had been observed in limited wind tunnel tests. In the near continuum domain, even a slight variation in the flow Knudsen number causes an appreciable change in the heat transfer. Noncontinuum approaches are considered to be imperative for understanding performances of certain hypersonic vehicles at high altitudes. O.G.

A92-47876#

NUMERICAL AND EXPERIMENTAL INVESTIGATION OF RAREFIED COMPRESSION CORNER FLOW

A. CHPOUN, J. C. LENGRAND, and K. S. HEFFNER (CNRS, Laboratoire d'Aerothermique, Meudon, France) AIAA, Thermophysics Conference, 27th, Nashville, TN, July 6-8, 1992. 12 p. refs

(Contract DRET-89-080)

(AIAA PAPER 92-2900) Copyright

This paper presents the results of an experimental and numerical work carried out at the Laboratoire d'Aerothermique du CNRS, in order to investigate a rarefied hypersonic flow over a compression corner at two levels of rarefaction. The numerical work consisted of calculations of the flow by both the continuum model (Navier-Stokes (NS) full equations + wall temperature jump and velocity slip) and the DSMC method. In the experimental work, the density field over the model was measured by the electron-beam fluorescence technique in the SR3-CNRS rarefied hypersonic wind tunnel. The heat flux of the wall was also measured by thin skin technique. The principal aim of the work is to discuss the ability and the accuracy of the continuum model (NS) for the resolution of such rarefied flows by comparing results with different approaches. Author

A92-47892*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HEAT TRANSFER CHARACTERISTICS OF HYPERSONIC WAVERIDERS WITH AN EMPHASIS ON LEADING EDGE EFFECTS
DENIS O. VANMOL and JOHN D. ANDERSON, JR. (Maryland, University, College Park) AIAA, Thermophysics Conference, 27th, Nashville, TN, July 6-8, 1992. 16 p. refs
(Contract NAG1-1192)
(AIAA PAPER 92-2920) Copyright

The present analysis of the heat-transfer characteristics of a family of viscous-optimized, 60 m-long waverider hypersonic vehicles gives attention to the transition from laminar to turbulent flow, and to how the transition affects aerodynamic heating distributions over the waverider surface. Two different constant-dynamic-pressure flight trajectories are considered, at 0.2 and 1.0 freestream atmospheres. For Mach numbers below 10, it is found that passive radiative cooling of the surface is sufficient. The degree of leading-edge bluntness required by aerodynamic heating constraints does not significantly degrade the aerodynamic performance of these waveriders. O.C.

A92-47894*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
SOLUTION OF THE BURNETT EQUATIONS FOR HYPERSONIC FLOWS NEAR THE CONTINUUM LIMIT
SCOTT T. IMLAY (Amtec Engineering, Inc., Bellevue, WA) AIAA, Thermophysics Conference, 27th, Nashville, TN, July 6-8, 1992. 11 p. refs
(Contract NAS8-38892)
(AIAA PAPER 92-2922) Copyright

The INCA code, a three-dimensional Navier-Stokes code for analysis of hypersonic flowfields, was modified to analyze the lower reaches of the continuum transition regime, where the Navier-Stokes equations become inaccurate and Monte Carlo methods become too computationally expensive. The two-dimensional Burnett equations and the three-dimensional rotational energy transport equation were added to the code and one- and two-dimensional calculations were performed. For the structure of normal shock waves, the Burnett equations give consistently better results than Navier-Stokes equations and compare reasonably well with Monte Carlo methods. For two-dimensional flow of Nitrogen past a circular cylinder the Burnett equations predict the total drag reasonably well. Care must be taken, however, not to exceed the range of validity of the Burnett equations. A.F.S.

A92-47915*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CHARACTERISTICS OF THE SHUTTLE ORBITER LEESIDE FLOW DURING A REENTRY CONDITION
WILLIAM L. KLEB and K. J. WEILMUENSTER (NASA, Langley Research Center, Hampton, VA) AIAA, Thermophysics Conference, 27th, Nashville, TN, July 6-8, 1992. 15 p. refs
(AIAA PAPER 92-2951) Copyright

A study of the leeside flow characteristics of the Shuttle Orbiter is presented for a reentry flight condition. The flow is computed using a point-implicit, finite-volume scheme known as the Langley Aerothermodynamic Upwind Relaxation Algorithm (LAURA). LAURA is a second-order accurate, laminar Navier-Stokes solver, incorporating finite-rate chemistry with a radiative equilibrium wall temperature distribution and finite-rate wall catalysis. The resulting computational solution is analyzed in terms of salient flow features and the surface quantities are compared with flight data. Author

A92-47917#
AEROTHERMODYNAMIC CALCULATIONS FOR THE SPACE SHUTTLE ORBITER
J. HAEUSER, J. MUYLAERT, H. WONG, M. SPEL (ESTEC, Noordwijk, Netherlands), and T. VOIRON (CNES, Evry, France) AIAA, Thermophysics Conference, 27th, Nashville, TN, July 6-8, 1992. 20 p. refs
(AIAA PAPER 92-2953) Copyright

Euler and Navier-Stokes computations have been performed for two different geometries, namely, the original Space Shuttle and a European version of Orbiter, using mono- and multiblock grids. Effects of varying Mach number and real gas effects were simulated using Euler solutions based on a monoblock grid. Both models showed that the main contribution of the real gas effect on the pitching moment originated from the expansion part on the windward side of Orbiter. The specific heat ratio was parametrically varied in a series of perfect gas computations which demonstrated the feasibility of using cold facilities for pitch-up sensitivity investigations. Multiblock grids are used for both Euler and Navier-Stoke solutions. The multiblock topology lead to a substantially reduced number of grid points. A comparison of the aerodynamic coefficients obtained by the two approaches shows that small differences in the nose region can be attributed to the grid singularity of the monoblock grid. O.G.

A92-48019
SOME EXACT AND NUMERICAL RESULTS FOR PLANE STEADY SHEARED FLOW OF AN INCOMPRESSIBLE INVISCID FLUID
TERRY BROCKETT and JUNG-CHUN SUH (Michigan, University, Ann Arbor) Fluid Dynamics Research (ISSN 0169-5983), vol. 10, no. 1, June 1992, p. 55-73. refs
Copyright

Analytical and numerical solutions are given for the steady flow of an inviscid fluid about symmetric lifting profiles at an angle of attack in a plane sheared onset flow for which conformal mapping plays a critical role. For uniform shear in two dimensions, the disturbance field is potential and a solution based on the conformal transformation technique may therefore be constructed. The data obtained indicate that the uniform-shear solution overpredicts the lift and surface speed on the suction side of the foil relative to the more realistic onset flow. The numerical solution predicts surface speeds which generally lie between those for the uniform flow and the uniformly sheared flow solutions. L.M.

A92-48207
EXPERIENCE WITH THE JOHNSON-KING TURBULENCE MODEL IN A TRANSONIC TURBINE CASCADE FLOW SOLVER
N. B. WOOD (National Power Technology and Environmental Centre, Leatherhead, England) International Journal of Heat and Fluid Flow (ISSN 0142-727X), vol. 12, no. 2, June 1991, p. 158-165. refs
Copyright

Experience is described of the application of the Dawes Navier-Stokes solver to a turbine test case involving shock-boundary-layer interaction. Modifying the implementation of the algebraic eddy-viscosity turbulence model gave improved agreement between the predictions and the experimental results. In order to improve the predictions still further, the nonequilibrium turbulence model of Johnson and King was incorporated into the code. This gave limited further improvement in the overall loss prediction, but the base pressure prediction was not improved. Only a minor shock-induced separation was predicted, compared with the increasing major separation observed in cascade tests with increasing outlet Mach number. Better prediction of the test flow may require the incorporation of higher-order turbulence models, in which the physics of the flow is more fully represented. Additionally, three-dimensional and unsteady capability may be needed. Author

A92-48577
CALCULATION OF FULLY THREE-DIMENSIONAL SEPARATED FLOWS WITH AN UNSTEADY VISCOUS-INVISCID INTERACTION METHOD
J. C. LE BALLEUR and P. GIRODROUX-LAVIGNE (ONERA, Chatillon, France) (International Symposium on Numerical and Physical Aspects of Aerodynamic Flows, 5th, California State University, Long Beach, CA, Jan. 13-15, 1992) ONERA, TP no. 1992-1, 1992, 15 p. Research supported by Ministere de la

Defense. refs
(ONERA, TP NO. 1992-1)

This paper presents a fully 3D time-consistent turbulent viscous-inviscid interaction technique, based on a marching thin-layer 3D-numerical method that switches locally a direct or inverse mode of solution, on a modeling of parametric 3D-turbulent velocity profiles, and on the 'semiimplicit' unsteady coupling algorithm, extended in 3D-flows. 3D turbulent separations are shown to be accessible to the calculation techniques based on viscous-inviscid interaction. The shock-induced transonic 3D-separation on rectangular wings is successfully computed, with standard grids, properly refined in chord but not in span. R.E.P.

A92-48579
SEPARATION AND VORTEX FORMATION IN TURBULENT FLOWS
JEAN M. DELERY (ONERA, Chatillon, France) (Caribbean Conference on Fluid Dynamics, 2nd, University of the West Indies, St. Augustine, Trinidad and Tobago, Jan. 5-8, 1992) ONERA, TP no. 1992-7, 1992, 10 p. Research supported by CNES and Ministere de la Defense. refs
(ONERA, TP NO. 1992-7)

A separation process in 3D flows and the formation of vortical structures were analyzed using the critical-point theory. The latter makes it possible to correctly interpret the surface flow patterns which constitute the imprints of the outer flow and to give a rational and coherent description of the vortical system generated by separation. O.G.

A92-48585
THE DESIGN AND TESTING OF AN AIRFOIL WITH HYBRID LAMINAR FLOW CONTROL
J. RENEAUX and A. BLANCHARD (ONERA, Chatillon, France) (European Forum on Laminar Flow Technology, 1st, Hamburg, Federal Republic of Germany, Mar. 16-18, 1992) ONERA, TP no. 1992-22, 1992, 12 p. Research supported by Direction Generale de l'Aviation Civile, Ministere de la Defense, and Airbus Industrie. refs
(ONERA, TP NO. 1992-22)

This study focuses on the design of an airfoil with hybrid laminar flow control and describes the performance of a wing employing this basic airfoil. Three tests on this airfoil were conducted in the ONERA-CERT T2 cryogenic wind tunnel. It is shown that the laminization of the upper surface alone will result in a 5.6 percent reduction in fuel consumption which is sufficient to permit the use of a high lift leading edge such as a Kreuger flap. R.E.P.

A92-48701#
ADVANCED CFD SIMULATION AND TESTING OF COMPRESSOR BLADING IN THE MULTISTAGE ENVIRONMENT
FREDERIC FALCHETTI (SNECMA, Moissy-Cramayel, France) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 10 p. Research supported by Service Technique des Programmes Aeronautiques and DRET. refs
(AIAA PAPER 92-3040) Copyright

An account is given of an experimental program conducted to investigate the flow behavior of the four rear stages of a high-speed compressor, with attention to the use of miniature transverse probes in conjunction with laser anemometry. A CFD study is then conducted of the 3D viscous effects encountered. The 3D Navier-Stokes solver used in the compressor's design methodology is shown to be a critically important tool in turbomachine aerodynamics. Expected improvements in high pressure compressor design as a result of this work are noted. O.C.

A92-48702#
NUMERICAL COMPUTATIONS OF TRANSONIC FLOWS THROUGH CASCADES
A. TERLIZZI, P. DI MARTINO, S. COLANTUONI (Alfa Romeo Avio S.p.A., Pomigliano d'Arco, Italy), and F. BASSI (Milano, Politecnico, Milan, Italy) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 9 p. refs
(AIAA PAPER 92-3041) Copyright

A Navier-Stokes solver is described for 2D turbomachinery flows characterized by two features well suited for application in the design of modern turbine bladings: (1) it uses an adaptive mesh embedding technique to improve locally the accuracy of the numerical solution; and (2) it can simulate fluid injection at specified locations along the blade surface. Computational results are presented to show the flexibility of the proposed mesh-embedding technique applied to 2D turbine cascades and the capability of the code to describe the aerodynamic features of the coolant injection. Author

A92-48703#
COMPARISON BETWEEN TWO 3D-NS-CODES AND EXPERIMENT ON A TURBINE STATOR
D. WEGENER (DLR, Cologne, Federal Republic of Germany), A. LE MEUR, G. BILLONNET, B. ESCANDE, and C. JOURDEN (ONERA, Chatillon, France) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 11 p. Research supported by DRET. refs
(AIAA PAPER 92-3042) Copyright

The object of this paper is to present a comparison between two calculations carried out with different 3D Navier-Stokes codes applied to a subsonic turbine stator. Additionally the numerical data will be validated to experimental data obtained in the annular turbine test rig at DLR. The confrontation between experimental data and the results of the two calculations focus on local distributions and averaged radial distributions of flow angle, Mach number and total pressure ratio. These quantities will be studied in four planes downstream of the stator. The development of the wake and the prediction of total pressure losses will be discussed. Author

A92-48704#
A HIGHER-ORDER ACCURATE NAVIER-STOKES SOLVER FOR TRANSONIC AND SUPERSONIC FLOWS IN TURBOMACHINERY
SATORU YAMAMOTO and HISAAKI DAIGUJI (Tohoku University, Sendai, Japan) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 9 p. refs
(Contract MOESC-03238202; MOESC-02452114; MOESC-03750110)
(AIAA PAPER 92-3044) Copyright

A higher-order Navier-Stokes solver is presented which is based on a compact MUSCL TVD finite-difference scheme with fourth-order accuracy in space and second-order accuracy in time. Shocks, weak discontinuities, and vortices can be captured through this scheme more accurately than through the existing TVD scheme. Numerical results indicate that the proposed solver has a capability of simulating the flow which has never been estimated yet by the existing solver for turbomachinery. The dramatic improvement of the resolution for shocks, vortices and their interactions is remarkable for the Navier-Stokes solver which will be developed in future to analyze complex flow in advanced turbomachinery. O.G.

A92-48705#
APPLICATION OF NON-REFLECTING BOUNDARY CONDITIONS TO THREE-DIMENSIONAL EULER EQUATION CALCULATIONS FOR THICK STRUT CASCADES
KUNIYUKI IMANARI and HIDEKAZU KODAMA (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 10 p. refs
(AIAA PAPER 92-3045) Copyright

In the present paper, three-dimensional non-reflecting boundary conditions regarding pressure waves and associated components in density and velocity waves have been formulated and applied to time-marching Euler equation calculations of steady flows around uncambered thick strut cascades. The linearized solutions including a Fourier-Bessel double expansion with an exponential variation in the axial direction have been developed for far-field perturbations from the uniform free stream with subsonic axial velocity in a cylindrical annular duct, and used to provide the information for the correction of boundary conditions. Numerical examples for the symmetric struts and the nonuniform strut cascades comprising two types of vanes have demonstrated the correctness and accuracy of the present method, allowing a considerable reduction of the computational domain. Author

A92-48720#
ESTABLISHING TWO-DIMENSIONAL FLOW IN A LARGE-SCALE PLANAR TURBINE CASCADE
P. RODGER, S. A. SJOLANDER (Carleton University, Ottawa, Canada), and S. H. MOUSTAPHA (Pratt & Whitney Canada, Longueuil) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 9 p. Research supported by NSERC. refs
(AIAA PAPER 92-3066) Copyright

A novel arrangement of endplates has been developed for controlling the flow convergence or divergence in a low-speed cascade test section. These endplates have been used to investigate the influence of the flow two-dimensionality on the midspan aerodynamic behavior of a turbine cascade. It appears that flow convergence has relatively less influence on the midspan losses than flow divergence. However, the observed deviation at the trailing edge was significantly influenced by both. Convergence or divergence appears to alter the blade aerodynamic behavior mainly through its effect on the pressure distribution on the rearward part of the blade, particularly the base pressure. The apparent influence on the base pressure suggests that transonic and other cascades with large trailing edge losses may be particularly sensitive to lack of two-dimensionality. Author

A92-48723*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DEVELOPMENT OF AN EFFICIENT ANALYSIS FOR HIGH REYNOLDS NUMBER INVISCID/VISCID INTERACTIONS IN CASCADES
M. BARNETT, J. M. VERDON, and T. C. AYER (United Technologies Research Center, East Hartford, CT) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 15 p. refs
(Contract NAS3-25425)
(AIAA PAPER 92-3073) Copyright

An efficient steady analysis for predicting strong inviscid/viscid interaction phenomena such as viscous-layer separation, shock/boundary-layer interaction, and trailing-edge/near-wake interaction in turbomachinery blade passages is described. It uses an inviscid/viscid interaction approach, wherein the flow in the outer inviscid region is assumed to be potential, and that in the inner or viscous-layer region is governed by Prandtl's equations. The inviscid solution is determined using an implicit, least-squares, finite-difference approximation. The viscous-layer solution is obtained using an inverse, finite-difference, space-marching method which is applied along the blade surfaces and the wake streamline. A semiinverse global iteration procedure permits the prediction of boundary-layer separation and other strong-interaction phenomena. Results are presented for two cascades where a range of inlet flow conditions was considered for one of them including conditions leading to large-scale flow separation. Author

A92-48724*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AIRFOIL WAKE AND LINEAR THEORY GUST RESPONSE INCLUDING SUB AND SUPERRESONANT FLOW CONDITIONS
GREGORY H. HENDERSON and SANFORD FLEETER (Purdue University, West Lafayette, IN) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 12 p. Research supported by NASA. refs
(AIAA PAPER 92-3074) Copyright

The unsteady aerodynamic gust response of a high solidity stator vane row is examined in terms of the fundamental gust modeling assumptions with particular attention given to the effects near an acoustic resonance. A series of experiments was performed with gusts generated by rotors comprised of perforated plates and airfoils. It is concluded that, for both the perforated plate and airfoil wake generated gusts, the unsteady pressure responses do not agree with the linear-theory gust predictions near an acoustic resonance. The effects of the acoustic resonance phenomena are clearly evident on the airfoil surface unsteady pressure responses. The transition of the measured lift coefficients across the acoustic resonance from the subresonant regime to the superresonant regime occurs in a simple linear fashion. O.G.

A92-48729*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A FAST, UNCOUPLED, COMPRESSIBLE, TWO-DIMENSIONAL, UNSTEADY BOUNDARY LAYER ALGORITHM WITH SEPARATION FOR ENGINE INLETS
ROBERT L. ROACH, CHRIS NELSON (Georgia Institute of Technology, Atlanta), BARBARA SAKOWSKI, DOUGLAS DARLING (NASA, Lewis Research Center, Cleveland, OH), and ALLAN G. VAN DE WALL (Case Western Reserve University, Cleveland, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 8 p. Previously announced in STAR as N92-27653. refs
(AIAA PAPER 92-3082) Copyright

A finite difference boundary layer algorithm was developed to model viscous effects when an inviscid core flow solution is given. This algorithm solved each boundary layer equation separately, then iterated to find a solution. Solving the boundary layer equations sequentially was 2.4 to 4.0 times faster than solving the boundary layer equations simultaneously. This algorithm used a modified Baldwin-Lomax turbulence model, a weighted average of forward and backward differencing of the pressure gradient, and a backward sweep of the pressure. With these modifications, the boundary layer algorithm was able to model flows with and without separation. The number of grid points used in the boundary layer algorithm affected the stability of the algorithm affected the stability of the algorithm as well as the accuracy of the predictions of friction coefficients and momentum thicknesses. Results of this boundary layer algorithm compared well with experimental observations of friction coefficients and momentum thicknesses. In addition, when used interactively with an inviscid flow algorithm, this boundary layer algorithm corrected for viscous effects to give a good match with experimental observations for pressures in a supersonic inlet. Author

A92-48730*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INTERFACE OF AN UNCOUPLED BOUNDARY LAYER ALGORITHM WITH AN INVISCID CORE FLOW ALGORITHM FOR UNSTEADY SUPERSONIC ENGINE INLETS
DOUGLAS DARLING and BARBARA SAKOWSKI (NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 11 p. Previously announced in STAR as N92-27037. refs
(AIAA PAPER 92-3083) Copyright

An uncoupled boundary layer algorithm was combined with an inviscid core flow algorithm to model flows within supersonic engine inlets. The inviscid flow algorithm that was used was the LArge Perturbation INlet Code (LAPIN). The boundary layer and inviscid core flow algorithms were formulated in different manners. The boundary layer algorithm was two dimensional and solved in nonconservation form, while the core flow algorithm was one dimensional and solved in conservation form. In order to interface the two codes, the following modifications were important. The coordinate system was set up to maintain the parabolic nature of the boundary layer algorithm while approaching the one dimensional core flow solution far from a wall. The pressure gradient used in the boundary layer equation was calculated using the core flow values and the boundary layer equations, so the boundary layer solution smoothly approached the core flow values far from the wall. Flaring was used for the advection terms perpendicular to the core flow to maintain the stability of the algorithm. With these modifications, the combined viscous/inviscid algorithm matched well experimental observations of pressure distributions with a supersonic inlet. Author

A92-48738*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

AERODYNAMIC PERFORMANCE OF A FULL-SCALE LIFTING EJECTOR SYSTEM IN A STOVL FIGHTER AIRCRAFT

BRIAN E. SMITH (NASA, Ames Research Center, Moffett Field, CA), DOUG GARLAND (de Havilland Canada, Toronto), and WILLIAM A. POPPEN (General Dynamics Corp., Fort Worth, TX) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 21 p. refs
(AIAA PAPER 92-3094) Copyright

The aerodynamic characteristics of an advanced lifting ejector system incorporated into a full-scale, powered, fighter aircraft model were measured at statically and at transition airspeeds in the 40- by 80- and 80- by 120-Foot Wind Tunnels at NASA-Ames. The ejector system was installed in an ejector-lift/vectored thrust STOVL (Short Take-Off Vertical Landing) fighter aircraft configuration. Ejector thrust augmentation ratios approaching 1.6 were demonstrated during static testing. Changes in the internal aerodynamics and exit flow conditions of the ejector ducts are presented for a variety of wind-off and forward-flight test conditions. Wind-on test results indicate a small decrease in ejector performance and increase in exit flow nonuniformity with forward speed. Simulated ejector start-up at high speed, nose-up attitudes caused only small effects on overall vehicle forces and moments despite the fact that the ejector inlet flow was found to induce large regions of negative pressure on the upper surface of the wing apex adjacent to the inlets. Author

A92-48740# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

COMPARATIVE STUDY OF TURBULENCE MODELS IN PREDICTING HYPERSONIC INLET FLOWS

KAMLESH KAPOOR, BERNHARD H. ANDERSON, and ROBERT J. SHAW (NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 17 p. Previously announced in STAR as N92-28102. refs
(Contract RTOP 505-62-40)
(AIAA PAPER 92-3098) Copyright

A numerical study was conducted to analyze the performance of different turbulence models when applied to the hypersonic NASA P8 inlet. Computational results from the PARC2D code, which solves the full two-dimensional Reynolds-averaged Navier-Stokes equation, were compared with experimental data. The zero-equation models considered for the study were the Baldwin-Lomax model, the Thomas model, and a combination of the Baldwin-Lomax and Thomas models; the two-equation models considered were the Chien model, the Speziale model (both low Reynolds number), and the Launder and Spalding model (high Reynolds number). The Thomas model performed best among the zero-equation models, and predicted good pressure distributions. The Chien and Speziale models compared wery well with the experimental data, and performed better than the Thomas model near the walls. Author

A92-48741*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

INTERNAL SHOCK INTERACTIONS IN PROPULSION/AIRFRAME INTEGRATED THREE-DIMENSIONAL SIDEWALL COMPRESSION SCRAMJET INLETS

SCOTT D. HOLLAND (North Carolina State University, Raleigh; NASA, Langley Research Center, Hampton, VA) and JOHN N. PERKINS (North Carolina State University, Raleigh) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 13 p. refs
(Contract NCC1-153)
(AIAA PAPER 92-3099) Copyright

The advantages and design requirements of propulsion/airframe integration for high Mach number flight are studied in terms of the 3D sidewall compression scramjet inlet. The present work addresses in a parametric fashion the inviscid effects of leading edge sweep, sidewall compression, and inflow Mach number on the internal shock structure in terms of inlet compression and mass capture. The source of the Mach number invariance with leading edge sweep for a constant sidewall compression class of inlet is identified, and a previously undocumented spillage phenomenon in a constant effective wedge angle class of inlets is discussed. Author

A92-48742#

FNS ANALYSIS OF AN AXISYMMETRIC SCRAMJET INLET

Y.-C. HSIA (Rockwell International Corp., Rocketdyne Div., Canoga Park, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 8 p. refs
(Contract F33657-91-C-2012)
(AIAA PAPER 92-3100) Copyright

A full Navier-Stokes computation was carried out on a mixed-compression axisymmetric scramjet inlet at Mach 5. The geometry including a blunt nose and cowl leading edge was modeled using a multi-zone approach which permitted running either time-marching or space-marching on individual zones. A Baldwin-Lomax turbulence model was used to simulate the effects of turbulence. The flow solution agreed very well with test data on the wall static pressure and throat total pressure. The numerical inlet performance calculated by post-processing the solution matched the wind tunnel test data as well. Author

A92-48744*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

COMPUTATIONAL ANALYSIS OF RAMJET ENGINE INLET INTERACTION

BEVERLY DUNCAN (Sverdrup Technology, Inc., Brook Park, OH) and SCOTT THOMAS (NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 12 p. refs
(AIAA PAPER 92-3102) Copyright

A computational analysis of a ramjet engine at Mach 3.5 has been conducted and compared to results obtained experimentally. This study focuses on the behavior of the inlet both with and without combustor backpressure. Increased backpressure results in separation of the body side boundary layer and a resultant static pressure rise in the inlet throat region. The computational results compare well with the experimental data for static pressure distribution through the engine, inlet throat flow profiles, and mass capture. The computational analysis slightly underpredicts the thickness of the engine body surface boundary layer and the extent of the interaction caused by backpressure; however, the interaction is observed at approximately the same level of backpressure both experimentally and computationally. This study demonstrates the ability of two different Navier-Stokes codes, namely RPLUS and PARC, to calculate the flow features of this ramjet engine and to provide more detailed information on the process of inlet interaction and unstart. Author

A92-48800#

WAKE MIXING AND PERFORMANCE MEASUREMENTS IN A LINEAR COMPRESSOR CASCADE WITH CRENULATED TRAILING EDGES

S. J. DECOOK, P. I. KING, and W. C. ELROD (USAF, Institute of Technology, Wright-Patterson AFB, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 12 p. refs
(AIAA PAPER 92-3188)

Trailing edge crenulations have been shown to enhance velocity recovery (wake dissipation) and to decrease total pressure losses in the blade wakes downstream of a low-aspect-ratio linear compressor cascade. A new study was performed to determine the influence of trailing edge crenulations on outlet flow in the presence of varied inlet flow conditions. Two levels of inlet flow turbulence intensity (about 0.15 and 3 percent were combined with sidewall boundary layer removal at the cascade inlet (on or off) to provide four test conditions. Testing included configurations with unmodified blades, blades with large crenulations, and blades with small crenulations. For each test condition a reduction of 10 to 20 percent in velocity variance (enhanced wake mixing) and in total pressure loss was observed in the outlet flow with the crenulated blades, while a slight decrease in turning angle was also observed. Author

A92-48804#
NUMERICAL INVESTIGATION OF SURGE AND ROTATING STALL IN MULTISTAGE AXIAL COMPRESSORS
H. ISHII and Y. KASHIWABARA (Hitachi, Ltd., Mechanical Engineering Research Laboratory, Ibaraki, Japan) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 11 p. refs
(AIAA PAPER 92-3193) Copyright

This paper investigates the effects of various parameters on the inception and post-stall characteristics of surge and rotating stall in multistage axial compressors by using a proposed numerical model. The parameters include the shape of the total pressure-loss and deviation angle characteristics, IGV outlet flow angle, inlet flow distortion, and bleeding. Some of the major findings are: there exist two types of rotating stall differing in magnitude; inlet distortion and the deterioration in compressor performance lower the inception margin of unstable behaviors; an optimal bleeding can exist to make the inception margin of unstable behaviors optimal. The usefulness of the present model is examined by the numerical investigations. The validity of the model is also discussed by comparisons with test results in a 3-stage compressor. Author

A92-48817#
NUMERICAL SOLUTIONS OF UNSTEADY OSCILLATING FLOWS PAST AN AIRFOIL
KOJI MORINISHI and SHIGERU MURATA (Kyoto Institute of Technology, Japan) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 11 p. refs
(AIAA PAPER 92-3212) Copyright

The numerical solutions of the incompressible Navier-Stokes equations are used to investigate the unsteady oscillating flows past an airfoil. The time accurate solutions of the Navier-Stokes equations are obtained by the method of artificial compressibility. The rational Runge-Kutta scheme is used for subiterations in the pseudotime. The convergences in the subiterations are accelerated by a multigrid algorithm. Sinusoidally oscillating flows are superimposed on uniform free streams. The Reynolds number and angle of attack of the uniform flows are fixed at 1000 and 15 deg, respectively. The reduced amplitude of the superimposed flows ranges from 5 to 20 percent of the uniform flow velocities, while the reduced frequencies are close to harmonies of the free vortex shedding frequency. The time histories of the lift coefficients are analyzed by means of a spectral analysis. The time histories of the lift coefficients at the small amplitude of the forced flows, oscillate at the forced frequency combined with the free vortex shedding frequency. The time histories at the larger forced amplitude oscillate at the forced frequency. Author

A92-48857#
THE ENHANCEMENT OF MIXING IN HIGH-SPEED HEATED JETS USING A COUNTERFLOWING NOZZLE
P. J. STRYKOWSKI (Minnesota, University, Minneapolis), A. KROTHAPALLI (Florida State University, Tallahassee), and D. WISHART (Florida Agricultural and Mechanical University, Tallahassee) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 7 p. refs
(Contract N00014-92-J-1406)
(AIAA PAPER 92-3262) Copyright

An experimental study was conducted to determine whether annular counterflow could be used to enhance mixing in high-speed subsonic and supersonic jets. Suction was applied to a collar placed concentrically about the main jet nozzle to establish a reverse flowing stream around the jet periphery. The main jet was operated at exit Mach numbers between 0.4 and 2, for stagnation temperatures from 20 C to 400 C. The results indicate that moderate levels of counterflow can be effectively used to enhance jet mixing under realistic operating conditions. Furthermore, the data suggest that the counterflowing technique becomes more effective as the jet temperature is increased. Author

A92-48897#
NAVIER-STOKES INVESTIGATION OF A TRANSONIC CENTRIFUGAL COMPRESSOR STAGE USING AN ALGEBRAIC REYNOLDS STRESS MODEL
R. F. KUNZ and B. LAKSHMINARAYANA (Pennsylvania State University, University Park) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 18 p. refs
(Contract DAAL03-86-G-0044)
(AIAA PAPER 92-3311) Copyright

A 3D Navier-Stokes procedure is presently used to arrive at flow field behavior results that are compared with extant laser two-focus meridional passage velocity measurements. A two-layer k-epsilon/algebraic Reynolds stress model is used to account for Reynolds-stress anisotropies. Relative helicity is used to clarify computational results and deepen insight into the secondary motions due to tip-clearance, curvature, and rotation. Results are presented for impeller-diffuser flowfield calculations with and without the two-layer model; good agreement with experimental meridional velocity and shroud static pressure measurements are obtained by both modeling approaches. O.C.

A92-48898#
A TURBULENCE MODEL BASED ON RNG FOR QUASI-THREE-DIMENSIONAL CASCADE FLOWS
G. V. HOBSON and C.-W. WANG (U.S. Naval Postgraduate School, Monterey, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 13 p. refs
(AIAA PAPER 92-3312) Copyright

Use of the algebraic renormalization group turbulence model is presented in a quasi-three-dimensional rotor viscous code. An initial baseline solution for an annular turbine cascade was established. The solutions obtained with the existing Baldwin-Lomax turbulence model and the RNG model are compared with available experimental data. The RNG model predictions need to be compared to experimentally measured skin friction data of a boundary layer undergoing transition from laminar to turbulent flow. Author

A92-48899#
A NAVIER-STOKES ANALYSIS OF A CONTROLLED-DIFFUSION COMPRESSOR CASCADE AT INCREASING INLET-FLOW ANGLES
GARTH V. HOBSON (U.S. Naval Postgraduate School, Monterey, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 15 p. refs
(AIAA PAPER 92-3313) Copyright

The extensive set of experimental data, which was measured primarily for code validation, was used for comparison with a finite volume, incompressible Navier-Stokes solution of the viscous flow through a set of controlled-diffusion compressor blades. This was done at increasing inlet-flow angles, and the solution was optimized for the design inlet-flow angle. The main objective of this paper is to predict the losses through the cascade; however, another objective is to predict the turbulence field upstream, through and aft of the blade row. Excellent comparisons were achieved at design incidence; however, at increasing flow angles the losses were not accurately predicted with the code. Author

A92-48906#
VANE-BLADE INTERACTION IN A TRANSONIC TURBINE. I - AERODYNAMICS
K. V. RAO, R. A. DELANEY (General Motors Corp., Allison Gas

Turbine Div., Indianapolis, IN), and M. G. DUNN (Calspan Advanced Technology Center, Buffalo, NY) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 10 p. refs
(Contract F33615-90-C-2028)
(AIAA PAPER 92-3323)

Part I of this paper presents results of a computational investigation of the effects of blade row interaction on the aerodynamics of a transonic turbine stage. The predictions are obtained using a 2D unsteady Navier-Stokes code based on an explicit Runge-Kutta algorithm and a new O-H grid system. This code simulates the flow in time-accurate fashion using nonreflective stage inflow and outflow boundary conditions and phase-lagging procedures for modeling arbitrary airfoil counts in the vane and blade rows. The O-H grid provides high spatial resolution of the high gradient regions near the airfoil surfaces and allows for arbitrary placement of stage inflow and outflow boundaries. Unsteady and time-averaged airfoil surface pressure predictions are compared with those from an older version of the code based on the explicit hopscotch algorithm and an O-grid system and experimental data obtained in a short-duration shock tunnel facility. Author

A92-48909*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INVESTIGATION OF THREE-DIMENSIONAL FLOW FIELD IN A TURBINE INCLUDING ROTOR/STATOR INTERACTION. II - THREE-DIMENSIONAL FLOW FIELD AT THE EXIT OF THE NOZZLE
M. ZACCARIA and B. LAKSHMINARAYANA (Pennsylvania State University, University Park) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 13 p. refs
(Contract NSG-3555)
(AIAA PAPER 92-3326) Copyright

The nozzle exit flowfield was measured at two axial locations with a miniature five-hole probe. Measurements were taken from hub-to-tip, blade-to-blade at 21 radial locations and at two axial locations downstream of the nozzle trailing edge to resolve the flowfield accurately including the nozzle wake, secondary flow region, horseshoe vortex and losses. All three components of the velocity, stagnation pressure, static pressure, and pitch and yaw angles have been resolved very accurately. The wake data seems to indicate that the decay of the wake is faster than the wake of an isolated nozzle row. The cause of this is attributed to the presence of the rotor downstream. A distinct vortex core has been observed near the tip. The indications are that the horseshoe vortex and the passage vortex have merged to produce a single loss core region. Roughly a third of the blade height passage near the tip and a third of the blade height near the hub is dominated by secondary flow, passage vortex and the horseshoe vortex phenomena. Only the middle third of the nozzle behaves as per design. These and other data are presented, interpreted and synthesized to understand the nozzle flowfield. Author

A92-49063*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SUPERSONIC JET MIXING ENHANCEMENT BY 'DELTA-TABS'
K. B. M. Q. ZAMAN (NASA, Lewis Research Center, Cleveland, OH), M. F. REEDER, and M. SAMIMY (Ohio State University, Columbus) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 15 p. Previously announced in STAR as N92-24958. refs
(AIAA PAPER 92-3548) Copyright

The results of a continuing investigation of the effect of vortex generators, in the form of small tabs at the nozzle exit, on the evolution of a jet are reported. Primarily, tabs of triangular shape are considered, and the effect is studied up to an equivalent jet Mach number of 1.8. By changing the orientation of the tab with respect to the nozzle exit plane, streamwise vortex pairs of opposite sign were generated. This resulted in either an outward selection of jet core fluid into the ambient or an inward indentation of the mixing layer into the core of the jet. A triangular shaped tab with its apex leaning downstream, referred to as a delta tab, was found to be the most effective in influencing the jet evolution. Two delta tabs, spaced 180 degrees apart, completely bifurcated the jet. Four delta tabs increased jet mixing substantially, more than by various other methods tried previously; the mass flux at fourteen jet diameters downstream from the nozzle increased by about 50 percent over that for the no tab case. The tabs were found to be effective in jets with laminar or turbulent boundary layers as well as in jets with low or high core turbulence intensities. Author

A92-49076#
IMPROVED METHOD FOR ESTIMATION OF THE MAXIMUM INSTANTANEOUS DISTORTION VALUES
D. W. LIANG and S. Y. ZHANG (Nanjing Aeronautical Institute, People's Republic of China) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 7 p. refs
(AIAA PAPER 92-3623) Copyright

In this paper, the statistical method for estimating the maximum instantaneous distortion in the Liang and Zhang (1989) method is developed further to estimate the maximum values of the instantaneous distortions in which the operation of peak values of dynamic pressure and correlation between them are involved. The effects of the correlation between fluctuating pressures on the estimation are discussed. Comparison between the estimated values and the experimental results shows that the newly developed method can quite accurately estimate the maximum value of the instantaneous distortion with operation of peak values of dynamic pressures involved, such as the distortion descriptor DC (theta). The accuracy of estimation of maximum instantaneous distortion can be improved by considering the correlation between fluctuation pressures, yet when the mean correlation coefficients is less than 0.1, the estimation can be effected by dispensing with correlation. Author

A92-49088#
NUMERICAL SIMULATION OF A CONFINED TRANSONIC NORMAL SHOCK WAVE/TURBULENT BOUNDARY LAYER INTERACTION
EDWIN BLOSCH, BRUCE F. CARROLL (Florida, University, Gainesville), and MARTIN J. MORRIS (McDonnell Douglas Research Laboratories, Saint Louis, MO) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 11 p. Research supported by McDonnell Douglas Independent Research and Development Program and DOE. refs
(AIAA PAPER 92-3668) Copyright

A steady, 2D, Mach 1.48 normal shock wave/turbulent boundary layer interaction (NSTBLI) has been simulated in a diffuser configuration. Particular attention is given to the role of the various parameters affecting the global features of NSTBLIs. Wall static pressure and displacement thickness distributions, and contours of the streamwise component of velocity, are compared with the experiment. The computed interaction is found to be stiffer than the experimental one in the sense that the upstream influence length is smaller, and the wall pressure is steeper; otherwise the agreement with experimental data is good. The simulation results provide some insight into the effect of the pressure gradient on the recovering boundary layer and provide a starting point for an investigation of the effect of local suction in the interaction region. O.G.

A92-49118#
NUMERICAL FLOW SIMULATION AND ANALYSIS OF A SHROUDED PROPFAN ROTOR
A. MELAKE (DLR, Institut fuer Antriebstechnik, Cologne, Federal Republic of Germany) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 13 p. refs
(AIAA PAPER 92-3773) Copyright

Propfan concepts are approaches toward fan engines with very high bypass ratio and therefore reduced specific fuel consumption. One of these concepts is the Counter Rotating Integrated Shrouded

Propfan (CRISP) with its swept variable-pitch blades. A comprehensive test program has been performed on the isolated first rotor of the CRISP, accompanied by numerical flow simulation using a 3D Navier-Stokes code. After having validated the code by comparison with experimental data, attention was given to the blade/hub corner and blade/casing corner surfaces at off-design operating condition. These are areas where vortices originate but are difficult to access experimentally. To check the validity of the code with respect to boundary-layer separation, an annular compressor cascade has been used and presented for which an extensive experimental data base was available. Author

A92-49188
SIMILARITY RELATIONS FOR CALCULATING THREE-DIMENSIONAL CHEMICALLY NONEQUILIBRIUM VISCOUS FLOWS [SOOTNOSHENIIA PODOBIIA DLIA RASCHETA TREKHMERNYKH KHIMICHESKI NERAVNOVESNYKH VIAZKIKH TECHENII]
I. G. BRYKINA, V. V. RUSAKOV, and V. G. SHCHERBAK (Moskovskii Gosudarstvennyi Universitet, Moscow, Russia) Teplofizika Vysokikh Temperatur (ISSN 0040-3644), vol. 30, no. 3, May-June 1992, p. 521-528. In Russian. refs
Copyright

Three-dimensional hypersonic flow of a chemically nonequilibrium viscous gas past blunt bodies is investigated analytically. A method for solving three-dimensional flow problems using two-dimensional solutions is proposed which is applicable for arbitrary Reynolds numbers and real gas properties. The method employs similarity ralations describing heat flux, friction, and component concentrations on the surface of an axisymmetric body. The accuracy of the similarity relations is estimated from finite difference calculations of three-dimensional equations of a viscous shock layer for bodies of different shapes moving along a gliding reentry trajectory. Various model of the surface catalytic activity are examined. V.L.

N92-28477*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
CALCULATION OF UNSTEADY TRANSONIC FLOWS WITH MILD SEPARATION BY VISCOUS-INVISCID INTERACTION
JAMES T. HOWLETT Jun. 1992 39 p
(Contract RTOP 509-10-02-03)
(NASA-TP-3197; L-16996; NAS 1.60:3197) Avail: CASI HC A03/MF A01

This paper presents a method for calculating viscous effects in two- and three-dimensional unsteady transonic flow fields. An integral boundary-layer method for turbulent viscous flow is coupled with the transonic small-disturbance potential equation in a quasi-steady manner. The viscous effects are modeled with Green's lag-entrainment equations for attached flow and an inverse boundary-layer method for flows that involve mild separation. The boundary-layer method is used stripwise to approximate three-dimensional effects. Applications are given for two-dimensional airfoils, aileron buzz, and a wing planform. Comparisons with inviscid calculations, other viscous calculation methods, and experimental data are presented. The results demonstrate that the present technique can economically and accurately calculate unsteady transonic flow fields that have viscous-inviscid interactions with mild flow separation. Author

N92-28511*# Maryland Univ., College Park. Dept. of Aerospace Engineering.
STUDIES IN GENERAL AVIATION AERODYNAMICS Final Technical Report
ALLEN E. WINKELMANN 1990 20 p
(Contract NAG1-681)
(NASA-CR-190431; NAS 1.26:190431) Avail: CASI HC A03/MF A01

The Department of Aerospace Engineering at the University of Maryland has completed a research study for NASA Langley on the application of drooped leading edges to high aspect wings. The experimental study conducted for this grant was a natural extension of work previously conducted at NASA Ames, the University of Michigan, NASA Langley and the University of Maryland. Previous research had shown that wing planform modifications (commonly referred to as drooped leading edge mods) could have a significant effect on reducing or eliminating the stall/spin characteristics of General Aviation (GA) aircraft. All aircraft studied in the earlier work had relatively low aspect ratio wings (AR = 6). Since future GA aircraft will feature higher aspect ratio wings, the obvious question was: how well will the dropped leading edge work on higher aspect ratio wings? The focus of the current study was to examine the effectiveness of the drooped leading edge modifications to higher aspect ratio wings with AR = 9 to 12. Author

N92-28657# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
ANALYSIS OF RESULTS OF AN EULER-EQUATION METHOD APPLIED TO LEADING-EDGE VORTEX FLOW
J. I. VANDENBERG, H. W. M. HOEIJMAKERS, and J. M. J. W. JACOBS 30 Oct. 1990 17 p Presented at the AGARD Fluid Dynamics Panel Symposium on Vortex Flow Aerodynamics, Scheveningen, Netherlands, 1-4 Oct. 1990 Previously announced as N92-13000 Sponsored by Netherlands Agency for Aerospace Programs
(NLR-TP-90368-U; ETN-92-91450) Avail: CASI HC A03/MF A01

The flow about a 65 deg sharp edged cropped delta wing with and without an underwing body is simulated by solving the Euler equations. Results are presented for the wing body configuration at a transonic free stream Mach number at incidences ranging from 10 to 20 deg for which in the flow field above the wing a strong vortex develops as well as shocks for the high incidence of 20 deg. Results for subsonic to transonic free stream Mach numbers at high incidence are obtained for the wing alone configuration for which, in the presence of a strong vortex, at transonic free stream Mach number, shocks appear in the solution. For the wing-body configuration, the computational results are compared with experimental data, and the solution in the near wake is investigated. ESA

N92-28658# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
COMPARISON OF LDA AND LTA APPLICATIONS FOR PROPELLER TESTS IN WIND TUNNELS
J. H. M. GOODEN and J. W. KOOI 7 May 1988 10 p Presented at the 4th International Symposium on Applications of Laser Anemometry to Fluid Mechanics, Lisbon, Portugal, 11-14 Jul. 1988 Previously announced in IAA as A89-33381
(Contract NIVR-03601-N)
(NLR-MP-88031-U; ETN-92-91512) Avail: CASI HC A02/MF A01

A study to investigate the performance of a two component Laser Doppler (LDA) and Laser Transit (LTA) Anemometer is presented. Both systems were compared under industrial testing conditions in the flow field of a propeller. Free stream flow speed was 40 m/s. The propeller, diameter 0.73 m, was operated at 3500 and 6000 rpm. Axial and tangential velocities were measured in front of, in between and behind the propeller blades. The results of the two systems were in good agreement within 1 m/s for the axial velocity. The error in the tangential velocity was about 1 to 2 m/s but of a different sign. The productivity and the capability of the LDA to measure in highly turbulent flows were superior. The high light concentration in the probe volumes of the LTA made artificial seeding superfluous. ESA

N92-28659# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
CALCULATION OF UNSTEADY SUBSONIC AND SUPERSONIC FLOW ABOUT OSCILLATING WINGS AND BODIES BY NEW PANEL METHODS
M. H. L. HOUNJET 14 Apr. 1989 24 p Presented at the European Forum on Aeroelasticity and Structural Dynamics, Aachen, Fed. Republic of Germany, 17-19 Apr. 1989 Previously announced in IAA as A90-33359 Sponsored in part by Royal Netherlands Air Force
(NLR-TP-89119-U; ETN-92-91518) Avail: CASI HC A03/MF A01

The unsteady aerodynamic loads in the subsonic and supersonic domain, obtained with two new panel methods, for lifting surfaces and for realistic aircraft configurations are presented. The General Unsteady Lifting (GUL) surface code and the Compressible Aerodynamic Response (CAR) methods were developed for calculations involving realistic aircraft configurations. A description of the methods is given. Results are presented and comparisons are made with results of existing methods and with experimental data for a fighter type wing with external stores. ESA

N92-28660# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.

CONSTRAINED SPANLOAD OPTIMIZATION FOR MINIMUM DRAG OF MULTI-LIFTING-SURFACE CONFIGURATIONS

R. F. VANDENDAM 10 Apr. 1989 19 p Presented at the AGARD Specialists Meeting on Computational Methods for Aerodynamic Design (Inverse) and Optimization, Loen, Norway, 22-23 May 1989
(Contract NIVR-01101-N)
(NLR-TP-89126-U; ETN-92-91519) Avail: CASI HC A03/MF A01

The development of a interactive computer program system that can be used in aircraft drag minimization studies is addressed. It comprises algorithms for choosing the spanwise distributions of lift, pitching moment, chord and thickness to chord ratio of lifting elements. The choices are optimal in that they minimize induced plus viscous drag while satisfying constraints of aerodynamic, flight mechanical and structural natures. The configurations that can be dealt with may consist of a number of segments representing, for instance, wings or parts of wings, horizontal tails or canards, winglets, flaprail-fairings, etc. Also the interaction between propellers and lifting elements may be included in the procedure. The induced drag is computed using the Trefftz plane integral (farfield analysis), while the viscous drag follows from form factor methods. Novel mathematical formulations of the constrained optimization problems based on the calculus of variations are used. The method was integrated in an infrastructure that allows the capabilties of the method to be efficiently exploited in a multidisciplinary environment. The theoretical models and methods underlying the analysis and optimization capability, comparisons with other theories, information aspects, and some examples of applications are presented. ESA

N92-28674*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

EXPERIMENTAL AND COMPUTATIONAL ICE SHAPES AND RESULTING DRAG INCREASE FOR A NACA 0012 AIRFOIL

JAIWON SHIN and THOMAS H. BOND Jan. 1992 12 p Presented at the 5th Symposium on Numerical and Physical Aspects of Aerodynamic Flows, Long Beach, CA, 13-16 Jan. 1992; sponsored in part by California State Univ.
(Contract RTOP 505-68-10)
(NASA-TM-105743; E-7148; NAS 1.15:105743) Avail: CASI HC A03/MF A01

Tests were conducted in the Icing Research Tunnel (IRT) at LeRC to document the repeatability of the ice shape over the range of temperatures varying from -15 to 28 F. Measurements of drag increase due to the ice accretion were also made. The ice shape and drag coefficient data, with varying total temperatures at two different airspeeds, were compared with the computational predictions. The calculations were made with the 2D LEWICE/IBL code which is a combined code of LEWICE and the interactive boundary layer method developed for iced airfoils. Comparisons show good agreement with the experimental data in ice shapes. The calculations show the ability of the code to predict drag increases as the ice shape changes from a rime shape to a glaze shape. Author

N92-28692# National Aerospace Lab., Amsterdam (Netherlands). Aerodynamics Div.

DEVELOPMENT AND VALIDATION OF A CHARACTERISTIC BOUNDARY CONDITION FOR A CELL-CENTERED EULER METHOD

J. I. VANDENBERG and J. W. BOERSTOEL 6 May 1990 12 p Presented at the 17th ICAS Congress, Stockholm, Sweden, 9-14 Sep. 1990 Sponsored in part by Netherlands Agency for Aerospace Programs
(NLR-TP-90144-U; ETN-92-91535) Avail: CASI HC A03/MF A01

The development and numerical validation of a solid wall boundary condition for the numerical solution of the Euler equations with a cell centered central difference scheme is presented. This solid wall boundary condition was obtained from the theory of characteristics, and was also formulated for a cell/centered central/difference scheme. The boundary condition was developed to clarify the question of what the effect is of various boundary/condition algorithms on the accuracy of the three dimensional numerical solution of the Euler equations. The numerical validation of the solid/wall boundary condition consists of a comparison of results obtained with the conventional and the new solid/wall boundary condition. Discretization and convergence errors as well as grid depency of the solution were investigated. As a test case, the NLR 7301 airfoil was chosen. Calculations were performed for the supercritical, shock free flow at M(sub infinity) = 0.721, alpha = 0.194 deg, and for a flow with a strong shock at M(sub infinity) = 0.70, alpha 2.0 deg. ESA

N92-28696*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

RESULTS OF A LOW POWER ICE PROTECTION SYSTEM TEST AND A NEW METHOD OF IMAGING DATA ANALYSIS

JAIWON SHIN, THOMAS H. BOND, and GEERT A. MESANDER (Air Force Logistics Command, Tinker AFB, OK.) Jun. 1992 18 p Presented at the 48th Annual Forum and Technology Display, Washington, DC, 3-5 Jun. 1992; sponsored in part by the American Helicopter Society
(Contract RTOP 505-68-10)
(NASA-TM-105745; E-6930; NAS 1.15:105745) Avail: CASI HC A03/MF A01

Tests were conducted on a BF Goodrich De-Icing System's Pneumatic Impulse Ice Protection (PIIP) system in the NASA Lewis Icing Research Tunnel (IRT). Characterization studies were done on shed ice particle size by changing the input pressure and cycling time of the PIIP de-icer. The shed ice particle size was quantified using a newly developed image software package. The tests were conducted on a 1.83 m (6 ft) span, 0.53 m (221 in) chord NACA 0012 airfoil operated at a 4 degree angle of attack. The IRT test conditions were a -6.7 C (20 F) glaze ice, and a -20 C (-4 F) rime ice. The ice shedding events were recorded with a high speed video system. A detailed description of the image processing package and the results generated from this analytical tool are presented. Author

N92-28709# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.

WAVE DRAG DETERMINATION IN THE TRANSONIC FULL-POTENTIAL FLOW CODE MATRICS

J. VANDERVOOREN and A. J. VANDERWEES 19 Feb. 1990 32 p
(Contract NIVR-RB-311.1-01501-N)
(NLR-TP-90062-U; ETN-92-91530) Avail: CASI HC A03/MF A01

The mathematical background of a method developed to calculate wave drag in transonic potential flow is described. The method is a generalization and extension of Garabedian's and McFadden's idea of determining wave drag by volume integration of the artificial viscosity. The generalization of Garabedian's and McFadden's idea involves the introduction of a reference artificial viscosity which provides a solid theoretical basis. At the same time this ensures that calculated wave drag is to a certain extent independent of the specific details of the artificial viscosity in different diodes. The extension of Garabedian's and McFadden's idea accounts for the fact that artificial viscosity does not smear out supersonic/subsonic shock waves completely, but leaves room for a truly discontinuous sonic/subsonic 'shock remainder' that contributes substantially to the wave drag. Both fully conservative and nonconservative shock capture in potential flow are covered. The method can be extended to handle also pseudo

Rankine-Hugoniot shock waves. An illustrative example for a transonic transport type wing is given. ESA

N92-28713# National Aerospace Lab., Amsterdam (Netherlands). Aerodynamics Div.
FLOW GRADIENT CORRECTIONS ON HOT-WIRE MEASUREMENTS USING AN X-WIRE PROBE
J. H. M. GOODEN (Fokker B.V., Schipol-Oost (Netherlands).) and M. VANLENT (Fokker B.V., Schipol-Oost, Netherlands) 11 Jul. 1990 18 p Presented at 12th Symposium on Turbulence, Rolla, MO, 1990 Previously announced in IAA as A91-54278
(Contract NIVR-01502-N)
(NLR-TP-90255-U; ETN-92-91543) Avail: CASI HC A03/MF A01
The development of a method to correct hot wire measurements by means of a single X-wire probe for the effect of gradients normal to the plane of the wires in the mean flow velocities as well as the turbulence intensities is reported. Data processing is performed in an iterative way, using the results of measurements with different probe rolling angles, to determine the gradient corrections along the traverse from the previous loop. The method is applied to measurements in the wake above the trailing edge flap of a wing. Substantial improvements in the results are shown. ESA

N92-28729* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NATURAL FLOW WING Patent
RICHARD M. WOOD, inventor (to NASA) and STEVEN X. S. BAUER, inventor (to NASA) 12 May 1992 13 p Filed 31 Jul. 1990
(NASA-CASE-LAR-14281-1; US-PATENT-5,112,120; US-PATENT-APPL-SN-560923; US-PATENT-CLASS-244-35R; US-PATENT-CLASS-244-36; INT-PATENT-CLASS-B64C-3/14)
Avail: US Patent and Trademark Office
The invention is a natural flow wing and a method for constructing the same. The method comprises contouring a three-dimensional upper surface and a three-dimensional lower surface of the natural flow wing independently of one another into a prescribed shape. Experimental data and theoretical analysis show that flow and pressure-loading over an upper surface of a wing tend to be conical about an apex of the wing, producing favorable and unfavorable regions of performance based on drag. The method reduces these unfavorable regions by shaping the upper surface such that the maximum thickness near a tip of the natural flow wing moves aft, thereby, contouring the wing to coincide more closely with the conical nature of the flow on the upper surface. Nearly constant compressive loading characterizes the flow field over a lower surface of the conventional wing. Magnitude of these compressive pressures on the lower surface depends on angle of attack and on a streamwise curvature of the lower surface of the wing and not on a cross-sectional spanwise curvature. The method, thereby, shapes the lower surface to create an area as large as possible with negative slopes. Any type of swept wing may be used to obtain the final, shaped geometry of the upper and lower surfaces of the natural flow wing.
Official Gazette of the U.S. Patent and Trademark Office

N92-28789# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction de lAerodynamique.
FEASIBILITY STUDY OF HYPERSONIC CLINOMETRIC MEASUREMENTS AT R3CH Final Summury Report [ETUDE DE FAISIBILITE DE MESURES CLINOMETRIQUES EN HYPERSONIQUE A R3CH. RAPPORT DE SYNTHESE FINAL]
M. C. MERIENNE and M. ALAPHILIPPE Jun. 1991 46 p In FRENCH
(Contract DRET-89-34-001)
(ONERA-RSF-136/1865-AY-728-A; ETN-92-91327) Avail: CASI HC A03/MF A01
The feasibility of clinometric measurements in hypersonic flow was investigated, by a miniaturized probe with five holes, in a R3Ch wind tunnel. The phases of the study were: estimation of the response time, the design, the calibration, and the measurements on a flat plate. The probe, with one end of 2 mm diameter, has a short response time and a high thermal resistance. The clinometric calibration performed under an incidence angle, between -4 and +4 degrees, shows a sensibility coefficient of the probe with a 4 maximal uncertainty, which represents a measurement error between 0.3 and 0.7 degrees. ESA

N92-28820*# State Univ. of New York, Buffalo. Dept. of Mechanical and Aerospace Engineering.
MODELING OF THE REACTANT CONVERSION RATE IN A TURBULENT SHEAR FLOW
S. H. FRANKEL, C. K. MADNIA, and P. GIVI *In its* Large Eddy Simulations (LES) and Direct Numerical Simulations (DNS) for the Computational Analyses of High Speed Reacting Flows 14 p 30 Apr. 1992 Submitted for publication
Avail: CASI HC A03/MF A02
Results are presented of direct numerical simulations (DNS) of spatially developing shear flows under the influence of infinitely fast chemical reactions of the type A + B yields Products. The simulation results are used to construct the compositional structure of the scalar field in a statistical manner. The results of this statistical analysis indicate that the use of a Beta density for the probability density function (PDF) of an appropriate Shvab-Zeldovich mixture fraction provides a very good estimate of the limiting bounds of the reactant conversion rate within the shear layer. This provides a strong justification for the implementation of this density in practical modeling of non-homogeneous turbulent reacting flows. However, the validity of the model cannot be generalized for predictions of higher order statistical quantities. A closed form analytical expression is presented for predicting the maximum rate of reactant conversion in non-homogeneous reacting turbulence. Author

N92-28865# Washington State Univ., Pullman.
STUDY OF THE LEADING-EDGE VORTEX DYNAMICS IN THE UNSTEADY FLOW OVER AN AIRFOIL Final Report, 1 Jan. 1990 - 31 Dec. 1991
B. R. RAMAPRAIN 27 Feb. 1992 54 p
(Contract AF-AFOSR-0131-90)
(AD-A247532; AFOSR-92-0222TR) Avail: CASI HC A04/MF A01
The two-year project to study the dynamics of the leading-edge vortex (LEV) over a pitching airfoil under conditions of dynamic stall, was started in January 1990. Several accomplishments have been made during these two years. The most significant of these are: (1) the construction of a special water channel suitable for the study of dynamic stall over a pitching airfoil; (2) the measurement of surface pressure distributions over the airfoil under several key operating conditions; and (3) development of the techniques of Particle Image Velocimetry (PIV) and its use in the measurement of instantaneous velocity and vorticity field in the two-dimensional flow around the airfoil. Some of these data which are the first of their kind have been used to understand the physics of unsteady vorticity dynamics over a pitching airfoil. These data are being made available to other investigators for use as database in validating their numerical models. GRA

N92-28883# Naval Postgraduate School, Monterey, CA.
FLOW VISUALIZATION STUDIES OF A SIDESLIPPING, CANARD-CONFIGURED X-31A-LIKE FIGHTER AIRCRAFT MODEL M.S. Thesis
CHANG H. KIM Dec. 1991 125 p
(AD-A245940) Avail: CASI HC A06/MF A02
A water tunnel flow visualization investigation was performed to study the vortex development and bursting phenomena on a 2.3 percent scale model of a X-31A-Like fighter aircraft. The main focus of this study was two-fold: first, to study the effects of angle of attack and static sideslip on the model vortical flow field; and secondly, to study the effects of dynamic sideslip motion at two reduced yaw rates. Results indicate that the wing root vortex bursting locations move upstream as the AOA increases; and at constant angle of attack (AOA less than 30 degrees) the leeward side vortex bursting location moves backward and outboard with sideslip inputs while the windward side vortex bursting location moves forward and inboard. The vortex asymmetry switches sides

at higher angle of attack (AOA greater than 30 degrees). The dynamic lag effects, which cause the leeward side vortex to burst earlier than in the static case during the positive sideslipping motion and later than in the static case during the negative sideslipping motion, increase with the magnitude of the sideslipping motion.
GRA

N92-28888# Ohio Univ., Athens. Dept. of Mechanical Engineering.
NONLINEAR NORMAL AND AXIAL FORCE INDICIAL RESPONSES FOR A TWO DIMENSIONAL AIRFOIL Final Report
G. M. GRAHAM, M. ISLAM, and K. C. FANG 15 Nov. 1991 79 p
(Contract AF-AFOSR-0502-89)
(AD-A247196; AFOSR-92-0077TR) Avail: CASI HC A05/MF A01
Normal and axial force indicial responses for a 2-D NACA 0015 airfoil undergoing small step changes in angle of attack have been measured in a tow tank. The airfoil was pitched about the quarter chord and the Reynolds number was 95,000. First order and second order tests were conducted. In the first order tests, the angle of attack prior to the step onset was held constant. In the second order study, the airfoil was ramped up at constant rate to the onset angle. Step onset angles in the range 0 less than alpha less than 60 deg were considered. The step responses have been integrated numerically to compute the loading during a ramp-up motion. The integrated results are compared with baseline load data taken with the same airfoil. GRA

N92-28980*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
LASER ANEMOMETER MEASUREMENTS AND COMPUTATIONS IN AN ANNULAR CASCADE OF HIGH TURNING CORE TURBINE VANES
LOUIS J. GOLDMAN and RICHARD G. SEASHOLTZ Jul. 1992 38 p
(Contract RTOP 505-62-52)
(NASA-TP-3252; E-6354; NAS 1.60:3252) Avail: CASI HC A03/MF A01
An advanced laser anemometer (LA) was used to measure the axial and tangential velocity components in an annular cascade of turbine stator vanes designed for a high bypass ratio engine. These vanes were based on a redesign of the first-stage stator, of a two-stage turbine, that produced 75 degrees of flow turning. Tests were conducted on a 0.771 scale model of the engine size stator. The advanced LA fringe system was designed to employ thinner than usual laser beams resulting in a 50-micron-diameter probe volume. Window correction optics were used to ensure that the laser beams did not uncross in passing through the curved optical access port. Experimental LA measurements of velocity and turbulence were obtained both upstream, within, and downstream of the stator vane row at the design exit critical velocity ratio of 0.896 at the hub. Static pressures were also measured on the vane surface. The measurements are compared, where possible with calculations from a 3-D inviscid flow analysis. The data are presented in both graphic and tabulated form so that they may be readily used to compare against other turbomachinery computations. Author

N92-29159# European Space Agency, Paris (France).
CALCULATION OF SUPPORT INTERFERENCES ON THE AERODYNAMIC COEFFICIENTS FOR A WIND TUNNEL CALIBRATION MODEL [BERECHNUNG DER SUPPORT-INTERFERENZEN FUER DIE AERODYNAMISCHEN BEIWERTE EINES WINDKANAL-EICHMODELLS]
DIETER STEINBACH (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen, Germany, F.R.) Feb. 1992 78 p Transl. into ENGLISH of German document (Goettingen, Fed. Republic of Germany, DLR), May 1990 p 1-63 Original language document was announced as N91-15998
(ISSN 0171-1342)
(ESA-TT-1247; DLR-FB-90-26; ETN-92-91207) Avail: CASI HC A05/MF A01; Original German Version available from DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, Cologne, Fed. Republic of Germany, 23 DM
Model support interferences are calculated in the form of corrections to the aerodynamic coefficients for a calibration model to be tested in a subsonic cryogenic wind tunnel. Two different model support systems are investigated: a horizontal sting (rear sting) and a vertical sting (ventral sting). The results of earlier experiments using these configurations already exist and the corrections obtained in the present work are therefore applied to these measurements for verification. In addition, the effect of the sting on the static longitudinal stability of the model is investigated in more detail. A three dimensional panel method is used for the calculations. This permits the simultaneous calculation of thickness and lift effects when several bodies of almost any given shape are present in the flow. The aerodynamic coefficients are obtained by numerical integration of the surface pressure distribution on the model. ESA

N92-29206# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction de l'Aerodynamique.
DEVELOPMENT OF AN UNSTEADY THREE-DIMENSIONAL VISCOUS-INVISCID INTERACTION NUMERICAL METHOD FOR THE CALCULATION OF AIRFOILS VIBRATION Final Summary Report [DEVELOPPEMENT D'UNE METHODE NUMERIQUE D'INTERACTION VISQUEUX-NON VISQUEUX TRIDIMENSIONNELLE INSTATIONNAIRE POUR LE CALCUL DU TREMBLEMENT DES VOILURES. RAPPORT DE SYNTHESE FINALE]
P. GIRODROUX-LAVIGNE and J. C. LEBALLEUR Sep. 1991 44 p In FRENCH
(Contract STPA-85-95-009)
(ONERA-RSF-7/3617-AY-022A; ETN-92-91325) Avail: CASI HC A03/MF A01
A study to predict the transonic vibration occurring in airfoils of a carrier aircraft is presented. The study was focused on the numerical technique of an inverse three dimensional unsteady boundary layer, as well as on the semi implicit unsteady coupling algorithm. The numerical results give a first approach of the coupling methods and the calculation of three dimensional separation, and restored the topology of the friction lines. The calculations were firstly performed for a subsonic flow in the following geometry conditions: a flat plate containing a wall hole with a very high three dimensionality. A separation through a transonic right wing type NACA0012 was predicted. ESA

N92-29329*# Brown Univ., Providence, RI. Div. of Engineering.
PARAMETER IDENTIFICATION FOR NONLINEAR AERODYNAMIC SYSTEMS Semiannual Progress Report No. 5, 23 Oct. 1991 - 23 Apr. 1992
ALLAN E. PEARSON 7 May 1992 34 p
(Contract NAG1-1065)
(NASA-CR-190264; NAS 1.26:190264) Avail: CASI HC A03/MF A01
Continuing work on frequency analysis for transfer function identification is discussed. A new study was initiated into a 'weighted' least squares algorithm within the context of the Fourier modulating function approach. The first phase of applying these techniques to the F-18 flight data is nearing completion, and these results are summarized. Author

N92-29361*# Tennessee Univ., Tullahoma. Space Inst.
DEVELOPMENT OF A MULTIGRID TRANSONIC POTENTIAL FLOW CODE FOR CASCADES Final Technical Report
JOHN STEINHOFF 29 Jun. 1992 26 p
(Contract NAG3-398)
(NASA-CR-190480; NAS 1.26:190480) Avail: CASI HC A03/MF A01
Finite-volume methods for discretizing transonic potential flow equations have proven to be very flexible and accurate for both two and three dimensional problems. Since they only use local properties of the mapping, they allow decoupling of the grid generation from the rest of the problem. A very effective method

for solving the discretized equations and converging to a solution is the multigrid-ADI technique. It has been successfully applied to airfoil problems where O type, C type and slit mappings have been used. Convergence rates for these cases are more than an order of magnitude faster than with relaxation techniques. In this report, we describe a method to extend the above methods, with the C type mappings, to airfoil cascade problems. Author

N92-29402*# Sverdrup Technology, Inc., Brook Park, OH.
A COMPARISON OF THE CALCULATED AND EXPERIMENTAL OFF-DESIGN PERFORMANCE OF A RADIAL FLOW TURBINE Final Report
LIZET TIRRES Jul. 1991 16 p Presented at the 28th Joint Propulsion Conference and Exhibit, Nashville, TN, 6-8 Jul. 1992; sponsored in part by AIAA, SAE, ASME, and ASEE
(Contract NAS3-25266; RTOP 535-05-10)
(NASA-CR-189207; E-7175; NAS 1.26:189207; AIAA PAPER 92-3069) Avail: CASI HC A03/MF A01

Off design aerodynamic performance of the solid version of a cooled radial inflow turbine is analyzed. Rotor surface static pressure data and other performance parameters were obtained experimentally. Overall stage performance and turbine blade surface static to inlet total pressure ratios were calculated by using a quasi-three dimensional inviscid code. The off design prediction capability of this code for radial inflow turbines shows accurate static pressure prediction. Solutions show a difference of 3 to 5 points between the experimentally obtained efficiencies and the calculated values. Author

N92-29445*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SPATIAL AND TEMPORAL ADAPTIVE PROCEDURES FOR THE UNSTEADY AERODYNAMIC ANALYSIS OF AIRFOILS USING UNSTRUCTURED MESHES M.S. Thesis
JOHN R. HOOKER (Purdue Univ., West Lafayette, IN.), JOHN T. BATINA, and MARC H. WILLIAMS (Purdue Univ., West Lafayette, IN.) Jul. 1992 16 p Presented at the AIAA 10th Applied Aerodynamics Conference, Palo Alto, CA, 22-24 Jun. 1992
(Contract NAG1-372; RTOP 505-63-50-12)
(NASA-TM-107635; NAS 1.15:107635) Avail: CASI HC A03/MF A01

An algorithm which combines spatial and temporal adaption for the time integration of the two dimensional Euler equations on unstructured meshes of triangles is presented. Spatial adaption involves mesh enrichment to add elements in high gradient regions of the flow and mesh coarsening to remove elements where they are no longer needed. Temporal adaption is a time accurate, local time stepping procedure which integrates the flow equations in each cell according to the local numerical stability constraint. The flow solver utilizes a four stage Runge-Kutta time integration scheme with an upwind flux-split spatial discretization. Results obtained using spatial and temporal adaption indicate that highly accurate solutions can be obtained with a significant savings of computing time over global time stepping. Author

N92-29539# Naval Surface Warfare Center, Dahlgren, VA.
SECOND-ORDER SHOCK-EXPANSION THEORY EXTENDED TO INCLUDE REAL GAS EFFECTS Final Report
FRANK G. MOORE, MICHAEL A. ARMISTEAD, STEVE H. ROWLES, and FRED R. DEJARNETTE Feb. 1992 177 p
(AD-A247191; NAVSWC-TR-90-683) Avail: CASI HC A09/MF A02

New methods have been developed to compute inviscid surface pressures and temperatures for both perfect and equilibrium chemically reacting flows on both pointed and blunt bodies of revolution. These new methods include an improved Shock-expansion Theory, an improved Modified Newtonian Theory (MNT), and an improved method for angle-of-attack effects. Comparison of these approximate engineering techniques to exact inviscid computations using a full Euler code showed that these new methods gave very good agreement of surface temperature and pressures as well as forces and moments. Incorporation of this new technology into the NAVSWC aeroprediction code will allow the code to be used for engineering estimates of inviscid surface temperature at high Mach numbers. These approximate temperatures can then be used as inputs to perform heat transfer analysis. GRA

N92-29625*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NASA WORKSHOP ON FUTURE DIRECTIONS IN SURFACE MODELING AND GRID GENERATION
W. R. VANDALSEM (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.), R. E. SMITH (National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.), Y. K. CHOO (National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.), L. D. BIRCKELBAW, and A. A. VOGEL Mar. 1992 24 p Workshop held at Moffett Field, CA, 5-7 Dec. 1989
(Contract RTOP 505-59-00)
(NASA-CP-10092; A-92072; NAS 1.55:10092) Avail: CASI HC A03/MF A01

Given here is a summary of the paper sessions and panel discussions of the NASA Workshop on Future Directions in Surface Modeling and Grid Generation held a NASA Ames Research Center, Moffett Field, California, December 5-7, 1989. The purpose was to assess U.S. capabilities in surface modeling and grid generation and take steps to improve the focus and pace of these disciplines within NASA. The organization of the workshop centered around overviews from NASA centers and expert presentations from U.S. corporations and universities. Small discussion groups were held and summarized by group leaders. Brief overviews and a panel discussion by representatives from the DoD were held, and a NASA-only session concluded the meeting. In the NASA Program Planning Session summary there are five recommended steps for NASA to take to improve the development and application of surface modeling and grid generation. Author

N92-29648# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Hubschrauber und Flugzeuge.
TECHNOLOGY PROGRAMME: AEROTHERMODYNAMICS AND PROPULSION INTEGRATION. NUMERICAL AND EXPERIMENTAL AEROTHERMODYNAMICS
E. H. HIRSCHEL 26 Aug. 1991 13 p Presented at the Review of the German Hypersonic Research and Technology Programme, Bonn, Fed. Republic of Germany, 16-17 Apr. 1991
(MBB-FE-202-S-PUB-0464-A; ETN-92-91497) Copyright Avail: CASI HC A03/MF A01

Work performed in the fields of 'aerothermodynamic predesign methods (approximate methods)', 'numerical methods of aerothermodynamics' and 'experimental methods of aerothermodynamics' is reviewed. The objective of the work is sketched, major results are listed, examples are given and future efforts are outlined. The examples include applications of predesign methods and numerical methods for the determination of global forces and moments, aerodynamic loads and heat loads (for the latter also a study of the influence of different flow physical model assumptions). From the field of experimental aerothermodynamics, an application of a fluorescence method is given, and the picture of a wind tunnel model is shown in order to demonstrate the complexity of such test articles. At the middle of phase 1 of the technology program, basic aerothermodynamic design tools and methods are available, which will reach the first validation level at the end of phase 1. Large deficiencies in flow physical models (transition laminar-turbulent, turbulence, etc.) were identified and basics oriented and applications oriented work was initiated at universities and research establishments. Thus, work will help the second validation level, which is needed when the development of the Saenger space transportation systems begins. ESA

N92-29649# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Unternehmensbereich Flugzeuge.
AEROTHERMODYNAMICS AND PROPULSION INTEGRATION IN THE SAENGER TECHNOLOGY PROGRAMME
E. H. HIRSCHEL 16 Sep. 1991 12 p Previously announced

in IAA as A92-17829
(MBB-FE-202-S-PUB-0469-A; AIAA PAPER 91-5041; ETN-92-91499) Copyright Avail: CASI HC A03/MF A01

The objectives of the technology program 'aerothermodynamics and propulsion integration' are defined. An overview of the special aerothermodynamic phenomena which must be regarded in the design of the Saenger lower stage, which presently stands in the center of the technology program, is given. The design tools, which must be provided, the components like the inlet, and the afterbody, which must be designed and tested, and the special problems like forebody optimization, heat load determination, and upper stage separation, which must be treated, are discussed. The general work plan, with the major activities up to the start of the development of the Saenger space transport system is presented, including the development and manufacturing of an experimental vehicle (HYTEX) as a means for the validation of the design tools and methods which are achieved in the technology program, and for the creation of a free flight data base. Examples given include applications of predesign methods and numerical methods for the determination of global forces and moments, aerodynamic loads and heat loads, for the latter also a study of the influence of different flow physical model assumptions. Results from the inlet study, the stage separation study, etc., show the advancement in these areas. ESA

N92-29657*# Texas A&M Univ., College Station. Dept. of Aerospace Engineering.
DETERMINATION OF AERODYNAMIC SENSITIVITY COEFFICIENTS FOR WINGS IN TRANSONIC FLOW
LELAND A. CARLSON and HESHAM M. EL-BANNA May 1992 6 p
(Contract NAG1-793)
(NASA-CR-190570; NAS 1.26:190570; TAMRF-5802-92-02) Avail: CASI HC A02/MF A01

The quasianalytical approach is applied to the 3-D full potential equation to compute wing aerodynamic sensitivity coefficients in the transonic regime. Symbolic manipulation is used to reduce the effort associated with obtaining the sensitivity equations, and the large sensitivity system is solved using 'state of the art' routines. The quasianalytical approach is believed to be reasonably accurate and computationally efficient for 3-D problems. Author

N92-29691*# California Polytechnic State Univ., San Luis Obispo. Dept. of Aeronautical Engineering.
COMPUTATION OF THREE-DIMENSIONAL EFFECTS ON TWO DIMENSIONAL WINGS Final Technical Report
RUSSELL M. CUMMINGS Jul. 1992 11 p
(Contract NCC2-536)
(NASA-CR-190576; NAS 1.26:190576) Copyright Avail: CASI HC A03/MF A01

A 2-D numerical investigation was performed to determine the effect of a Gurney flap on a NACA 4412 airfoil. A Gurney flap is a flat plate on the order of 1 to 3 percent of the airfoil chord length, oriented perpendicular to the airfoil chord line and located at the trailing edge of the airfoil. An incompressible Navier Stokes code, INS2D, was used to calculate the flow field about the airfoil. The fully turbulent results were obtained using the Baldwin-Barth one-equation turbulence model. Gurney flap sizes of 0.5, 1, 1.25, 1.5, 2, and 3 percent of the airfoil chord were studied. Computational results were compared with experimental results where possible. The numerical solutions show that the Gurney flap increases airfoil lift coefficient with only a slight increase in drag coefficient. Use of a 1.5 percent chord Gurney flap increases the maximum lift coefficient by approximately 0.3 and decreases the angle of attack for a given lift coefficient by more than 3 degrees. The numerical solutions exhibit detailed flow structures at the trailing edge and provide a possible explanation for the increased aerodynamic performance. Author

N92-29713# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Unternehmensbereich Flugzeuge.
HYPERSONIC FLOW PAST RADIATION-COOLED SURFACES
E. H. HIRSCHEL, A. KOC, and S. RIEDELBAUCH (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen, Germany, F.R.) 16 Sep. 1991 10 p Previously announced in IAA as A92-17821
(MBB-FE-202-S-PUB-0468-A; AIAA PAPER 91-5031; ETN-92-91498) Copyright Avail: CASI HC A02/MF A01

Hypersonic vehicles employ surface radiation cooling in order to reduce heat loads. The radiation adiabatic surface temperature is the result of the balance of the heat conduction towards the surface and the heat radiated away from the surface, if no heat transport into the surface occurs. It is shown by means of a local analysis that the radiation adiabatic temperature depends, other than the recovery temperature, on a characteristic boundary layer thickness. The state of the boundary layer (laminar or turbulent) has a much larger influence on the radiation adiabatic temperature than on the recovery temperature. The local analysis explains, for example, why hot spots appear along attachment lines. With the classical wind tunnel simulation techniques the radiation adiabatic temperature cannot be determined. A 'hot experimental technique' is needed if an accurate determination of heatloads in the presence of radiation cooling is desired. It involves a duplication or near duplication of Mach and Reynolds number, total temperature, and a model surface in radiation adiabatic equilibrium. The length scale dependency of the radiation adiabatic temperature then makes a scaling to full size necessary. This is shown to be possible for laminar flow, but not yet for turbulent flow. ESA

N92-29741# Universitaet der Bundeswehr Muenchen, Neubiberg (Germany, F.R.). Fakultaet fuer Luft- und Raumfahrttechnik.
A SEMI EMPIRICAL METHOD FOR THE ANALYTICAL REPRESENTATION OF STATIONARY MEASURED PROFILE COEFFICIENTS FOR APPLICATIONS OF ROTARY WING AERODYNAMICS Ph.D. Thesis [EINE HALBEMPIRISCHE METHODE ZUR ANALYTISCHEN DARSTELLUNG STATIONAAR GEMESSENER PROFILBEIWERTE FUER ANWENDUNGEN DER DREHFLUEGLERAERODYNAMIK]
MANFRED LERCH 1990 190 p In GERMAN
(ETN-92-91491) Avail: CASI HC A09/MF A02

The semi empirical process presented is used for the closed representation of aerodynamic coefficients, from the point of view of flow conditions occurring in rotor blades. The aerodynamic coefficients are formulated analytically in the model as a function of the inflow components. Analytical functions are presented on the basis of the superposition principle. They reproduce the various flow conditions by simple theoretical and empirical formulations. The superposition of these functions leads to a qualitatively accurate representation of the aerodynamic coefficients. On the basis of the quaternions transformation, a mechanical auxiliary model was developed for the computation of the motion behavior of helicopter rotors. ESA

N92-29884# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
EVALUATION OF MEASURED-BOUNDARY-CONDITION METHODS FOR 3D SUBSONIC WALL INTERFERENCE
T. E. LABRUJERE, T. A. MAARSINGH, and J. SMITH 31 Mar. 1988 102 p
(NLR-TR-88072-U; ETN-92-91547) Avail: CASI HC A06/MF A02

Measurements of a simple aircraft model on both an appropriately sized and a relatively large, low/speed, solid/wall test section were used to analyze the accuracy and consistency of Measured/Boundary/Condition (MBC) methods. For completeness, the classical method of images, with two different correction procedures, was also analyzed. For the MBC methods, large reductions in the amount of in situ measured boundary data turn out to be possible, while almost retaining the accuracy obtained from abundant boundary data. In addition, high computing efficiency was achieved allowing on line wall interference assessment and correction during a wind tunnel test. The classical assessment methods turns out to be competitive with the MBC methods for the mode and test conditions considered (CL less than or equal to 2, no massive flow separation). Its applicability is limited, like any method requiring a theoretical representation of the mode flow. Some attention was paid to the definition of the reaction of the model to the wall/induced velocity field, i.e., the correction procedure. The analyses suggest that improvements and/or adaptations are desirable. ESA

N92-29889# Universitaet der Bundeswehr Muenchen, Neubiberg (Germany, F.R.). Fakultaet fuer Luft- und Raumfahrttechnik.
PRODUCTION OF PERIODICAL MACH NUMBER VARIATIONS IN HIGH SUBSONIC FLOW IN A BLOW DOWN WIND TUNNEL, AND ITS INFLUENCE ON PROFILE MEASUREMENTS Ph.D. Thesis [ERZEUGUNG PERIODISCHER MACHZAHLAENDERUNGEN IN HOHEN UNTERSCHALL IN EINEM BLOW-DOWN-WINDKANAL UND IHR EINFLUSS AUF DIE PROFILMESSUNGEN]
ROBERT SPELTEN 1990 138 p In GERMAN
(ETN-92-91492) Avail: CASI HC A07/MF A02

The properties of unsteady flow in a blow down wind tunnel are described. A follow up system allows the Mach number variations to be correlated from two channel gage lengths. It is determined that transonic profile flows display strong dynamic attenuation phenomena for the transmission of the mass flow stimulation. A process based on the measured Mach number variations was developed, according to which the representative Mach numbers can be theoretically determined for the model. The model developed is to be used for other two and three dimensional models. ESA

N92-29916# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
A METHOD FOR COMPUTING THE 3-DIMENSIONAL FLOW ABOUT WINGS WITH LEADING-EDGE VORTEX SEPARATION. PART 2: DESCRIPTION OF COMPUTER PROGRAM VORSEP
H. W. M. HOEIJMAKERS 10 Jan. 1986 282 p
(NLR-TR-86006-U; ETN-92-91546) Avail: CASI HC A13/MF A03

The VORSEP program, which computes the three dimensional flow about wings with leading edge vortex separation, is described. An introduction to the computation method is given. The input required for running the program is detailed. A technical description of VORSEP and its subroutine is given. Common blocks employed in the program are detailed and the auxiliary files used are described. A sample case of the output generated by the program is presented. ESA

N92-30182*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EXPERIMENTAL INVESTIGATION OF THE FLOWFIELD OF AN OSCILLATING AIRFOIL
J. PANDA and K. B. M. Q. ZAMAN Jun. 1992 20 p Presented at the 10th Applied Aerodynamics Conference, Palo Alto, CA, 22-24 Jun. 1992; sponsored by AIAA
(Contract RTOP 505-62-52)
(NASA-TM-105675; E-7046; NAS 1.15:105675; AIAA PAPER 92-2622-CP) Avail: CASI HC A03/MF A01

The flowfield of an airfoil oscillated periodically over a wide range of reduced frequencies, 0 less than or = k less than or = 1.6 is studied experimentally at chord Reynolds numbers of R sub c = 22,000 and 44,000. The NACA0012 airfoil is pitched sinusoidally about one quarter chord between angles of attack (alpha) of 5 and 25 degrees. Detailed flow visualization and phase averaged vorticity measurements are carried out for k = 0.2 to document the evolution and the shedding of the dynamic stall vortex (DSV). In addition to the DSV, an intense vortex of opposite sign originates from the trailing edge just when the DSV is shed. After being shed into the wake, the two together take the shape of a large 'mushroom' while being convected away from the airfoil. The unsteady circulation around the airfoil and, therefore, the time varying component of the lift is estimated in a novel way from the shed vorticity flux and is found to be in good agreement with the lift variation reported by others. The delay in the shedding of the DSV with increasing k, as observed by previous researchers, is documented for the full range of k. The DSV, for example, is shed nearly at the maximum alpha of 25 degrees at k = 0.2, but is shed at the minimum alpha of 5 degrees at k = 0.8. At low k, the flowfield appears quasi-steady and the bluff body shedding corresponding to the maximum alpha (25 degrees) dominates the unsteady fluctuations in the wake. Author

03

AIR TRANSPORTATION AND SAFETY

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

A92-44931 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
WHO OR WHAT SAVED THE DAY? A COMPARISON OF TRADITIONAL AND GLASS COCKPITS
ASAF DEGANI (San Jose State University Foundation; NASA, Ames Research Center, Moffett Field, CA), SHERYL L. CHAPPELL (NASA, Ames Research Center, Moffett Field, CA), and MICHAEL S. HAYES (Air Line Pilots Association, Herndon, VA) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 1. Columbus, OH, Ohio State University, 1991, p. 227-234. Research supported by NASA, Air Line Pilots Association, and Delta Air Lines, Inc. refs
(Contract NCC2-237)

This study examined incidents reported to NASAs Aviation Safety Reporting System from a different perspective: rather than focusing on the factors contributing to or causing incidents, this study concentrated on who and what (subsystems and information) enabled the recovery from an anomaly. Incident reports describing altitude deviations were classified as to cockpit type (glass or traditional), flight phase, agent restoring safety, and cockpit subsystems providing specific information that helped restore safety. The data revealed and quantified the agents, information, and factors that 'saved the day'. The flight crews used many sources of information to detect the altitude deviations: altimeter, outside scene, altitude alert, kinesthesia, attitude and communications monitoring. In the glass cockpits the crews also used the map display and autothrottles to detect deviations from assigned altitudes. There was an interaction between the person detecting the anomaly (controller/flight crew) and the type of cockpit. Glass cockpit flight crews detect proportionally more deviations than their counterparts in traditional cockpits, while controllers tend to detect more deviations involving traditional cockpits. There was no effect of cockpit position (captain/first officer). A model that details the flow of altitude information between air traffic control, flight crews, and cockpit subsystems, was developed and validated. This model identifies strengths and weaknesses in the flow of altitude information within the current ground/air system. Author

A92-44985* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A RE-ANALYSIS OF THE CAUSES OF BOEING 727 'BLACK HOLE LANDING' CRASHES
MARTIN F. J. SCHWIRZKE (San Jose State University, CA) and C. T. BENNETT (NASA, Ames Research Center, Moffett Field, CA) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 1. Columbus, OH, Ohio State University, 1991, p. 572-576. refs

A review is presented of Kraft and Elworth's (1969) investigation and analysis of night visual approaches; their data is reanalyzed, and the reliability of the visual angle hypothesis is discussed. To increase pilot awareness of the hazardous illusions inherent in black hole landings, it was suggested that pilots should monitor their altimeters more often during night approaches. It was also recommended that greater attention should be given to airport design, so that the effects of black hole conditions could be minimized. R.E.P.

A92-44993

AN AIRCRAFT LANDING ACCIDENT CAUSED BY VISUALLY INDUCED SPATIAL DISORIENTATION

WILLIAM R. ERCOLINE, LISA F. WEINSTEIN (Krug International Corp., Technology Life Sciences Div., Brooks AFB, TX), and KENT K. GILLINGHAM (USAF, Armstrong Laboratory, Brooks AFB, TX) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 619-623. refs

Contrary to popular belief, the causes of pilot spatial disorientation are not restricted to false vestibular sensations; the contributions of additional sensory effects are presently explored in view of an accident scenario involving the nighttime landing of three different large aircraft. The mishap is shown to have been precipitated by the confluence of three separate sensory illusions: a narrow runway whose lights implied greater-than actual altitude, the absence of green threshold lights, and the visual degradation effects of shallow fog over the runway. O.C.

A92-44995

SCENARIO ANALYSIS OF THIGH GAP RELATED EJECTION INJURIES

JOHN SCHMIDT, GARY WHITMAN, DAVE ROSE, and LISA STEVENS (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 630-635. refs

Ejection injuries were examined to determine the impact of thigh gap. Tower test films, seat velocity analyses, cockpit fit checks, modeled cockpit comparisons, and combined expert opinions indicate it primarily puts specific body parts at risk during ejection. Statically, hip rotation causes poor back and neck positioning. Dynamically, the seat impacts the upper leg and drives down the lower portion, stressing both the thigh and knee. Scenario analysis of an ejection mishap experience data base, focusing on these sequences, revealed that only 122 (6.2 percent) of the total 1,966 cases considered were potentially related to thigh gap. Further, only ten cases temporarily disqualified aircrew from flight and none permanently did so, indicating thigh gap is not a major hazard. Author

A92-44996

STOP, LOOK AND LEARN FROM ACCIDENT INVESTIGATION

HENRY L. COOK (Jungle Aviation and Radio Service, Waxhaw, NC) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 636-639.

An account is given to a method for helping pilots and aircraft mechanics learn from the mistakes of others through role-playing. In this training process, the reading of an accident report is followed by the participants' efforts to recreate the sequence of events which led to the mishap. The illustrative case from which lessons concerning the power of imaginative recreations of an accident scenario are drawn involved a helicopter landing. O.C.

A92-44997

THE EFFECTIVENESS OF TRAINING PROGRAMS FOR PREVENTING AIRCREW 'ERROR'

ALAN DIEHL (USAF, Inspection and Safety Center, Norton AFB, CA) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 640-655. refs

This paper summarizes statistics on the prevalence of various categories of aircrew errors (procedural, perceptualmotor, and decisional) in general aviation, airline, and military operations. Decisional mistakes accounted for over one-half of such errors in all three operational environments. For that reason, the last decade has seen the growing use of cockpit resource management and judgment training programs to improve the effectiveness of individual and crew decisionmaking. These innovative programs ideally incorporate five kinds of training tools dealing with attention, crew, stress, mental attitude and risk management. The evidence suggests that such programs may reduce accident rates from 28 to 81 percent. A model is proposed to explain the feedback mechanisms involving situational awareness and the procedural, perceptualmotor, and decisional tasks along with the faculties of knowledge, motivations, and abilities. Author

A92-44998

THE EFFECT ON AIRCRAFT EVACUATIONS OF PASSENGER BEHAVIOUR AND SMOKE IN THE CABIN

HELEN MUIR and CLAIRE MARRISON (Cranfield Institute of Technology, England) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 656-661. refs

In response to a request from the UK CAA, an experimental program was conducted to characterize the effects of passenger behavior on the flow rates of emergency evacuation under conditions of vision impairment by smoke. The objective of this investigation was to ascertain the optimum width of the bulkhead prior to type I exit, as well as the seating configuration adjacent to the overwing exit. The results of a comparison of video data from competitive and noncompetitive evacuations (NCEs) indicate that NCEs effectively simulated aircraft behavior in precautionary evacuations, and in evacuations in which cabin physical conditions have not deteriorated. O.C.

A92-44999

AIRLINE DEREGULATION - IMPACT ON HUMAN FACTORS

W. H. GUNN (Kansas, University, Medical Center, Kansas City) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 662-667. refs

Advocates of airline deregulation defend the associated relaxation of government surveillance of industry economics by citing statistics which deny that air safety has been compromised. An examination is presently conducted of possible deleterious effects of deregulation on airline safety, associated with such factors as the straining of ATC by increased traffic volumes, reduced financial capacity of carriers, engineering and safety staff cutbacks, and crew fatigue due to increased pressure to meet schedule demands. Attention is given to five actual cases of deregulation-related accidents in airline operation. O.C.

A92-45000

ORGANIZATIONAL FACTORS IN HUMAN FACTORS ACCIDENT INVESTIGATION

NEIL JOHNSTON IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 668-673. refs

It is argued that many previous aircraft-accident investigations have been superficial, with inevitable consequences for the effectiveness of accident-prevention programs. Attention is drawn to the need to look beyond proximate events associated with a given accident or incident, in order to ascertain less obvious but perhaps more significant precursor events. Organizational factors are noted to be a major source of precursors that are easily overlooked, as investigators focus on the failures of individuals to the exclusion of 'systems'. O.C.

A92-45041

ELIMINATING PILOT-CAUSED ALTITUDE DEVIATIONS - A HUMAN FACTORS APPROACH

ROBERT L. SUMWALT, III (Air Line Pilots Association, Columbia, SC) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 929-934. refs

The consequences of commercial aircraft altitude deviations range from rapid maneuvers to correct the oversight to near-collision incidents and actual accidents. An account is presently given of an airline's design and implementation of an altitude-awareness program involving: (1) mandatory education, (2) alerter-setting procedures, (3) altitude callouts, and (4) several recommended techniques. In the course of 8 months after program initiation, the airline has witnessed a 60-65 percent reduction in altitude deviations with loss of flight-path separation. Additional improvements are expected due to learning-curve considerations. O.C.

A92-45044
A TRAINING PROGRAM FOR AIRLINE LINE INSTRUCTORS
ROSS TELFER (Newcastle, University, Australia) and JOHN BENT (Cathay Pacific Airways, Hong Kong) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 945-951. refs

Line-training of pilots has in the past been dominated by short-term needs and virtual crisis management. Innovative proposals for change in line-instructor preparation have nevertheless been obviated by relative success with conventional, piecemeal methods. Attention is presently given to a workshop teaching-based program for line-pilot training, which employs as its literature a 24-page course preparation booklet, a 39-page presenter's guide, and a 113-page reference manual. O.C.

A92-45048
JUDGEMENT TRAINING FOR ALASKAN PILOTS
JOHN H. DALY, III IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 970-973.

After reviewing Alaskan aviation accident records and statistics, it was realized that their information was too general and often incomplete to serve as a basis for determining the character of the content of a judgment-training program for pilots. After reviewing Arctic Training programs, it was decided that these were of limited value in determining the Alaska Transition Pilots course requirements, due to their heavy reliance on 'on-the-job' flight training. Attention is given to a methodology which combines the Flanagan (1954) 'critical accident technique' with the Instructional Systems Development job-analysis process. O.C.

A92-45052
REJECTED TAKEOFFS - CAUSES, PROBLEMS, AND CONSEQUENCES
ROY W. CHAMBERLIN (Battelle, Aviation Safety Reporting System Program Office, Mountain View, CA) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 993-998.

Rejected takeoffs (RTOs), which introduce risks associated not only with the takeoff-abort process itself but with numerous consequent events, are indicative of a general breakdown in human performance. Successfully managed RTOs involve an adroit combination of pilot perception and suitable action in order to avoid hazardous consequent events. An account is presently given of RTO-factors studies being conducted within the framework of NASA's Aviation Safety Reporting System. The most significant causes of crew-induced RTOs are improper communications procedures influenced by such external conditions as approach-frequency congestion and general schedule pressures. O.C.

A92-45054* National Aeronautics and Space Administration, Washington, DC.
EMPIRICAL FOUNDATIONS AND SENSITIVITY TESTING - IS IT ENOUGH FOR THE 90'S?
JAMES P. JENKINS (NASA, Washington, DC) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 1008-1013. refs

The FAA, in conjunction with the DOD, NASA, and the UK's Civil Aviation Administration, has devised a National Plan for Aviation Human Factors (NPAHF). Attention is presently given to the scope of research methods that are most useful for implementing NPAHF. Program managers in industry, government, and academia should identify tradeoffs intrinsic to the assembly of such methods, and justify the rationale for their choices in their research proposals. O.C.

A92-45055
ICAO FLIGHT SAFETY AND HUMAN FACTORS PROGRAMME
DANIEL E. MAURINO (International Civil Aviation Organization, Montreal, Canada) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 1014-1019. refs

The ICAO established its Flight Safety and Human Factors Program and Study Group. The first step toward achieving the Program's educational objectives is the organization of regional five-day seminars; two of these will be conducted each year in three-year cycles. At the end of each such cycle, a world-wide symposium will be held so that recent progress in human factors can be examined by leading authorities of the aviation community; the plan of investigative efforts for the following three-year period can then be reformulated in light of these discussions. The first of these symposia was held in Leningrad (now St. Petersburg) in April, 1990. O.C.

A92-45080
GETTING TEST ITEMS TO MEASURE KNOWLEDGE AT THE LEVEL OF COMPLEXITY WHICH LICENSING AUTHORITIES DESIRE - ANOTHER DIMENSION TO TEST VALIDITY
GRAHAM J. F. HUNT (Massey University, Palmerston North, New Zealand) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 1169-1177. refs

Initial findings are presented from a study that may be fundamentally relevant to training/licensing examinations; a very significant mismatch is noted between the intent of competency specifications and their reality. A methodology is presented for the reduction of this discrepancy through explication of desirable attributes for each content- and process-level intercept. It is recommended that more emphasis be placed on the development of test construction technologies which facilitate a 'content-process construct' of validity, which may be as important to overall test validity as the conventional 'criterion-referenced' validity. O.C.

A92-45081
MANDATORY PSYCHOLOGICAL TESTING OF PILOTS AS A REQUIREMENT FOR LICENSING IN NORWAY?
GRETE MYHRE (Royal Norwegian Air Force, Institute of Aviation Medicine, Blindern, Norway) and BJARNE HATTESTAD (SAS Norway, Oslo) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 1178-1183.

A test battery has been devised for evaluating pilot-training candidates which proceeds entirely on the basis of pencil and paper. The battery encompasses a short version of the Raven progressive matrices test for general mental abilities, the Gottshaldt embedded figure test for visual ability, a mechanical comprehension test, a spatial relations test, an instrument-dial interpretation test, a long-term memory test, a mathematical comprehension test, an English-comprehension test, and the Plutchick Life Style Index of Defensive Strategies test for identification of the mentally disturbed. O.C.

A92-45424
AIRCRAFT COMMAND IN EMERGENCY SITUATIONS (ACES)
THOMAS L. REYNOLDS (FAA, Washington, DC) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 545-561.
(SAE PAPER 912039) Copyright

This paper describes a multiphase technical study that has defined two advanced inflight smoke/fire detection system approaches for commercial jet aircraft. Four specific areas are studied: sensing, alerting, crew response, and crew decision making. The objective of Phase I was to identify system concepts that would provide for accurate, timely, and complete guidance to the flight crew for their use in responding to inflight smoke and fire events within the pressurized fuselage. Phase II of the project, currently in work, will result in the functional test and demonstration of the prototype system concepts defined in Phase I. Author

A92-45425
SPECTROGRAM DIAGNOSIS OF AIRCRAFT DISASTERS
FRANK W. SLINGERLAND (National Research Council of Canada, Ottawa) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 563-567. Research supported by National Research Council of Canada. refs
(SAE PAPER 912041) Copyright

Impulsive forces applied to an aircraft fuselage generate radial vibration waves in the structure analogous to those in a classical thin shell. It has been found that these waves are detected by the cockpit area microphone, and that spectrogram analysis of the microphone recording can provide information on the nature, origin and strength of the source, whether an explosion or a sudden decompression. Author

A92-45426
ON THE POSSIBILITY OF FREEZING AND STICKING PHENOMENA IN A TRANSPORT DURING THE GROUND TAXIING AND TAKEOFF RUN AND ON THE PREVENTIONS OF THE HAZARD
KINGO TAKSAWA (National Aerospace Laboratory, Tokyo, Japan) and MITSUO SAKA (Japan Air System, Tokyo) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 569-580. refs
(SAE PAPER 912042) Copyright

In the present analytical study of slush-sticking and freezing phenomena associated with the tail surfaces of a commuter airliner during ground operations, a simple model decribing outflows of heat from slush to the surrounding airflow, involving both conduction and evaporation, has given attention to meteorological and operational conditions' effects on the heat-transfer rate. Also noted is the effect of the spraying of aircraft deicing fluid, as reflected by a survey of pilots' experiences. O.C.

A92-46660
OSCILLATIONS OF BALLOON-FLIGHT ALTITUDE [O KOLEBANIIAKH VYSOTY POLETA AEROSTATA]
E. L. ALEKSANDROV and Z. M. KOZLOVA IN: Atmospheric optics. Moscow, Gidrometeoizdat, 1990, p. 55-62. In Russian. refs
Copyright

The oscillating motions of a balloon situated at the equilibrium level are examined. Radar observations of balloon flight are analyzed. Altitude oscillations of balloon flight are revealed whose parameters can be described by the theory of the oscillation of an isolated gaseous volume in a stably stratified atmosphere. L.M.

A92-46779
STRUCTURAL RISK ASSESSMENT IN THE ISRAEL AIR FORCE FOR FLEET MANAGEMENT
ZOHAR YOSIBASH (Israeli Air Force, Tel Aviv, Israel) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 540-544. refs
Copyright

As operational aircraft accumulate service hours in the Israel Air Force (IAF), cracks begin to appear in structural components. IAF Logistic Center is often requested to determine whether flying can be continued without repair and the associated risk of failure. Those questions and many others cannot be addressed using only the Damage Tolerance Assessment. A computer program, 'RISK', based on statistical methods, was developed in the IAF to provide fleet managers with quantitative assessments of the risk associated with each maintenance decision. This paper presents the theoretical background, details of the computer program RISK and samples of two risk analyses performed by the IAF using it. Author

A92-46784
AIRCRAFT-TRIGGERED LIGHTNING - PROCESSES FOLLOWING STRIKE INITIATION THAT AFFECT AIRCRAFT
VLADISLAV MAZUR (NOAA, National Severe Storms Laboratory, Norman, OK) and JEAN-PATRICK MOREAU (ONERA, Chatillon, France) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 575-580. refs
(Contract DTFA03-87-A-00021)
Copyright

The analysis of airborne electromagnetic records of seven lightning strikes to the FAA CV-580 instrumented airplane during the 1987 field campaign and eleven strikes to the French C-160 airplane during the 1988 Transall campaign was aimed at revealing and interpreting processes taking place during the intracloud propagation of lightning strikes initiated on or intercepted by the airplane. It is shown that intracloud development of the strike may consist of recoil streamers, dart leader/return stroke sequences, and the secondary initiations of new discharges. These processes, with their high current-pulse amplitudes, may present greater threat to aircraft than current pulses during strike initiation. The latter are presently considered by the technical community to be the primary lightning threat to aircraft. Author

A92-47775
SAFETY IN THE SKY - DESIGNING BOMB-RESISTANT BAGGAGE CONTAINERS
STEVEN ASHLEY Mechanical Engineering (ISSN 0025-6501), vol. 114, no. 6, June 1992, p. 81-86.
Copyright

A review is presented of how experts in explosives and aircraft-survivability methods are researching ways to make commercial airliners more résistant to terrorist bombs. The immediate focus is on redesigned baggage containers that suppress shock waves and contain exploding fragments while safely bleeding off or venting high-pressure gases. Attention is given to the research and testing being conducted at the FAA Technical Center, various commercial organizations, military research bureaus, and foreign research laboratories. R.E.P.

A92-47925
AIRPORT X-RAY SCREENING TECHNOLOGY BECOMES A VIABLE EXPLOSIVES DETECTOR
FRANK G. MCGUIRE SAFE Journal, vol. 22, no. 3, May-June 1992, p. 11-16.
Copyright

The use of advanced X-ray technologies in detecting explosives at airports is shown to be practical by considering current capacities for X-ray exploitation. The development of X-ray technology is reviewed, and attention is given to the theoretical and functional aspects of modern X-ray detection. The paper emphasizes the relative merits of backscatter vs normal X-ray techniques, and the human operator is identified as the key weakness in X-ray detection effectiveness. An automatic 'explosives detection system' (EDS) is described which uses a backscatter system and artificial intelligence to replace video and human monitors. Training is shown to be a determining factor in the assessment of security risks that may be equal to the selection of suitable technology. C.C.S.

A92-48793#
COMPUTATIONAL ICING ANALYSIS FOR AIRCRAFT INLETS
E. P. SCHUSTER, M. S. FISHER, and J. M. GAMBILL (McDonnell Aircraft Co., Saint Louis, MO) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 12 p. refs
(AIAA PAPER 92-3178) Copyright

The consideration of inlet icing in the aircraft design process requires analytical processes to provide accurate and timely predictions of icing extent and rate. The objective of the effort discussed in this paper was to establish a rapid inlet icing analysis procedure, suitable for preliminary inlet design, that can provide +/- 10 percent accuracy when compared to experimental data. An icing analysis procedure, utilizing several analytical computer codes, has been developed that meets this objective. This procedure builds on current capability existing for airfoils and expands it to inlets. With this procedure, water collection efficiencies of exposed aircraft inlet surfaces are determined by computation of water droplet trajectories and impingements for given conditions of airspeed, engine airflow, atmospheric pressure and temperature, and inlet angle of attack. Author

N92-28530# Naval Air Test Center, Patuxent River, MD. Strike Aircraft Test Directorate.
USE OF HIGH-FIDELITY SIMULATION IN THE DEVELOPMENT OF AN F/A-18 ACTIVE GROUND COLLISION AVOIDANCE SYSTEM
TIMOTHY R. FITZGERALD and MICHAEL T. BRUNNER *In* AGARD, Piloted Simulation Effectiveness 13 p Feb. 1992
Copyright Avail: CASI HC A03/MF A03

An active Ground Collision Avoidance System (GCAS) was developed for the F/A-18 using the Naval Air Test Center's F/A-18 simulation. The simulation was used for the development of all three components of GCAS: (1) the algorithms used to determine the recovery initiation altitude; (2) the additional flight control laws (FCL's) necessary to perform the recovery maneuver; and (3) the visual and audio cues used to provide recovery status information to the pilot. The use of a simulation has allowed the rapid development of a viable F/A-18 GCAS that incorporates technology from the F/A-18 Integrated Fire and Flight Control (IFFC) simulation and the Advanced Fighter Technology Integration (AFTI) F-16 program. Complete system development and preliminary evaluations were performed using the simulation. This increased overall project safety while decreasing development and potential flight test costs significantly. Author

N92-28655# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
APPLICATION OF KNOWLEDGE-BASED SYSTEMS FOR DIAGNOSIS OF AIRCRAFT SYSTEMS [TOEPASSING VAN KENNISSYSTEMEN VOOR DIAGNOSE VAN VLIEGTUIGSYSTEMEN]
J. C. DONKER and M. A. PIERS 28 Apr. 1990 22 p In DUTCH Presented at the AI Applications Conference, Kerkrade, Netherlands, 10-15 Jun. 1991
(Contract NIVR-01708-N)
(NLR-TP-90192-U; ETN-92-91439) Avail: CASI HC A03/MF A01

The applicability of knowledge based systems for the monitoring and diagnosis of aircraft systems was investigated in order to provide tools with which maintenance can be performed more effectively and efficiently. A knowledge based system was designed to support ground engineers in the maintenance of the Fokker 100 air conditioning system. The evaluation shows that the system performs well if complaints are described with enough detail. The main conclusion is that design and experience knowledge needed to support the maintenance personnel can be collected and implemented in a usable system. ESA

N92-28900# Federal Aviation Administration, Atlantic City, NJ.
DROP TEST: CESSNA GOLDEN EAGLE 421B Technical Report, Feb. - Nov. 1990
ROBERT MCGUIRE, WILLIAM NISSLEY, and ANTHONY WILSON May 1992 139 p
(DOT/FAA/CT-TN91/32; AD-A252734) Avail: CASI HC A07/MF A02

The results of two airplane vertical impact tests conducted at the Federal Aviation Administration (FAA) Technical Center, Atlantic City International Airport, New Jersey are presented. These tests entailed dropping a low wing, twin engine Cessna 421B aircraft from a vertical height of 11.2 feet, resulting in an impact velocity of approximately 26.0 feet per second (ft/s). In both tests, the aircraft was configured to simulate actual in-flight conditions including seats, occupants, and fuel. The structural response of the airframe, seats, and simulated occupants (anthropomorphic dummies) were measured throughout the tests, and the results are presented. The data collected in these tests and future tests of other commuter type aircraft will provide the basis for improved seat standards for commuter airplanes. These tests describe the impact response characteristics of commuter category airplane airframes, floor structures, seats, seat attachments, and occupant restraint systems. Author

N92-29182# Federal Aviation Administration, Washington, DC. Office of Aviation Policy and Plans.
FAA AVIATION FORECASTS
Feb. 1992 280 p
(AD-A250412; FAA-APO-92-1) Avail: CASI HC A13/MF A03

This report contains forecasts of aviation activity at Federal Aviation Administration facilities. These include airports with FAA control towers, air route traffic control centers, and flight service stations. Detailed forecasts were made for the major users of the National Aviation System: air carriers, air taxi/commuters, military and general aviation. The forecasts have been prepared to meet the budget and planning needs of the constituent units of the FAA and to provide information that can be used by state and local authorities, the aviation industry, and the general public. The lethargy of the domestic and international economies over the past year have caused the aviation industry to experience its worst year ever. However, the outlook for the 12-year forecast period is for moderate economic growth, stable real fuel prices, and moderate inflation. Based on these assumptions, aviation activity by fiscal year 2003 is forecast to increase by 25.7 percent at towered airports, 28.3 percent at air route traffic control centers, and 4.8 percent in flight services performed. Hours flown by general aviation are forecast to increase 15.1 percent and domestic revenue passenger miles (RPM's) are forecast to increase 54.9 percent, with scheduled international RPM's forecast to increase by 112.8 percent and regional/commuter RPM's forecast to increase by 146.5 percent. GRA

N92-29703# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
ON THE OPTIMIZATION OF WINDSHEAR WARNING AND GUIDANCE SYSTEMS
J. L. SOESMAN 25 Jun. 1990 31 p Presented at the 17th ICAS Congress Student Session, Stockholm, Sweden, 9-14 Sep. 1990
(NLR-TP-90196-U; ETN-92-91440) Avail: CASI HC A03/MF A01

The results of a survey of several investigations into windshear detection, guidance and modeling is presented. The use of the results to improve future windshear warning and guidance systems and wind models for simulation, to obtain safer operation in windshear conditions, is shown. Some natural causes and simple models of windshear are presented and a theoretical analysis on the effect of windshear on performance and flight safety is made. Optimally guided flight trajectories through windshear that are computed in open loop form, using a point mass model, are compared with simulated closed loop suboptimal trajectories. The effect on survivability of different initial conditions and early warnings by forward looking detection systems are discussed. Experiences with an operational reactive windshear warning system aboard aircraft are reported. Natural causes of the shear, pilot's reactions and their result on the flight safety level are discussed. ESA

N92-30108*# Douglas Aircraft Co., Inc., Long Beach, CA. Airworthiness Assurance Programs.
MAINTAINING THE SAFETY OF AN AGING FLEET OF AIRCRAFT
AMOS W. HOGGARD *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 49-65 Jul. 1992
Avail: CASI HC A03/MF A04

The current status of the Douglas Aging Fleet is examined in light of increasing concern for the possibility of the onset of widespread cracking and recent industry activity to minimize the

concern. A fleet monitoring program together with an augmented maintenance program is proposed as a possible means to reduce the concern. Six candidate options for maintenance program augmentation are examined which have been shown to be effective in detection of widespread fatigue damage. A brief example of how this system might be applied to the DC-9 Fleet is presented.
Author

N92-30123*# Airbus Industrie, Blagnac (France).
AGEING AIRPLANE REPAIR ASSESSMENT PROGRAM FOR AIRBUS A300
J. M. GAILLARDON, HANS-J. SCHMIDT, and B. BRANDECKER *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 283-289 Jul. 1992
Avail: CASI HC A02/MF A04

This paper describes the current status of the repair categorization activities and includes all details about the methodologies developed for determination of the inspection program for the skin on pressurized fuselages. For inspection threshold determination two methods are defined based on fatigue life approach, a simplified and detailed method. The detailed method considers 15 different parameters to assess the influences of material, geometry, size location, aircraft usage, and workmanship on the fatigue life of the repair and the original structure. For definition of the inspection intervals a general method is developed which applies to all concerned repairs. For this the initial flaw concept is used by considering 6 parameters and the detectable flaw sizes depending on proposed nondestructive inspection methods. An alternative method is provided for small repairs allowing visual inspection with shorter intervals. Author

N92-30124*# Federal Express Corp., Memphis, TN. Aircraft Reliability Div.
COMMUNICATION: AN IMPORTANT ELEMENT OF MAINTENANCE AND REPAIR
JAMES S. TRIPP *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 291-299 Jul. 1992
Avail: CASI HC A02/MF A04

People from the airlines, the FAA, and the manufacturers have worked together in an effort to improve the Service Difficulty Reporting system. Their work to date is summarized as follows: (1) design a worldwide reporting system to provide safety alerts to aircraft operators, manufacturers, repair facilities, and regulatory authorities; (2) design a companion system to provide worldwide reliability experience; and (3) overhaul regulatory requirements to be consistent with (1) and (2) to provide information necessary and useful for public consumption. H.A.

N92-30128*# Federal Aviation Administration, Seattle, WA.
THE FAA AGING AIRPLANE PROGRAM PLAN FOR TRANSPORT AIRCRAFT
DAYTON CURTIS and JESS LEWIS (Federal Aviation Administration, Washington, DC.) *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 321-325 Jul. 1992
Avail: CASI HC A01/MF A04

The Federal Aviation Administration (FAA) Aging Airplane Program is focused on five program areas: maintenance, transport airplanes, commuter airplanes, airplane engines, and research. These programs are complementary and concurrent, and have been in effect since 1988. The programs address the aging airplane challenge through different methods, including policies, procedures, and hardware development. Each program is carefully monitored and its progress tracked to ensure that the needs of the FAA, the industry, and the flying public are being met. Author

N92-30129*# National Aerospace Lab., Emmeloord (Netherlands).
AGEING AIRCRAFT RESEARCH IN THE NETHERLANDS
J. B. DEJONGE and G. BARTELDS *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 327-335 Jul. 1992 Sponsored in part by FAA and Dept. of Civil Aviation
Avail: CASI HC A02/MF A04

The problems of aging aircraft are worldwide. Hence, international cooperative actions to overcome or prevent problems should be taken. The Federal Aviation Administration (FAA) and the Netherlands Civil Aviation Department (RLD) signed a Memorandum of Cooperation in the area of structural integrity, with specific reference to research on problems in the area of aging aircraft. Here, an overview is given of aging research that is going on in the Netherlands. The work described is done largely at the National Aerospace Laboratory; much of the research is part of the forementioned cooperative agreement. Author

N92-30130*# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
SURVEY OF FRENCH ACTIVITIES CONCERNING STRUCTURAL AIRWORTHINESS AND AGING AIRCRAFT
ROGER LABOURDETTE *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 337-360 Jul. 1992
Avail: CASI HC A03/MF A04

French activities concerning structural airworthiness and aging aircraft are presented. Basic applied research, full-scale testing, teardown inspections, crack initiation, fatigue crack growth, fretting fatigue, non-destructive inspection, and damage tolerance are among the topics covered. Author

N92-30131*# Department of Transport, Ottawa (Ontario). Airworthiness Branch.
TRANSPORT CANADA AGING AIRCRAFT ACTIVITIES
S. R. DIDRIKSON *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 361-365 Jul. 1992
Avail: CASI HC A01/MF A04

A description is given of recent initiatives undertaken in Canada to address the problems of aging passenger airplanes. In addition to participation in and support of U.S. aging aircraft programs, independent activities were undertaken in such areas as regulatory control of nondestructive testing, aging fleet evaluations, and measures to address the airworthiness of aging Canadian-manufactured airplanes. Author

N92-30133*# Saab-Scania, Linkoping (Sweden). Aircraft Div.
A MANUFACTURER'S APPROACH TO ENSURE LONG TERM STRUCTURAL INTEGRITY
HANS ANSELL, BILLY FREDRIKSSON, and INGVAR HOLM *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 379-405 Jul. 1992
Avail: CASI HC A03/MF A04

The main features of the design concepts for the Saab 340 and Saab 2000 aircraft are described with respect to structural integrity and high reliability. Also described is the approach taken at Saab Aircraft to ensure structural integrity and high reliability. The concepts of global and local loads and sequences, and the fatigue and damage tolerance sizing and their verification are discussed. Also described is quality assurance in the production and structural maintenance program. Structural repair and feedback from operators are also covered. Author

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

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

A92-44919
DATA LINK INTEGRATION IN COMMERCIAL TRANSPORT OPERATIONS
WILLIAM H. CORWIN (Honeywell Systems and Research Center, Minneapolis, MN) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 1. Columbus, OH, Ohio State University, 1991, p. 145-153. refs

This paper addresses the issues associated with the interface of the flight crew with Data Link, and the integration of operational functions in commercial transport aircraft. Data Link is used to refer to a variety of air-to-ground communication links in commercial aviation. Within the next few years airlines may be conducting both company business (ACARS and AVPAC) as well as complying with federally regulated air-traffic control (Mode S) using avionic boxes all collectively referred to as Data Links. Operational sequence diagrams will be used to illustrate the effects of different candidate systems, with varying levels of integration, on operator workload. Author

A92-44920
MODE S DATA LINK PILOT-SYSTEM INTERFACE - A BLESSING IN DE SKIES OR A BEAST OF BURDEN?
MICHAEL C. REYNOLDS and MARK E. NEUMEIER (Midwest Systems Research, Inc., Dayton, OH) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 1. Columbus, OH, Ohio State University, 1991, p. 154-159. refs

Mode S data link is being proposed by the FAA in response to increases in air traffic communications. This paper focuses on the flight deck pilot-interface portion of the system and issues that are included in a datalink human factors research plan currently under development are presented. The research tools that will be utilized to address the data link human factors issues are described. R.E.P.

A92-44932
THE APPROPRIATE CONCERN FOR POSSIBLE ABERRATIONS IN LANDING GUIDANCE SIGNALS
RICHARD H. MCFARLAND (Ohio University, Athens) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 1. Columbus, OH, Ohio State University, 1991, p. 235-240. refs

The question of how a pilot and his flight might be affected by aberrations and the pilot's concern as to any adverse effects (flight technical error and safety) is discussed. It is maintained that there should be minimal concern, basically no concern, for aberrations affecting the ILS landing guidance signals such that the safety of flight would be downgraded. The long history of no accidents due to out-of-tolerance ILS facilities is a prime justification for drawing this conclusion. R.E.P.

A92-44969
REAL TARGETS, UNREAL DISPLAYS - THE INADVERTENT SUPPRESSION OF CRITICAL RADAR DATA
THOMAS G. LUSCH (FAA, Oberlin, OH) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 1. Columbus, OH, Ohio State University, 1991, p. 460-465. refs

In today's Air Route Traffic Control Center (ARTCC) environment, some very important low-altitude radar data is suppressed. This radar data is not suppressed by the controllers themselves. Rather, it is a result of a compromise in the radar data processing software, and the manner in which the software is adapted by automation personnel. This suppressed radar data has led to air traffic controllers being unable to provide accurate and timely advisories about aircraft which pose a collision threat. An existing software technique to correct a portion of this problem has existed for years, but it is optional and is not adapted system-wide. There must be a concerted effort to address this inadvertent suppression of low-altitude radar data, as well as an examination into the human factors aspect of why it is allowed to continue. Author

A92-45373
SELECTED MODELS OF AIRCRAFT NAVIGATION SPACE [WYBRANE MODELE SRODOWISKA NAWIGACYJNEGO LOTU]
STEFAN BRAMSKI and JERZY GRAFFSTEIN (Instytut Lotnictwa, Warsaw, Poland) Instytut Lotnictwa, Prace (ISSN 0509-6669), no. 128, 1992, p. 16-37. In Polish. refs

A method for modeling aircraft navigation space is presented for use in a ground situated laboratory modeling aircraft flight dynamics, drive systems and aeronautical equipment. Principles of mapping the geoid, the basic pressure distribution on the ground surface, parameter changes in the function of flight altitude under various climatic conditions, as well as modeling three components of atmospheric turbulence, the distribution of ground based radio navigation means, and the visibility of orientation objects on the ground for visual navigation have been accepted as essential elements of modeling the navigation space. Author

A92-47511
AIRBORNE/SHIPBORNE PSK TELEMETRY DATA LINK
JOHN R. CARLSON (Aydin Corp., Computer and Monitor Div., Horsham, PA) and ARLEN SCHMIDT (Intera Systems, Inc., Calgary, Canada) IN: ITC/USA/'91; Proceedings of the International Telemetering Conference, Las Vegas, NV, Nov. 4-7, 1991. Research Triangle Park, NC, Instrument Society of America, 1991, p. 137-147.
Copyright

Design considerations and methodology applied to solve the practical problems involved in the creation of a high bit rate telemetry relay system are examined. The system discussed has been designed to operate as a data link for an airborne SAR imaging system used for support of navigation through ice in Canadian waters. The use of convolutional and differential encoding, scrambling, and judicious antenna choices establish a reliable data link at small grazing angles over ice at ranges well in excess of 200 nautical miles. The principal performance characteristics of the system are given. V.L.

A92-47566
GLOBAL POSITIONING SYSTEM TELECOMMAND LINK
DANIEL F. ALVES, JR. (Alpha Instrumentation and Information Management, Santa Maria, CA) IN: ITC/USA/'91; Proceedings of the International Telemetering Conference, Las Vegas, NV, Nov. 4-7, 1991. Research Triangle Park, NC, Instrument Society of America, 1991, p. 743-749.
Copyright

The Global Positioning System of satellites and pseudosatellite ground stations (GPS) is designed to provide very accurate time, space, and position information and to additionally provide a telecommand link. The existing L-band RF link is designed so that it can carry command information, when required, as well as TSPI information. Author

A92-47574
AIRBORNE DATA ACQUISITION AND RELAY SYSTEM
ALLAN NETZER (USAF, Hill AFB, UT) IN: ITC/USA/'91; Proceedings of the International Telemetering Conference, Las Vegas, NV, Nov. 4-7, 1991. Research Triangle Park, NC, Instrument Society of America, 1991, p. 809-818. refs
Copyright

The telemetry-tracking and relay capabilities of the Surrogate Carrier Launch Platform (SCLP) aircraft using the Airborne Data Acquisition and Relay System (ADARS) station are discussed. The ADARS uses a combination of tracking and omnidirectional antennas to acquire, track, record, and retransmit telemetry data. The configuration of the ADARS system and its performance are described, as are some planned improvements to the system. V.L.

A92-47630
COMPUTER-CONTROLLED NAVIGATION SYSTEM/GENERAL POSITIONING SYSTEM (CCNS/GPS) - A GUIDANCE, POSITIONING, AND MANAGEMENT SYSTEM FOR REMOTE SENSING FLIGHTS [COMPUTER-CONTROLLED NAVIGATION SYSTEM/GENERAL POSITIONING SYSTEM /CCNS/GPS/ - EIN FUEHRUNGS-, POSITIONIER- UND MANAGEMENTSYSTEM FUER FERNERKUNDUNGS-FLUEGE]
ALBRECHT GRIMM Ortung und Navigation (ISSN 0474-7550), no. 1, 1992, p. 89-99. In German. refs

The requirements for computer and GPS-controlled sensing flight are reviewed. The realization of these requirements using the system CCNS Computer-Controlled Navigation System is demonstrated with examples. C.D.

A92-47631
CONSTRUCTION OF A REAL-TIME DGPS EXPERIMENTAL SYSTEM [AUFBAU EINES ECHTZEIT-DGPS-EXPERIMENTALSYSTEMS]
T. MUELLER, M. POPPE, H. ROHLING (Braunschweig, Technische Universitaet, Federal Republic of Germany), C. MEIER, K. KLEIN (DLR, Cologne, Federal Republic of Germany), and F. HEIMBERG (Hannover, Universitaet, Hanover, Federal Republic of Germany) Ortung und Navigation (ISSN 0474-7550), no. 1, 1992, p. 101-105. In German. refs

An experimental system constructed for the purpose of studying the DGPS (Differential Global Positioning System) system behavior and for transmitting correction data in an airport environment is described. Preliminary qualitative results from applying the system are summarized. C.D.

A92-48308
TIME-TO-GO ESTIMATION FROM INFRARED IMAGES
K. C. MARKHAM (British Aerospace /Defence Systems/, Ltd., Bristol, England) IEE Proceedings, Part I: Communications, Speech and Vision (ISSN 0956-3776), vol. 139, no. 3, June 1992, p. 356-363. refs
Copyright

The problem of an aircraft flying toward a rendezvous point using passive image data to calculate the flight duration is considered. A technique is described which estimates time-to-go from a sequence of infrared images by applying a generalization of a conventional correlation process. The method relies on measurements from a multiple point correlation tracker, which is able to track a landmark or object. It is shown that a difference squared correlator is equivalent to the measurement equation of a parameter estimation scheme with tracking offsets as states. A simple relative motion model is postulated which uses magnification, rotation and translation, with the instantaneous measure of time-to-go related to the magnification scale factor. A series of experiments using simulated data is detailed and the results are discussed. In the latter stages of flight, the time-to-go estimates are shown to give acceptable results for many applications. Author

A92-48416
MOTION ERRORS IN AN AIRBORNE SYNTHETIC APERTURE RADAR SYSTEM
STEFAN BUCKREUSS (DLR, Institut fuer Hochfrequenztechnik, Oberpfaffenhofen, Federal Republic of Germany) European Transactions on Telecommunications and Related Technologies (ISSN 1120-3862), vol. 2, no. 6, Nov.-Dec. 1991, p. 655-664. refs
Copyright

An approach is demonstrated whereby the effects of motion induced phase errors on SAR image quality are determined statistically. The expected image quality can be predicted if the power spectral density (PSD) is measured with an inertial measurement unit (IMU) strapdown system. The required accuracy of an IMU for SAR motion compensation is represented by the PSD of the tolerable uncompensated motion error. The determination of the PSD and the IMU transfer function are described. V.L.

A92-48470
AUTONOMOUS LANDING - FUNCTIONAL REQUIREMENTS
KEITH FITSCHEN and ANDY ZEMBOWER (IIT Research Institute, Chicago, IL) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 374-381.
Copyright

For military aviation, an autonomous landing (AL) capability is sought to enable operations out of landing fields which are battle-damaged, or have less than adequate approach aids or lighting. The authors focus on an AL capability for future transport and special operations aircraft. Attention is given to AL requirements, the satisfaction of approach requirements, vision systems, and functional capability requirements. I.E.

A92-48480
LOCATION AND TRACKING TECHNIQUE IN A MULTISTATIC SYSTEM ESTABLISHED BY MULTIPLE BISTATIC SYSTEMS
LI X. HE and ZHONGKANG SUN (National University of Defense Technology, Changsha, People's Republic of China) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 437-441. refs
Copyright

The authors present the detailed derivation of the WMEKF (weighted modified extended Kalman filter) algorithm for a bistatic system, in which the passive observer measures the azimuth, elevation, and time difference. A unique multistatic system composed of netted-distatic systems is proposed. The processed results at each bistatic system are sent over a communication network to a central processor and processed with the WLS (weighted least sequence) algorithm. The tracking performance of the multistatic system is evaluated by means of the Monte Carlo simulation technique. I.E.

N92-28718*# Ohio Univ., Athens. Dept. of Electrical and Computer Engineering.
LORAN-C PERFORMANCE ASSURANCE ASSESSMENT PROGRAM Final Report
ROBERT W. LILLEY and N. KENT BROOKS Jun. 1992 36 p
(Contract NAG1-816)
(NASA-CR-190469; NAS 1.26:190469; OU/AEC-EER-92-2)
Avail: CASI HC A03/MF A01

The Federal Aviation Administration (FAA) has accepted the Loran-C navigation system as a supplemental navigation aid for enroute use. Extension of Loran-C utilization to instrument approaches requires establishment of a process by which the current level of performance of the system is always known by the pilot. This system 'integrity' translates into confidence that, if the system is made available to the pilot, the guidance will be correct. Early in the consideration of Loran-C for instrument approaches, the Loran-C Planning Work-Group (LPW) was formed with membership from the FAA, the US Coast Guard, various state governments, aviation users, equipment manufacturers and technical experts. The group was hosted and co-chaired by the National Association of State Aviation Officials (NASAO). This forum was ideal for identification of system integrity issues and for finding the correct process for their resolution. Additionally, the Wild Goose Association (WGA), which is the international Loran-C technical and user forum, regularly brings together members of the FAA, Coast Guard, and the scientific community. Papers and discussions from WGA meetings have been helpful. Given here is a collection of the issues in which Ohio University became involved. Issues definition and resolution are included along with the recommendations in those areas where resolution is not yet complete. Author

N92-29103*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A ROTORCRAFT FLIGHT DATABASE FOR VALIDATION OF VISION-BASED RANGING ALGORITHMS
PHILLIP N. SMITH Apr. 1992 17 p
(Contract RTOP 505-64-36)
(NASA-TM-103906; A-92021; NAS 1.15:103906) Avail: CASI HC A03/MF A01

A helicopter flight test experiment was conducted at the NASA Ames Research Center to obtain a database consisting of video imagery and accurate measurements of camera motion, camera calibration parameters, and true range information. The database was developed to allow verification of monocular passive range estimation algorithms for use in the autonomous navigation of rotorcraft during low altitude flight. The helicopter flight experiment is briefly described. Four data sets representative of the different helicopter maneuvers and the visual scenery encountered during the flight test are presented. These data sets will be made available to researchers in the computer vision community. Author

N92-29605# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
EUROPEAN STUDIES TO INVESTIGATE THE FEASIBILITY OF USING 1000 FT VERTICAL SEPARATION MINIMA ABOVE FL 290. PART 1: OVERVIEW OF ORGANISATION, TECHNIQUES EMPLOYED, AND CONCLUSIONS
J. M. TENHAVE, M. E. COX (Eurocontrol Agency, Brussels, Belgium), and D. A. FORRESTER (Meteorological Office, Bracknell, England) 18 Feb. 1991 27 p Submitted for publication
(NLR-TP-91062-U-PT-1; ETN-92-91454) Avail: CASI HC A03/MF A01

Primarily in response to airline pressures for fuel economies, International Civil Aviation Organization (ICAO) established a study program to determine the feasibility of having the Vertical Separation Minimum (VSM) used above FL 290 to 1000 ft. The first of a three part article describing a European contribution to this program is presented. The aims and organization of the experimental work are outlined, the choice of methodology available to measure height keeping errors is described, and an indication of the measurement accuracy achieved is given. Overall, the work shows that, whereas it would be feasible to introduce a 1000 ft. VSM in the North Atlantic region, other measures would be necessary before it could be used in continental airspace. Today, in certain areas, the need for a reduced VSM has become even more pressing in order to achieve the gains in airspace capacity necessary to handle rapidly growing volumes of air traffic. ESA

N92-29615# National Aerospace Lab., Amsterdam (Netherlands). Electronics Dept.
APPLICATION OF VME-TECHNOLOGY ON AN AIRBORNE DATA LINK PROCESSOR UNIT
P. J. H. M. MANDERS 6 Jun. 1988 15 p Presented at the VITA Conference on VME Bus in Research, Zurich, Switzerland, Oct. 1988
(NLR-MP-88040-U; ETN-92-91513) Avail: CASI HC A03/MF A01

The technical concept of a Data Link Processor Unit (DLPU), which is a five slot, VME based, computer system, is described. In civil aircraft the DLPU will interface a secondary surveillance radar mode select transponder with various avionics systems in order to support data link operations. A militarized 68020 processor board will be applied. The interfaces with the transponder and the avionic systems apply a 68000 microprocessor for handling the lower level protocols. Electrically the interfaces with the aircraft systems follow the ARINC specification 429. The requirements for volume, environment, performance and certification are described. The application of the VME bus technology made possible the use of standardized boards and application standardized methods for the multiprocessor communication. ESA

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A92-45304* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
JET-POWERED V/STOL AIRCRAFT - LESSONS LEARNED
SETH B. ANDERSON (NASA, Ames Research Center, Moffett Field, CA) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. II.1.1-II.1.14. refs
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Over the years a variety of jet-powered V/STOL aircraft were studied in test facilities and flight. The tests disclosed several fundamental limitations: (1) lack of design features conducive to good STOL performance, (2) inadequate performance margins and poor handling qualities, (3) performance and handling qualities degradation due to propulsion system induced flow and ground effect, and (4) inadequate integration of flight control and propulsion systems. The purpose of this paper is to review the lessons learned from tests of jet V/STOL aircraft in key technology areas including: (1) aerodynamic/performance tradeoffs, (2) unique propulsion requirements and induced flow effects, (3) handling qualities, and (4) operating procedures. The sensitivity of current ASTOVL designs to meet requirements in these critical technology area is examined. Author

A92-45305
HARRIER INTERNATIONAL PROGRAMME
H. I. PHILLIPS (McDonnell Aircraft Co., Saint Louis, MO) and M. S. SHARLAND (British Aerospace /Military Aircraft/, Ltd., Preston, England) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. II.2.1-II.2.11. refs
Copyright

The evolution of the power lift vectored thrust concept as depicted by the Harriet aircraft program is reviewed, with emphasis on the Harrier II, a second-generation vectored thrust V/STOL aircraft. The aircraft has an all-weather day/night capability and is operated in both close air support and air defense roles from ships, dispersed sites and paved and unpaved runways. The aircraft uses essentially the same Pegasus vectored thrust turbofan, albeit uprated to 21,750 lb static thrust, that powered earlier Harrier designs. Significant improvements in V/STOL performance that were made through improved aerodynamic design are addressed. Major AV-8B configuration changes are illustrated. C.A.B.

A92-45308
MILITARY UTILITY OF MEDIUM SPEED V/STOL DESIGNS
LISA COWLES (U.S. Navy, Naval Air Development Center, Warminster, PA) and MARK J. WILLIAMS (McDonnell Aircraft Co., Saint Louis, MO) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. II.6.1-II.6.19. refs
Copyright

Recent design concepts for medium-speed V/STOL aircraft are reviewed, and the unique military utility that this class of aircraft offers is discussed. Primary emphasis is placed on naval applications, and the applicability of medium-speed V/STOL aircraft in Navy, Air Force, and Marine Corps operations is addressed. In Navy service these concepts offer the prospects of allowing highly capable ASW and AEW aircraft to be deployed from a variety of non-CV platforms. In Air Force service MS/V/STOL aircraft can provide significant advance in reaction times for search and rescue missions. Larger medium-speed V/STOL aircraft combine range, speed, and payload with vertical landing capability to provide an ideal special operations aircraft. In Marine Corps Service medium-speed STOL aircraft are ideal complements to their

V/STOL fighters and helicopters as the Corps moves toward its goal of an all-V/STOL force. Potential missions range from transport to early warning/command-control-communications to observation and attack. C.A.B.

A92-45310

A USAF ASSESSMENT OF STOVL FIGHTER OPTIONS

D. L. HAMMOND, R. E. FREDETTE, G. C. TAMPLIN, and R. L. ASHBY (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. II.8.1-II.8.12.
Copyright

The paper examines the recent efforts of the USAF Wright Research and Development Center's efforts to define the key attributes of a possible STOVL fighter so that the technology base could be developed to make an operational aircraft a possibility by the year 2005. The goal was to evaluate whether STOVL, super-cruise, supermaneuverability, and low observables are compatible. It was found that the choice of the maximum allowable exhaust gas temperature in ground-effect has a pronounced effect on the ranking of the powered lift concepts. Technology programs were initiated to help solve some design-related problems such as lift engine design and advanced STOVL control concepts. C.A.B.

A92-45311

EVOLUTION OF ASTOVL AIRCRAFT DESIGN

J. T. PLATT, K. AINSCOW, and G. STOTT (British Aerospace /Military Aircraft/, Ltd., Preston, England) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. II.10.1-II.10.1.14.
Copyright

Attention is given to the evolution of an ASTOVL vehicle with Harrier-like powered lift operation which satisfies the requirement of combining the STOVL advantages into a single viable engine airframe configuration without compromising operational effectiveness. This is achieved by incorporating a novel Rolls Royce engine design which provides low specific thrust for benign operations during powered lift and high specific thrust for conventional agile supersonic flight. The configuration drivers and design compromises are identified and discussed. STOVL and CTOL aircraft configurations with and without powered-lift constraints are illustrated. C.A.B.

A92-45312

ASTOVL PROPULSION SYSTEMS CONFIGURATION AND CONCEPT CHOICE

N. A. MITCHELL (Rolls-Royce, PLC, London, England) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. II.11.1-II.11.10. Research supported by Ministry of Defence Procurement Executive. refs
Copyright

Studies conducted in the 1980s by Rolls Royce to test a wide variety of ASTOVL propulsion concepts against a number of different customer requirements including NST6464 and the operational targets of the studies carried out under the auspices of the U.S./U.K. Memorandum of Understanding are reviewed, with particular reference to those aspects which affect concept choice and the quality of the overall system. The key elements of this propulsion system are that in the STOVL regime the system is unmixed and has the characteristics of the Pegasus (i.e., cool front jets and full nozzle vectoring) but is a mixed flow afterburning turbofan in the flight regime. The critical technologies for this propulsion system are identified, and the programs required to underwrite them are outlined. The major characteristics of this propulsion system are compared with other systems, and those elements which contribute to a low-risk propulsion system are identified. C.A.B.

A92-45313* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

LARGE-SCALE WIND TUNNEL STUDIES OF A JET-ENGINED POWERED EJECTOR-LIFT STOVL AIRCRAFT

MICHAEL R. DUDLEY, BRIAN E. SMITH, VICTOR CORSIGLIA, and DALE L. ASHBY (NASA, Ames Research Center, Moffett Field, CA) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. III.1.1-III.1.10. refs
Copyright

A full-scale model of a supersonic STOVL single engine flighter aircraft employing an ejector to augment lift in hover and in low-speed flight was tested in the 40- by 80-ft and 80- by 120-ft test sections of the National Full-Scale Aerodynamics Complex located at the NASA Ames Research Center. The measured ejector augmentation ratio in hover met the design requirement of 1.6 and continued to provide the lift necessary in forward flight for good transition qualities. The up-and-away aerodynamics (ejector system stowed) were found to be conventional for this class of vehicle. The pitch control provided by the full-span blown flaps is sufficient to control the large pitching moments generated by ventral exhaust nozzle vectoring and propulsion induced aerodynamic effects such as the turning of the flow entrained into the ejectors. Author

A92-45315

CONFIGURATION EFFECTS ON THE INGESTION OF HOT GAS INTO THE ENGINE INTAKE

P. G. KNOTT (British Aerospace /Military Aircraft/, Ltd., Preston, England) and C. M. MILFORD (British Aerospace /Military Aircraft/, Ltd., Kingston-upon-Thames, England) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. III.3.1-III.3.13. refs
Copyright

The ingestion of hot engine exhaust gas into the engine air intakes of combat aircraft which use jet lift to enable the aircraft to perform V/STOL is discussed. The effect of configuration variables on hot gas ingestion (HGI), with respect to the intake air temperature rise dependence in space and time, is discussed. It is concluded that development of the Harrier family should use low-temperature fan air front jets in vertical operation in ground effect. The HGI level can then be controlled by the use of CADs and modest splay angles. Side-by-side two-poster jet lift systems are proposed. It is concluded that it is very difficult to achieve low levels of HGI with this arrangement. C.A.B.

A92-45381

THE HIGH SPEED CHALLENGE FOR ROTARY WING AIRCRAFT

EVAN A. FRADENBURGH (Sikorsky Aircraft, Stratford, CT) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 91-109. refs
(SAE PAPER 911974) Copyright

This paper reviews the problems associated with developing a vertical takeoff and landing (VTOL) aircraft that has desirable helicopter-like attributes in hover and low-speed operation but is capable of efficient high subsonic cruise speed. A number of different configurations are reviewed, and an assessment is made of the relative probabilities of future success. Factors considered to be important discriminators include speed potential, disk loading, empty weight fraction, the need for supplementary propulsion systems or convertible engines, and technical risk. The tilt-rotor configuration has considerable merit but will not achieve the highest speeds desired. It is concluded that incorporation of variable geometry, in the form of a variable diameter rotor system, has the best chance of providing the 'ideal' VTOL. The variable diameter tilt-rotor adds on the order of 100 knots to the speed potential of the tilt-rotor and provides numerous other benefits as well. For highest speeds, the variable-diameter single stowed rotor configuration has the desired combination of attributes. Author

A92-45383
HIGH SPEED VSTOL ON THE HORIZON - THE ANSWER TO CONGESTION?
WILLIAM F. CHANA (William F. Chana Associates, Inc., San Diego, CA) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 121-130. refs
(SAE PAPER 911976) Copyright

A review of design issues and factors relating to the tilt-wing and tilt-rotor aircraft is presented. Demonstrator vehicles have shown that tilt-wing and tilt-rotor aircraft can meet performance requirements. Advances in materials, propulsion, avionics and flight controls places aeronautical technology on the threshold of practical and cost effective high-speed VSTOL aircraft. R.E.P.

A92-45387
THE FATIGUE SCATTER FACTORS AND REDUCTION FACTORS IN THE DESIGN OF AIRCRAFT AND HELICOPTER'S STRUCTURAL LIVES
FU-ZE ZHANG (Beijing University of Aeronautics and Astronautics, People's Republic of China) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 173-178. refs
(SAE PAPER 911984) Copyright

It is shown that, in the design of aircraft and helicopter structural lives, the fatigue scatter factors can be classified into scatter factors for fatigue testing and those for theoretical computations. Each type of fatigue scatter factors can also be divided into scatter factors for crack-initiation lives and those for crack-growth lives. The values of different types of scatter factors and various formulas used for calculations are examined and compared. The feasibility of using a unified formula for calculating scatter factors and reduction factors is discussed. I.S.

A92-45396
AN ACROBATIC AIRSHIP 'ACROSTAT'
MASAHIKO ONDA and YASUSHI MORIKAWA (MITI, Mechanical Engineering Laboratory, Tsukuba, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 269-273.
(SAE PAPER 911994) Copyright

A novel type of airship or a powered LTA aircraft is proposed which is designed with a rather conventionally shaped hull and with conventional thrusters and is not made as a control configured vehicle nor does it utilize any sophisticated control mechanism. None of the control surfaces are installed but couples of stabilizers equipped to the aft hull, and without any active control tricks the vehicle holds its stability and realizes enhanced maneuverability performances. This newly conceived type model is named Acrostat. This airship can ascend and descend vertically and can perform somersaults, spiral flights, and rotates around its CG as the center of the movement. The paper deals with the structural design concept of the model, design data, and the attitude control principle. Author

A92-45397
DUCTED FAN VTOL FOR WORKING PLATFORM
SHOHEI NIWA and MASAYUKI SUZUKI (Nagoya University, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 275-285. refs
(Contract MOESC-62850016)
(SAE PAPER 911995) Copyright

An automatic flight control system is designed for research models of remotely piloted ducted fan VTOL. Special attention is given to the study of control problems which would arise when the VTOL is used as a high-position working platform. Among these problems are the application of two time scale control theory for the feedback control system design, and the application of Kalman filter theory to process sensor data. I.S.

A92-45406
RESULTS AND LESSONS LEARNED FROM THE STOL AND MANEUVER DEMONSTRATION PROGRAM
DAVID J. MOORHOUSE and JAMES A. LAUGHREY (USAF, Wright Laboratory, Wright-Patterson AFB, OH) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 365-373. refs
(SAE PAPER 912005) Copyright

The STOL and Maneuver Technology Demonstrator Program has validated a set of technologies that give a surpersonic fighter all-weather STOL performance while also enhancing up-and-away maneuverability. Significant reductions in both takeoff and landing distances, compared with the unmodified F-15, have been measured. The additional pitch control power of thrust vectoring has been demonstrated up to 30 deg angle of attack. The effectiveness of up-and-away reversing has been identified. First, major flight test results are presented, and then lessons learned from this integration program are discussed. Author

A92-45410
AERODYNAMIC DEVELOPMENT OF BOUNDARY LAYER CONTROL SYSTEM FOR NAL QSTOL RESEARCH AIRCRAFT 'ASKA'
HIROTOSHI FUJIEDA, HITOSHI TAKAHASHI, YOSHIT MIYAMOTO (National Aerospace Laboratory, Chofu, Japan), JUNICHI MIYASHITA, KENJI SAKAI (Kawasaki Heavy Industries, Ltd., Kobe, Japan), and YOSHIO MORITA (Mitsubishi Heavy Industries, Ltd., Tokyo, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 405-412. refs
(SAE PAPER 912010) Copyright

ASKA, developed by National Aerospace Laboratory, is a quiet short take-off and landing (QSTOL) research aircraft adopting upper surface blowing concept as a powered high lift system. To achieve sufficient STOL performance by augmenting stall angle of attack and roll control power, a blowing BLC technique was applied to the outboard leading edges and ailerons. To supply high pressure air to save the BLC piping space, a BLC system which was fit for using high-pressure air was developed. The BLC system, in which BLC air is discharged by a series of discrete jets from small drilled holes (0.8 to 3.0 mm in diameter) arranged in a row, is one of the unique features of the aircraft. In this paper, the summary of the aerodynamic development of the BLC system is presented except for the air piping system. Author

A92-45436
FEASIBILITY STUDY ON A MICROWAVE-POWERED UNMANNED AERIAL VEHICLE FOR THE COMMUNICATION RELAY UTILIZATION
KINGO TAKASAWA (National Aerospace Laboratory, Tokyo, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 665-676. refs
(SAE PAPER 912052) Copyright

Some component tests and a system definition study have verified the feasibility of microwave powered UAVs for communication relay utilization. The best choice of a power system composition is proposed with emphasis placed on the overall efficiency in cruise phase and adaptability in the climb phase. The integration into the ATC system, towed climb, monitored descent and emergency operations are described. R.E.P.

A92-45437
STRUCTURAL CONCEPT OF MAIN WINGS OF HIGH ALTITUDE UNMANNED AERIAL VEHICLE AND BASIC PROPERTIES OF THERMOPLASTIC COMPOSITES AS CANDIDATE MATERIAL

TAKASHI ISHIKAWA, YOICHI HAYASHI, MASAMICHI MATSUSHIMA (National Aerospace Laboratory, Tokyo, Japan), TATSUO SATO (Fuji Heavy Industries, Ltd., Tochigi, Japan), and KINGO TAKASAWA (National Aerospace Laboratory, Chofu, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 677-686. refs
(SAE PAPER 912053) Copyright

A conceptual design of an unmanned aerial vehicle operated at an altitude of 20 km and powered by microwave was developed using CAD software. Possible applications of this aircraft would be a platform for telecommunication relay or an earth observation base. It is found that an all-up mass of 400 kg would provide an optimal payload of 50 kg under certain input power conditions, and that an extreme weight reduction, such as a 93-kg main wing of 30-m span, would be required. A fundamental structural concept of this aircraft, particularly the main wing, is defined. Maneuvering envelopes are discussed and basic flight loads are determined. The spanwise thickness distribution of the tubular spar is calculated, and bending and torsional deflections are estimated. Static and fatigue tensile tests are conducted at an ambient temperature and a low temperature of -60 C for CF/PEEK specimens. C.A.B.

A92-45438
HIGH-ALTITUDE LIGHTER-THAN-AIR POWERED PLATFORM
MASAHIKO ONDA and YASUSHI MORIKAWA (MITI, Mechanical Engineering Laboratory, Tsukuba, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 687-694. refs
(SAE PAPER 912054) Copyright

To tackle global environmental problems, the acquisition of plentiful and precise data is necessary, and a means of conducting long-lasting high-resolution measurements over broad areas is required. A feasibility study has been made on a high-altitude (about 20 km), superpressured, helium-filled powered lighter-than-air (PLTA) vehicle as an ideal platform for environmental observation. It has a long service life and carries a larger payload than an artificial satellite. This PLTA platform, named HALROP (High Altitude Long Range Observational Platform), uses a solar-powered electric propulsion system to maintain its position in space against wind currents. The solar power is acquired from solar cells. For night use, solar energy is stored in regenerative fuel cells. This study examines energy balance and provides a structural analysis of the vehicle. Author

A92-45439
EXPERIMENTAL AND NUMERICAL STUDY OF AERODYNAMIC CHARACTERISTICS FOR SECOND GENERATION SST
KENJI YOSHIDA and KENJI HAYAMA (Kawasaki Heavy Industries, Ltd., Kakamigahara, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 695-707. Research supported by Kawasaki Heavy Industries, Ltd. refs
(SAE PAPER 912056) Copyright

Attention is given to the effects of three typical drag reduction technologies, namely, the application of a suitable wing planform, a warped wing, and an area-ruled body by employing both experimental and numerical approaches. The increment of the cruise L/D is about 0.1 for an arrow planform, 0.6 for a warped wing, and 0.5 for an area-ruled body. It is inferred that the present SST configuration has an L/D of about 8.6 at cruise Mach number 2.0, including some corrections on the Reynolds number, fuselage volume, etc. Applying the present Navier-Stokes calculation code for these test models, it is found that the CFD code is very useful in predicting the characteristics of design conditions. C.A.B.

A92-45455
DEVELOPMENT OF THE DDV ACTUATION SYSTEM ON THE IDF AIRCRAFT
YEN-NIEN HSU, CHEN-YAN LAI, MING-HWANG HSU, and YUN-KUN LEE (Chung Shan Institute of Science and Technology, Republic of China) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 871-881.
(SAE PAPER 912080) Copyright

Consideration is given to the problems and challenges of designing the closed-loop electronic control of a direct drive valve (DDV) actuator system. Advantages and disadvantages of the DDV concept compared to the electrohydraulic valve EHV are outlined. Loop closer servoamplifier design, failure monitoring, current equalization, and testability of the DDV are also discussed. The Taiwanese Indigenous Defensive Fighter is the testbed for the design, integration, and testing of one such DDV system. The DDV driven actuators have exhibited reliable high-performance flight-test operation. Recent improvements include more complete DDV modeling information, allowance for overtravel, and surface rigging. C.A.B.

A92-45491#
TWO-POINT OPTIMIZATION OF COMPLETE THREE-DIMENSIONAL AIRPLANE CONFIGURATION
K. KUBRYNSKI (Warsaw, Technical University, Poland) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 172-180. refs
(AIAA PAPER 92-2618) Copyright

A subcritical panel method applied to flow analysis and aerodynamic multipoint design of complex aircraft configurations is presented. The analysis method is based on linearized, compressible, subsonic flow equations and indirect Dirichlet boundary conditions. Quadratic doublet and linear source distribution on flat panels are applied. In the case of aerodynamic design the geometry which minimizes discrepancy between target and actual pressure distributions on different parts of configuration at different angles of attack is found iteratively using numerical optimization technique. Geometry modifications are modeled by surface transpiration. Constraints in respect to resulting geometry can be specified. Examples of 3D design are presented. The software is adopted to personal computers, and as a result an unexpected low cost of computations is obtained. Author

A92-45501#
EFFECTS OF WING PLANFORM ON HSCT OFF-DESIGN AERODYNAMICS
C. P. NELSON (Boeing Commercial Airplane Group, Seattle, WA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 285-303. refs
(AIAA PAPER 92-2629) Copyright

Wing planforms for high-speed civil-transport (HSCT) aircraft are considered with attention given to off-design performance and flight characteristics. A review is given of the aerodynamics of supersonic planforms detailing key subsonic-transonic flow phenomena including those corresponding to high angles of attack. Three HSCT wing-body planforms are compared to study the off-design impact of strake size as well as the effects of inboard leading-edge bluntness. The three configurations include wings with 35, 50, and 60 percent strake with different sweep designs. Scale models are used in a wind tunnel at Mach numbers of 0.40-1.05 to test such conditions as transonic overland cruise, acceleration, holding/diversion, and maneuvering at high angles of attack. The best performance is demonstrated by the 'cranked-arrow' wing with blunt inboard wing sections and moderate outboard sweep. C.C.S.

A92-45519#
RECENT CFD APPLICATIONS ON JET TRANSPORT CONFIGURATIONS
B. C. CLEM, J. K. ELLIOTT, T. L. B. TAMIGNIAUX, and E. N. TINOCO (Boeing Commercial Airplane Group, Seattle, WA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June

22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 486-493. refs
(AIAA PAPER 92-2658) Copyright

The application of two full-potential codes with coupled boundary layer (A488 and TRANAIR) to two- and four-engine configuration is presented. It is concluded that both A488 and TRANAIR exhibit good agreement with test data, especially on the inboard portion of the wing where aeroelastic effects are not as strong. These codes are capable of providing timely, high quality CFD solutions on 'real world' problems and geometries. O.G.

A92-45573#
APPLICATION OF THE EULER METHOD EUFLEX TO A FIGHTER-TYPE AIRPLANE CONFIGURATION AT TRANSONIC SPEED
S. HEISS, A. EBERLE, L. FORNASIER, and W. PAUL (MBB GmbH, Munich, Federal Republic of Germany) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 19 p. Research supported by MBB GmbH. refs
(AIAA PAPER 92-2620) Copyright

The paper reports the application of the finite volume Euler method EUFLEX to an advanced fighter airplane configuration using an H-type monoblock grid topology. Comparisons of the numerical results with wind tunnel data both in terms of global aerodynamic coefficients and of wing-surface pressures are used to assess the capabilities of the present approach in the analysis of complex flow phenomena experienced by the aircraft throughout its flight envelope. Investigated phenomena include flow nonlinearities induced by the highly swept delta wing at moderate to high angles of attack and by recompression shocks at transonic and supersonic speeds, and interference flows due to wing-canard coupling, underwing pylon-missile installation close to wing tip pod and propulsion effects. In addition, trailing-edge flap deflection is simulated using a novel local grid topology. A description of the Euler solver is provided and the interactive technique used to generate the numerical grid directly from the CAD model of the configuration is presented. Selected results for Mach numbers 0.60, 0.90, 1.20 and 1.30 are discussed. Author

A92-45580#
APPLIED COMPUTATIONAL AERODYNAMICS - CASE STUDIES
W. H. MASON (Virginia Polytechnic Institute and State University, Blacksburg) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 13 p. refs
(AIAA PAPER 92-2661) Copyright

Case studies of current aircraft are used as term projects in a senior elective course at VPI, Applied Computational Aerodynamics. The case studies illustrate the role of computational aerodynamics in aircraft design and analysis. The objective is to connect classroom instruction to actual current aerodynamic concepts and configuration development. Students have shown considerable interest in these projects. The paper discusses a sampling of the projects that have been used over the past several years. They include: the B-2, a comparison of the Beech Starship and the Grumman X-29, and a comparison of the YF-22 and YF-23 ATF candidates. The paper presents highlights from the term projects, including the key lessons learned from the analysis of the design. Author

A92-46800
SYSTEM FOR GENERATING SEQUENCES OF PHASED GUST OR TAXI LOADINGS
ROBERT G. EASTIN, TRYGVE R. LERWICK, and SVEN M. SOEDEL (McDonnell Douglas Corp., Long Beach, CA) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 686-692. refs
(Contract F33657-81-C-2108)
Copyright

A method is presented for Monte Carlo generation of phased load conditions for multiple loading durability testing. These load conditions are consistent with the gust and taxi environmental-dynamic model used in aircraft design. Time histories of individual loads from sequences of load conditions are consistent with the load sequences used in standard single load point durability and damage tolerance testing and analysis. Truncation can be applied to a sequence of load conditions so that only the most severe are retained. The truncation process is consistent with the mission analysis approach to design and to durability and damage tolerance. The load conditions can be modified using an induced autocorrelation approach to give variation in the number of zero crossings of the load time histories. Author

A92-46806
OPTIMUM CRUISE LIFT COEFFICIENT IN INITIAL DESIGN OF JET AIRCRAFT
RODRIGO MARTINEZ-VAL and EMILIO PEREZ (Madrid, Universidad Politecnica, Spain) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 712-714. refs
Copyright

An attempt is made to develop a more realistic model of the optimum cruise of a jet aircraft by considering the effect of the Mach number on the specific fuel consumption. It is assumed that the specific fuel consumption is influenced by the Mach number in accordance with a potential law, which, along with the constant altitude constraint, allows a simple analytical treatment of the range equation and related expressions. The final results are written in closed form. An application of the results to performance prediction is illustrated. V.L.

A92-46807
ADVANCED PNEUMATIC IMPULSE ICE PROTECTION SYSTEM (PIIP) FOR AIRCRAFT
CHARLES A. MARTIN and JAMES C. PUTT (BF Goodrich Aerospace, Uniontown, OH) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 714-716. Previously cited in issue 06, p. 763, Accession no. A90-19875. refs
Copyright

A92-46812
WING MASS FORMULA FOR SUBSONIC AIRCRAFT
SERGEI V. UDIN and WILLIAM J. ANDERSON (Michigan, University, Ann Arbor) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 725-727. refs
Copyright

A new formula for estimating the wing mass is derived, and detailed calculations are presented for a transport aircraft. The formula is shown to be accurate to within -10.8/+9.5 percent; the rms error is 5.9 percent. The accuracy of the formula can be improved by using statistical data. V.L.

A92-46813
WHIRL-FLUTTER STABILITY OF A PUSHER CONFIGURATION IN NONUNIFORM FLOW
F. NITZSCHE and E. A. RODRIGUES (EMBRAER - Empresa Brasileira de Aeronautica, S.A., Sao Jose dos Campos, Brazil) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 727-729. Previously cited in issue 11, p. 1607, Accession no. A90-29397. refs
Copyright

A92-46815
OPTIMIZATION OF CONSTANT ALTITUDE-CONSTANT AIRSPEED FLIGHT OF TURBOJET AIRCRAFT
SHIVA K. OJHA (Indian Institute of Technology, Bombay, India) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 731-734. refs
Copyright

Analytical expressions are derived for calculating the optimum cruising flight of a turbojet aircraft at the preliminary design stage. The altitude and airspeed are kept constant during the flight. First, the basic equation is written for the range, and the airspeed for the maximum range is then obtained. The optimum flight is illustrated by a realistic numerical example. V.L.

A92-46884
SENSITIVITY ANALYSIS OF DISCRETE PERIODIC SYSTEMS WITH APPLICATIONS TO HELICOPTER ROTOR DYNAMICS
YI LU and V. R. MURTHY (Syracuse University, NY) AIAA Journal (ISSN 0001-1452), vol. 30, no. 8, Aug. 1992, p. 1962-1969. refs
Copyright

This paper presents a sensitivity formulation for periodic systems and a theoretical model for a helicopter rotor in forward flight. The formulation and the rotor model are validated by a few comparisons with other available methods and experimental values. The greatest advantage of the present sensitivity analysis is that the order of the Floquet matrix is independent of the number parameters to be investigated. This yields substantial savings in computation times over the existing methods. The formulation yields unique derivatives for the eigenvalues in spite of the nonuniqueness in the eigenvalues, and this includes also the frequency-locked region. The derivatives of the eigenvectors also follow from the same formulation except that it breaks down in the frequency-locked region. Author

A92-46919
AHS INTERNATIONAL SPECIALISTS' MEETING ON ROTORCRAFT BASIC RESEARCH, GEORGIA INSTITUTE OF TECHNOLOGY, ATLANTA, MAR. 25-27, 1991, PROCEEDINGS
Meeting sponsored by AHS. Alexandria, VA, American Helicopter Society, 1991, 597 p. For individual items see A92-46920 to A92-46960.

The present conference on fundamental aspects of helicopter-related research discusses 1D beam dynamics, rotor dynamic hub load prediction, chaotic oscillation in rotor blade stall response, a nonlinear rigid body mass FEM for rotary wing dynamics, appropriate bases for nonlinear dynamic modal analysis, periodic trim solutions with hp-version finite elements in time, the unsteady interaction of a 3D vortex filament with a cylinder, and rotor wake development and wake/body interactions in hover. Also treated are the buckling of imperfect composite shells under compression and torsion, the nonlinear analysis of anisotropic rods, the buckling and crippling of thin-walled composite airframe structures under compression, the effect of damage on elastically tailored composite laminates, nonlinear anisotropic shell model analyses of rotor flex-structure, flow visualization of a small-diameter rotor operating at high rotational speeds, and a Eulerian/Lagrangian method for computing blade/vortex impingement. O.C.

A92-46921
PREDICTION OF DYNAMIC HUB LOAD OF A ROTOR EXECUTING MULTIPLE SINUSOIDAL BLADE PITCH VARIATIONS
GIZO HASEGAWA, TOMOARI NAGASHIMA, and TOSHIFUMI NEKOHASHI (National Defense Academy, Yokosuka, Japan) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 3-1 to 3-15. refs

Analytical and experimental studies were carried out for dynamic hub vertical load responses of a hingeless rotor in forward flight due to simultaneous implementation of multiple sinusoidal blade pitch variations. The unsteady air loads were evaluated by the hybrid wake model to stress a near shed wake effects. By applying the generalized harmonic balance method to a linear, model equation of motion of the blade, elastic blade motions and associated unsteady air load distributions were determined iteratively and time histories of hub vertical load responses were expressed by the Fourier series in terms of the reduced blade azimuth angle. Effects of control input parameters on the dynamic hub vertical load responses were numerically examined at various advance ratios and the optimum combinations of control input parameters which could minimize the dynamic hub vertical loads were ascertained. Author

A92-46922
CHAOTIC OSCILLATION IN HELICOPTER BLADE STALL RESPONSE
D. M. TANG and E. H. DOWELL (Duke University, Durham, NC) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 4-1 to 4-12. refs
(Contract DAAL03-87-K-0023)

In this paper an ONERA aerodynamic stall model is applied to the analysis of helicopter blade stall response. The nonlinear state variable equations and the linear state variable perturbation equations are solved. A typical evolution process of the rotor blade stall response from periodic to aperiodic or chaotic motion and a necessary condition for onset of chaotic response are discussed. A comparison between the results from the ONERA stall model and a simpler nonlinear aerodynamic model is discussed. Author

A92-46924* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A GENERAL PURPOSE NONLINEAR RIGID BODY MASS FINITE ELEMENT FOR APPLICATION TO ROTARY WING DYNAMICS
B. K. HAMILTON, F. K. STRAUB (McDonnell Douglas Helicopter Co., Mesa, AZ), and G. C. RUZICKA (U.S. Army, Aeroflightdynamics Directorate; NASA, Ames Research Center, Moffett Field, CA) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 8-1 to 8-15. refs
(Contract NAS2-12343)

The Second Generation Comprehensive Helicopter Analysis System employs the present formulation of the general-purpose nonlinear rigid body mass finite element, which represents the hub masses, blade tip masses, and pendulum vibration absorbers. The rigid body mass element has six degrees of freedom, and accounts for gravitational as well as dynamic effects. A consequence of deriving the element's equations from various physical principles is that, prior to the transformation which couples the rigid body mass element to the rotor blade finite element, the forces obtained for each element are fundamentally different; this is true notwithstanding the degrees-of-freedom of each element are parameterized using the same coordinates. O.C.

A92-46925
RELATIVE ENERGY CONCEPTS IN HELICOPTER DYNAMICS
G. T. S. DONE (City University, London, England) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 10-1 to 10-4. refs

For a model that can be represented by a mixed coordinate model, as in the case of the present helicopter ground-resonance model, energy contributions can be resolved and balanced despite the 'relative' form of some. This allows the model to be rationally described either as conservative, when expressed in the Coleman coordinate system, or nonconservative, when expressed in either fixed axes or a mixture of fixed and moving axes. The description is thus strictly relative to the frame of reference employed in the system definition. Similar understanding may be obtained on the basis of simpler dynamic models. O.C.

A92-46926
CHAOTIC DYNAMIC BEHAVIOR IN A SIMPLIFIED ROTOR BLADE LAG MODEL
GEORGE T. FLOWERS (Auburn University, AL) and BENSON H. TONGUE (California, University, Berkeley) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 11-1 to 11-9. refs

An investigation into the effects of pitch oscillation on the dynamical behavior of a simplified nonlinear rotor blade lag model is presented. The objective is to evaluate under what conditions a rotor blade might exhibit chaotic behavior. Such behavior is shown to exist and to exhibit a strong dependence on the specific parametric configuration of the system. Author

A92-46927
ON THE CHOICE OF APPROPRIATE BASES FOR NONLINEAR DYNAMIC MODAL ANALYSIS
O. A. BAUCHAU and D. GUERNSEY (Rensselaer Polytechnic Institute, Troy, NY) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 12-1 to 12-13. refs
(Contract DAAL03-88-C-0004)

This paper focuses on assessing the accuracy of various modal bases in nonlinear dynamic modal analysis of helicopter rotor blades by comparing their prediction with a reference solution obtained by integrating in time the full finite element equations. Perturbation modes are shown to provide an excellent basis for the modal analysis, as they accurately capture the nonlinear kinematic couplings. They provide a more accurate model than that based on natural vibration mode shapes. Author

A92-46930
BILINEAR FORMULATION APPLIED TO THE STABILITY AND RESPONSE OF HELICOPTER ROTOR BLADE
GRZEGORZ KAWIECKI (Tennessee, University, Knoxville) and NITHIAM T. SIVANERI (West Virginia University, Morgantown) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 17-1 to 17-13. refs

A time FEM based on Hamilton's law of varying action is applied to the analysis of helicopter blade dynamics. The bilinear formulation of Hamilton's law is used to discretize the temporal dependence of the equations of motion. Two approaches to the numerical implementation of the bilinear formulation are used. One of the approaches obtains the response of a general dynamical system using marching in time. The other approach is based on the assumption that the solution is identical at the beginning and at the end of one period. Thus, this approach is suitable for periodical systems. The bilinear formulation in marching mode is applied to test the response and the stability of rigid blade flapping. The bilinear formulation in imposed periodicity mode is used to investigate the response of a rigid blade with flap and lag DOFs in forward flight. Author

A92-46932* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AN AEROELASTIC ANALYSIS WITH A GENERALIZED DYNAMIC WAKE
CHENG J. HE and DAVID A. PETERS (Georgia Institute of Technology, Atlanta) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 19-1 to 19-15. Research sponsored by NASA. refs

An aeroelastic model with generalized dynamic wake is developed for application in the integration of aerodynamic, dynamic, and structural optimization of a rotor blade. The investigation is carried out with special attention to efficiency and accuracy of aeroelastic modeling. Each blade is assumed to be an elastic beam undergoing flap bending, lead-lag bending, elastic twist and axial deflections. The nonuniform blade is discretized into finite beam elements, each of which consists of twelve degrees of freedom. Such important blade design variables as pretwist, and chordwise offsets of the blade center of gravity and of the aerodynamic center from the elastic axis have been included in the analysis. Aerodynamic loads are computed from unsteady blade element theory where the rotor three-dimensional unsteady wake is modeled using a generalized dynamic wake theory. The noncirculatory loads based on unsteady thin airfoil theory are also included. Author

A92-46943
FREQUENCY DOMAIN FLIGHT TESTING AND ANALYSIS OF AN OH-58D HELICOPTER
JOHNNIE A. HAM and WILLIAM H. STORMER (U.S. Army, Aviation Technical Test Center, Fort Rucker, AL) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 50-1 to 50-14. refs

A U.S. Army OH-58D helicopter has been used to demonstrate frequency-domain flight testing and analysis techniques in the course of 3 flight hours of hover and 60-knot forward flight operations. Bandwidth and phase-delay parameters were ascertained on the basis of the flight test data obtained according to the definitions of Aeronautical Design Standard ADS-33C, 'Handling Qualities Requirements of Military Rotorcraft'. A frequency-response identification program, FRESPID, was used to derive the parameters via discretized FFT algorithm on input control deflections and integrated output airframe angular rates. Excellent agreement was obtained between handling-qualities ratings and ADS-33-based handling quality level predictions. O.C.

A92-46945* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ON THE ADEQUACY OF MODELING TURBULENCE AND RELATED EFFECTS ON HELICOPTER RESPONSE
V. V. GEORGE, G. H. GAONKAR (Florida Atlantic University, Boca Raton), J. V. R. PRASAD, and D. P. SCHRAGE (Georgia Institute of Technology, Atlanta) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 53-1 to 53-16. Research sponsored by NASA and Georgia Institute of Technology. refs

The present closed-form solution of a frequency-time spectrum for the dominant vertical turbulence velocity at an arbitrary blade station accounts for the instantaneous turbulence-energy transfer due to rotational velocity from the low-frequency to the high-frequency region, with the occurrence of several spectral peaks and split peaks. Comparisons of blade-flapping response to blade- and body-fixed turbulence is also presented, over a range of turbulence-scale length and advance ratios. Attention is given to the use of cyclostationary turbulence and blade-response frequency-time spectra to simultaneously predict temporal and frequency characteristics. Rotational velocity substantially affects response statistics in low-altitude, low advance-ratio flight. O.C.

A92-46960
A MACH-SCALED POWERED MODEL FOR ROTOR-FUSELAGE INTERACTIONAL AERODYNAMICS AND FLIGHT MECHANICS INVESTIGATIONS
SYED R. AHMED (DLR, Braunschweig, Federal Republic of Germany) and FRIEDRICH-WILHELM MEYER (Braunschweig, Technische Universitaet, Federal Republic of Germany) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 36-1 to 36-12. Research supported by BMFT. refs

The present 1.5-m diameter Mach-scaled powered model for helicopter model aerodynamic research employs a four-blade hingeless rotor that is driven by a 16-kW hydraulic motor. Preliminary tests have been conducted with this apparatus for the case of a BO 105 helicopter's model fuselage to assess the effects of rotor operation on time-averaged fuselage pressure distributions at different advance ratios. O.C.

A92-47122
FREE VIBRATION ANALYSIS OF BRANCHED BLADES BY THE INTEGRATING MATRIX METHOD
J. D. CULP and V. R. MURTHY (Syracuse University, NY) Journal of Sound and Vibration (ISSN 0022-460X), vol. 155, no. 2, June 8, 1992, p. 303-315. refs
Copyright

The integrating matrix method is applied to determine the free vibration characteristics of bearingless rotor blades containing multiple branches at the root. It is necessary to include the axial degree-of-freedom in this analysis to account for the differential axial displacements in the branches. The inclusion of the axial degree-of-freedom leads to a nonlinear problem to determine the tension coefficients in the branches. The integrating matrix method is again applied to solve this nonlinear problem. The eigenvalue problem corresponding to branched bearingless blades forms a proper Sturm-Liouville problem and the associated orthogonality condition between the eigenfunctions is identified. The method is validated through comparisons with existing methods. Author

A92-47404

WING LEADING EDGE DESIGN WITH COMPOSITES TO MEET BIRD STRIKE REQUIREMENTS

L. K. JOHN (DeHavilland Aircraft of Canada, Ltd., Canada) IN: Composites in manufacturing - Case studies. Dearborn, MI, Society of Manufacturing Engineers, 1991, p. 3-18.

Copyright

Details of the design and testing of a wing leading edge for the DASH 8 aircraft, sufficiently rugged to withstand bird strikes and other incidental impacts, are discussed. The fiber-reinforced composite leading edge designed for bird-impact resistance is shown to be comparable in weight with a conventional metal design that does not meet the bird-impact requirements and significantly lighter than metal designs that would meet these requirements. In addition to meeting the design criteria, the DASH 8 leading edge made with aramid fiber and honeycomb core provides cost and weight benefits together with aerodynamic cleanliness, resulting in greater fuel efficiency. V.L.

A92-47406

DESIGN AND TEST OF AIRCRAFT AFT FUSELAGE STRUCTURE USING POSTBUCKLED SHEAR PANELS

JOHN H. PIMM (Vought Corp., Dallas, TX) IN: Composites in manufacturing - Case studies. Dearborn, MI, Society of Manufacturing Engineers, 1991, p. 33-48.

Copyright

The possible use of composites for the manufacture of the aft fuselage structure is investigated. Design concepts for composite aft fuselage components are considered, and test results are presented for several alternatives. Criteria for the choice of a material (e.g., graphite versus aramid fiber) in several different components are discussed. It is estimated that the use of composites instead of metal in the aft fuselage structure can provide a saving of 31.4 percent in nonrecurring costs and an overall saving of 15 percent. V.L.

A92-47408

DESIGN OF HELICOPTER COMPOSITE STRUCTURES FOR CRASHWORTHINESS

JAMES D. CRONKHITE (Bell Helicopter Textron, Inc., Fort Worth, TX) IN: Composites in manufacturing - Case studies. Dearborn, MI, Society of Manufacturing Engineers, 1991, p. 79-92. refs

(Contract DAAK51-79-C-0037)

Copyright

Results of tests for the compliance with the MIL-STD-1290 crashworthiness requirements are reported for an all-composite helicopter. In particular, attention is given to concepts behind successful crashworthiness design; the use of compressive failure tests for graphite, aramid fiber, and fiberglass cylinders to assist in material selection; energy-absorbing floor beam design concepts; and design, manufacture, and testing of cabin test sections. It is demonstrated that MIL-STD-1290 crashworthiness requirements can be met with a composite fuselage structure if designed with energy absorption and load attenuation in controlled areas. Specially designed energy-absorbing aramid/epoxy sandwich structures are found to be particularly crashworthy. V.L.

A92-47591

AIRBUS A319 - COMPLETION OF THE STANDARD FUSELAGE FAMILY [AIRBUS A319 - ERGAENZUNG DER STANDARDRUMPF-FAMILIE]

Luft- und Raumfahrt (ISSN 0173-6264), vol. 13, no. 3, May-June 1992, p. 12-14. In German.

Copyright

The completion of the Airbus A319, a shortened version of the A320, is discussed. Market considerations supporting the production of an aircraft of this size are reviewed. The role of government regulations in the decision to develop the aircraft is addressed. C.D.

A92-47629

THE EFFECT OF COMPOSITE MATERIAL ALLOWABLE CHANGES ON VTOL AIRFRAME WEIGHTS

R. L. FOYE (Sterling Software, Inc., Dallas, TX) and R. J. PEYRAN (U.S. Army, Washington, DC) Weight Engineering (ISSN 0583-9270), vol. 51, no. 3, Spring 1992, p. 39-51. refs

Copyright

A method for estimating changes in structural weight required to compensate for small changes in the principal mechanical weight allowables of the materials of construction is described. The method is statistically based on the distribution and usage of structurally active composite materials in the Boeing V-22 tilt rotor, Boeing 360 tandem rotor, and single rotor ACAP airframes. For each structural weight category, the percentage of composite that is critical in each material allowable category is estimated. Relations are proposed that link these material volumes to the requirement levels and allowable values. This permits the calculation of component weight changes necessary to compensate for fractional allowable changes while maintaining full structural capacity and margins of safety. Issues such as cost changes corresponding to allowable changes and vehicle size effects have also been included. Two example problems are given. A.F.S.

A92-47657

PROBABILITY ANALYSIS OF STRUCTURE FAILURE FOR THE WINGS WITH MAIN AND SUBORDINATE COMPONENTS

WEI ZHANG (Shaanxi Aircraft Co., Dept. of Development, Chengdu, People's Republic of China) and FU-JIA LIN (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 13, no. 3, March 1992, p. A133-A138. In Chinese. refs

A reliability analysis methodology based on the probability fracture mechanics was developed for a wing with main and subordinate components, with account taken for such factors as the crack detection probability, the inspection interval, the inital flaw distribution, the crack growth, and residual strength. The method uses the crack size-time relationship a(t) = a(0) exp (at), in which the equivalent initial flaw size a(0) is a lognormal random variable. The correlation between the main and the subordinate components in fatigue properties is considered, and equations are derived for computing the failure rate and the failure probability of structures in any service interval. Results of a calculation example for the wings of a fighter show that the fatigue life of subordinate components has significant effect on the probability of failure of the main component. I.S.

A92-47664

DURABILITY ANALYSIS FOR A MAIN BULKHEAD SUBJECTED TO LOAD ON THE BODY OF AN AIRCRAFT

WEN-TING LIU (Beijing University of Aeronautics and Astronautics, People's Republic of China), JUN JIANG, GUI-WEN LI, LI-ZHONG SHEN, GUO-RONG JIA, and RONG-MING SHI Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 13, no. 3, March 1992, p. A187-A192. In Chinese. refs

Results are presented of a durability analysis for the main aircraft bulkhead, with fastener holes on the cross beams, subjected to a load on the body of an aircraft. The degree of damage and the economic life of the main bulkhead were evaluated for a fleet of airframes. Results were used to design a rational repair program. I.S.

A92-47666

SONIC FATIGUE ANALYSIS AND ANTI-SONIC FATIGUE DESIGN OF AIRCRAFT STRUCTURE

XIU-YI ZHANG Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 13, no. 3, March 1992, p. A197-A201. In Chinese. refs

Sonic fatigue was calculated for several types of typical structural elements of an aircraft, using a quick analysis method which made it possible to accommodate various noise spectrum shapes. The structural response frequency expressions for different structural configurations were derived, which define the response of the acoustic specimen and the sonic fatigue damage accumulation rate. The design of an antiacoustic-fatigue aircraft structure is considered. I.S.

A92-47667
A FAILURE ANALYSIS FOR LANDING GEAR STRUCTURAL SYSTEM
ZHONG XU (Nanjing Aeronautical Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 13, no. 3, March 1992, p. A202-A205. In Chinese. refs

A failure analysis method based on the reliability theory is developed and used to analyze an aircraft landing gear system. Using published data on a large number of landing gear investigations, failure distribution curves were determined and the reliability during economic life was calculated. It is shown that the new method is simple, effective, and economic. I.S.

A92-47759
THE AIRPLANE
Lockheed Horizons (ISSN 0459-6773), no. 30, May 1992, p. 28-43.
Copyright

An overview is presented of the F-117 Stealth Fighter, the first operational aircraft to exploit low observable stealth technology. The single-seat fighter is designed to penetrate dense threat environments at night and to attack high-value targets with pinpoint accuracy. Attention is given to the twin turbofan engines, the FBW flight controls, and the cockpit layout that includes a large video monitor to display IR imagery from onboard sensors. R.E.P.

A92-47969
A340 HANDLING, COCKPIT DESIGN IMPROVE ON PREDECESSOR A320
DAVID M. NORTH Aviation Week and Space Technology (ISSN 0005-2175), vol. 137, no. 2, July 13, 1992, p. 38-41, 44, 45.
Copyright

A92-47975
US NAVY REVISITS ESCAPE MODULES
JOHN KELLER Interavia Aerospace Review (ISSN 0020-6512), vol. 47, July 1992, p. 28-30.
Copyright

U.S. Navy scientists are researching a technology that has been considered in the past, to develop several high-speed and high-altitude aircraft escape modules, in which the pilot remains strapped in and the jettisoned self-contained module parachutes to the ground. One option under consideration would transform the cockpit after separation into a tiny aircraft, thus allowing combat pilots to fly to safe areas for rapid and easy rescue. The work in this research area of the Naval Air Warfare Center, and several civilian aircraft manufacturers is reviewed. R.E.P.

A92-48022
AEROSPACE PRESSURIZATION SYSTEM DESIGN
SAE Aerospace Information Report SAE AIR 1168/7, March 15, 1991, 19 p. refs
(SAE AIR 1168/7) Copyright

The pressurization system design considerations are presented in this Aerospace Information Report. Problems discussed include human physiological requirements, characteristics of pressurization air sources, methods of controlling cabin pressure, cabin leakage control, leakage calculation methods, and methods of emergency cabin pressure release. O.G.

A92-48352
CHARACTERIZATION OF THERMAL PERFORMANCE OF WHEEL OUTBOARD OF AN AIRCRAFT
K. VAFAI and C. DESAI (Ohio State University, Columbus) International Communications in Heat and Mass Transfer (ISSN 0735-1933), vol. 19, no. 4, July-Aug. 1992, p. 541-547. Research supported by BF Goodrich zco. and Ohio Supercomputer Center. refs
Copyright

The wheel outboard portion of an aircraft brake housing which is modeled as an annular cavity with one end open to the ambient surroundings is investigated in this work. To simulate actual conditions, a set of boundary conditions obtained from brake system tests were fed into the numerical model. Based on proper non-dimensionalization, and using a finite element numerical model a set of psuedo-universal dimensionless temperatures for different Rayleigh numbers associated with each of the temperature conditions corresponding to the actual test data were obtained. Pertinent temporal and steady state thermal performance characteristics of the wheel outboard portion of the brake housing are also examined. Author

A92-48408
BISTATIC SCATTERING ON A MONOSTATIC RADAR RANGE
WOLFGANG F. HERDEG (DLR, Institut fuer Hochfrequenztechnik, Oberpfaffenhofen, Federal Republic of Germany) and HORST WENDEL (Telefunken Systemtechnik GmbH, Ulm, Federal Republic of Germany) European Transactions on Telecommunications and Related Technologies (ISSN 1120-3862), vol. 2, no. 4, July-Aug. 1991, p. 459-461. refs
Copyright

Suitable combination of monostatic radar range and reflector plate allows to study bistatic scattering while varying only the aspect angle. The scheme is exemplified by measuring the scattering from an isolated rectangular metal edge. The various scattering contributions are discriminated by high resolution imaging. Author

A92-48586
THE A320 LAMINAR FIN PROGRAMME
J. J. THIBERT (ONERA, Chatillon, France), A. QUAST (DLR, Braunschweig, Federal Republic of Germany), and J. P. ROBERT (Airbus Industrie, Toulouse, France) (European Forum on Laminar Flow Technology, 1st, Hamburg, Federal Republic of Germany, Mar. 16-18, 1992) ONERA, TP no. 1992-23, 1992, 8 p.
(ONERA, TP NO. 1992-23)

A review is presented of ongoing research into hybrid laminar flow as a drag reduction technique for the next generation of transport aircraft. The wind tunnel model, its equipment and the suction device are described. Results concerning the aerdynamic aspects and current progress of the program are presented. R.E.P.

A92-48589
RESEARCH ON HELICOPTER ROTORS - PROGRESS IN AERODYNAMICS, AEROELASTICITY AND ACOUSTICS [RECHERCHES SUR LES ROTORS D'HELICOPTERES - PROGRES EN AERODYNAMIQUE, AEROELASTICITE ET ACOUSTIQUE DES ROTORS D'HELICOPTERES]
JEAN-JACQUES PHILIPPE (ONERA, Chatillon, France) (L'Aeronautique et l'Astronautique, no. 152, 1992, p. 13-17) ONERA, TP no. 1992-27, 1992, 6 p. In French. refs
(ONERA, TP NO. 1992-27) Copyright

Several research and development improvements on helicopter rotors accomplished over the past 20 years at ONERA are reviewed. Continuing studies focusing on new rotor concepts to assure a better compromise between aerodynamic performance, vibration levels, and rotor noise are described. Attention is given to the aerodynamics of rotors, the aeroelasticity of rotor blades, and the various areas of external noise generation. R.E.P.

A92-48739#
INVESTIGATIONS OF PROPULSION INTEGRATION INTERFERENCE EFFECTS ON A TRANSPORT AIRCRAFT CONFIGURATION
C.-C. ROSSOW (DLR, Institut fuer Entwurfsaerodynamik, Braunschweig, Federal Republic of Germany), J.-L. GODARD (ONERA, Direction de l'Aerodynamique, Chatillon, France), H. HOHEISEL (DLR, Institut fuer Entwurfsaerodynamik, Braunschweig,

Federal Republic of Germany), and V. SCHMITT (ONERA, Direction de l'Aerodynamique, Chatillon, France) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 17 p. refs
(AIAA PAPER 92-3097) Copyright

In a joint effort ONERA and DLR have assessed the interference effects of a genetic twin-engine transport aircraft configuration equipped with throughflow nacelles. Both experimental and theoretical investigations were performed. The results showed that the installation of the nacelles had substantial effects on total forces at cruise Mach number. With respect to the clean configuration, total lift decreased at constant incidence, and total drag increased at constant lift. A detailed analysis of the flowfield revealed that for transonic flows the installation of the nacelle influenced the complete upper wing surface. On the lower wing surface the flow was considerably accelerated due to the propulsion system, and a supersonic region terminated by a shock wave appeared. The nacelle pressure distribution was also substantially influenced by interference effects. Comparison of experimental and numerical results showed that the solution of the Euler equations is well capable of simulating the interference effects. Author

A92-48915#
FIGHTER AIRFRAME/PROPULSION INTEGRATION - A GENERAL DYNAMICS PERSPECTIVE
J. V. KITOWSKI (General Dynamics Corp., Fort Worth, TX) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 14 p. refs
(AIAA PAPER 92-3332) Copyright

General Dynamics Fort Worth Division, along with the General Electric Co., recently completed the initial phase of the Fighter Airframe Propulsion Integration Pre-Design investigation. The study, conducted for the USAF Wright Laboratory addresses the application of Multi-Axis Thrust Vectoring (MATV) technology to derivative configurations of the F-16 aircaraft. This paper summarizes the findings in two key areas: configuration trade studies with associated integration issues and combat effectiveness assessment with benefit-to-cost trends. The configuration trades section considers MATV installation options, perfromance and maneuver improvements, air-frame design impacts, flying qualities, and propulsion/flight controls integration. The combat effectiveness investigation compares mission capabilities of the baseline configuration versus MATV options for selected air-to-air and air-to-ground missions. Author

A92-48916#
FIGHTER AIRFRAME/PROPULSION INTEGRATION - A MCDONNELL AIRCRAFT PERSPECTIVE
JAMES MACE and GREGORY NYBERG (McDonnell Aircraft Co., Saint Louis, MO) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 10 p. refs
(AIAA PAPER 92-3333) Copyright

McDonnell Aircraft is active in integrated aerodynamic/propulsion controls research having flown three demonstrator aircraft (SMTD, HARV, HIDEC/PSC) with thrust vectoring and/or integrated flight/propulsion control devices into new conceptual multimission fighter aircraft has also been examined. It was found that the use of advanced aerodynamic control techniques, multiplane thrust vectoring and flight/propulsion control technologies allowed new strike aircraft concepts to evolve. These concepts have expanded mission capabilities and lower takeoff gross weights when compared to a fighter without the advanced devices. Author

A92-48917#
EMERGING AIRFRAME/PROPULSION INTEGRATION TECHNOLOGIES AT GENERAL ELECTRIC
R. MISHLER and T. WILKINSON (GE Aircraft Engines, Cincinnati, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 12 p. refs
(AIAA PAPER 92-3335) Copyright

The present survey of a major airframe manufacturer's efforts toward military powerplant/airframe integration highlights the design features and performance capabilities of the Axisymmetric Vectoring Exhaust Nozzle (AVEN) for the F-110 engine. In the AVEN, the compression links of the F-110 engine's conventional nozzle is replaced by an external loadcarrying flap/frame system that is connected to a pitch-and-yaw-axis-vectoring ring. All turning of the exhaust flow is accomplished by the divergent section of the nozzle, aft of the (normally choked) nozzle throat; if the rin is translated fore-and-aft rather than tilted, the effect is an opening and closing of the exhaust exit area. O.C.

A92-48941#
AN EIGHT MONTH GEARBOX DEVELOPMENT PROGRAM
GREGORY PEREZ, JR. and ROBERT B. BOSSLER, JR. (Lucas Western, Inc., City of Industry, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 6 p.
(AIAA PAPER 92-3368) Copyright

An engine-mounted accessory-drive gearbox for a new gas turbine engine for commercial aircraft was developed from layout to delivery of the first unit in eight months, rather than the 15 to 18 months normally required. The gearbox drives seven accessories, weighs 50 pounds and has an input of 121 horsepower at 19,837 RPM. The design includes a zerol-type spiral-bevel set and eight spur gears, all carburized and ground. The program required detailed project management, innovative concurrent engineering, manufacturing coordination and careful attention to component lead times. Author

N92-28435*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INTEGRATING AERODYNAMICS AND STRUCTURES IN THE MINIMUM WEIGHT DESIGN OF A SUPERSONIC TRANSPORT WING
JEAN-FRANCOIS M. BARTHELEMY (Lockheed Engineering and Sciences Co., Hampton, VA.), GREGORY A. WRENN (Lockheed Engineering and Sciences Co., Hampton, VA.), AUGUSTINE R. DOVI (Lockheed Engineering and Sciences Co., Hampton, VA.), PETER G. COEN, and LAURA E. HALL (Unisys Corp., Hampton, VA.) Apr. 1992 15 p Presented at the AIAA/ASCE/ASME/AHS/ASC 33rd Structures, Structural Dynamics and Materials Conference, Dallas, TX, 13-15 Apr. 1992
(Contract RTOP 505-63-50-06)
(NASA-TM-107586; NAS 1.15:107586) Avail: CASI HC A03/MF A01

An approach is presented for determining the minimum weight design of aircraft wing models which takes into consideration aerodynamics-structure coupling when calculating both zeroth order information needed for analysis and first order information needed for optimization. When performing sensitivity analysis, coupling is accounted for by using a generalized sensitivity formulation. The results presented show that the aeroelastic effects are calculated properly and noticeably reduce constraint approximation errors. However, for the particular example selected, the error introduced by ignoring aeroelastic effects are not sufficient to significantly affect the convergence of the optimization process. Trade studies are reported that consider different structural materials, internal spar layouts, and panel buckling lengths. For the formulation, model and materials used in this study, an advanced aluminum material produced the lightest design while satisfying the problem constraints. Also, shorter panel buckling lengths resulted in lower weights by permitting smaller panel thicknesses and generally, by unloading the wing skins and loading the spar caps. Finally, straight spars required slightly lower wing weights than angled spars. Author

N92-28468# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Mechanics Panel.
AIRCRAFT SHIP OPERATIONS [LE COUPLE AERONEF-NAVIRE DANS LES OPERATIONS]
J. G. HOEG (Naval Air Test Center, Patuxent River, MD.) Apr. 1992 13 p Presented at the Flight Mechanics Panel Symposium,

Seville, Spain, 20-23 May 1991
(AGARD-AR-312; ISBN-92-835-0668-5) Copyright Avail: CASI HC A03/MF A01

Worldwide interest in the use of shipborne aircraft as a major weapons system is very broad. Many NATO countries operate fixed wing aircraft from ships. Additionally, the use of ships as helicopter platforms is extensive in the NATO community and brings another important dimension to the aircraft/ship interface issue. Thus, it seemed that both fixed and rotary wing aviation deserved equal billing in the Aircraft/Ship Interface Symposium which is the subject of this Technical Evaluation Report. The Symposium contained twenty-five presentations grouped under the following topics: Keynote Addresses; Ship Environment; Guidance, Controls, and Displays; Flight Test and Simulation Techniques; Launch, Recovery, and Handling Systems Development; and Operational Views and Future Developments. Author

N92-28469# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Structures and Materials Panel.
INTEGRATED DESIGN ANALYSIS AND OPTIMISATION OF AIRCRAFT STRUCTURES [L'ANALYSE INTEGRALE DE LA CONCEPTION ET L'OPTIMISATION DES STRUCTURES DES AERONEFS]
May 1992 88 p Lectures held in Pasadena, CA, 8-9 Jun. 1992, in Lisbon, Portugal, 22-23 Jun. 1992, and in London, England, 25-26 Jun. 1992
(AGARD-LS-186; ISBN-92-835-0675-8) Copyright Avail: CASI HC A05/MF A01

There is a lack of precise information on the effectiveness of specific methods in generating optimum designs for realistic aircraft structures. In this situation it is difficult for designers to make decisions on which systems to employ for a given design problem and which developments to pursue. Thus it is necessary for designers to be aware of the relative merits of the different methods currently used for the design optimization of advanced aircraft. This lecture series covers the methods available for the computer based design analysis and design optimization of aircraft structures. The lecture series deals with the principles and practices adopted to integrate the various factors which are considered in the design of advanced aircraft. These factors include: structural shape, aerodynamics, active control technology and aircraft performance.

N92-28470# Cranfield Inst. of Tech., Bedford (England). Dept. of Aerospace Science.
FUNDAMENTALS OF STRUCTURAL OPTIMISATION
A. J. MORRIS *In* AGARD, Integrated Design Analysis and Optimisation of Aircraft Structures 13 p May 1992
Copyright Avail: CASI HC A03/MF A01

Structural optimization is concerned with the computerized automatic design of structures which are optimum with respect to some major design parameter. In the aircraft industry this parameter has usually been structural weight, though cost, performance, or other factors are now being considered. The general problem which is characterized here remains unchanged so that the basic nature of the optimization problem is the same for all applications. Also the structural optimization problem is always characterized by the finite element method (FEM). The use and application of these methods to computer aided design (CAD) requires some understanding of the underlying mathematical principles. It is shown that this process of developing solution methods use the optimization criteria as the basis for creating the up-date formulae which are the solution algorithm drivers. H.A.

N92-28471# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Military Aircraft Div.
PRACTICAL ARCHITECTURE OF DESIGN OPTIMISATION SOFTWARE FOR AIRCRAFT STRUCTURES TAKING THE MBB-LAGRANGE CODE AS AN EXAMPLE
J. KRAMMER *In* AGARD, Integrated Design Analysis and Optimisation of Aircraft Structures 16 p May 1992
Copyright Avail: CASI HC A03/MF A01

The structural optimisation system MBB-Lagrange allows the optimization of homogeneous isotropic, orthotropic or anisotropic structures as well as fiber reinforced materials. With the simultaneous consideration of different requirements in the design of aircraft structures it is possible to reduce the number of iteration steps between design, analysis and manufacturing. Based on finite element methods for structures and panel methods for aerodynamics, the analysis with sensitivity includes modules for static, buckling, dynamic, static aeroelastic and flutter calculations. The optimization algorithms consists of mathematical programming methods and an optimization and analysis/sensitivity is the optimization model which leads to a very modular architecture. Typical application examples show the power and generality of the approach. Author

N92-28472# Dassault (E. M.) Co., Saint Cloud (France).
STRUCTURAL OPTIMIZATION OF AIRCRAFT
C. CORNUAULT and C. PETIAU *In* AGARD, Integrated Design Analysis and Optimisation of Aircraft Structures 17 p May 1992
Copyright Avail: CASI HC A03/MF A01

A general survey of Dassault experience and knowledge on Aircraft Design with Optimization Methods is depicted. This survey results from compiling the developments and the results already worked out and already presented in several papers. Part 1 gives a detailed description of the methodology. The special features of optimization with composite materials are shown. The organization of design resulting from use of optimization techniques is described and techniques neighboring optimization as model adjustment are reviewed, as well as further developments. Part 2 illustrates this methodology by an actual case study of an aircraft design by Dassault-Aviation with relevant examples of structural and aeroelastic optimization on carbon structures of a wing and a fin. Author

N92-28473*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MULTIDISCIPLINARY DESIGN AND OPTIMIZATION
JAROSLAW SOBIESZCZANSKI-SOBIESKI *In* AGARD, Integrated Design Analysis and Optimisation of Aircraft Structures 15 p May 1992 Presented as A System Approach to Aircraft Optimization, Paper No. 2 at the AGARD Workshop on Integrated Design Analysis and Optimization of Aircraft Structures, Bath, England, 1-2 May 1991
(AGARD-PAPER-2) Copyright Avail: CASI HC A03/MF A01

Mutual couplings among the mathematical models of physical phenomena and parts of a system such as an aircraft complicate the design process because each contemplated design change may have a far reaching consequence throughout the system. This paper outlines techniques for computing these influences as system design derivatives useful to both judgmental and formal optimization purposes. The techniques facilitate decomposition of the design process into smaller, more manageable tasks and they form a methodology that can easily fit into existing engineering optimizations and incorporate their design tools. Author

N92-28474# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Military Aircraft Div.
MATHEMATICAL OPTIMIZATION: A POWERFUL TOOL FOR AIRCRAFT DESIGN
OTTO SENSBURG *In* AGARD, Integrated Design Analysis and Optimisation of Aircraft Structures 19 p May 1992
Copyright Avail: CASI HC A03/MF A01

Formal mathematical optimization methods have been developed during the past 10 to 15 years for the structural design of aircraft. Together with reliable analysis programs like finite element methods they provide powerful tools for the structural design. They are efficient in at least two ways: (1) producing designs that meet all specified requirements at minimum weight in one step; and (2) relieving the engineer from a time consuming search for modifications that give better results, they allow more creative design modifications. MBB has developed a powerful optimization code called MBB-Lagrange which uses mathematical programming and gradients to fulfill different constraints simultaneously. Some examples depicting the successful application of the

MBB-LAGRANGE code are presented. Also results of other optimization codes are shown. The paper closes with an outlook on how the optimization problem could be enlarged to include the shape and size of airplanes. Author

N92-28531# Royal Aerospace Establishment, Bedford (England). FMS Div.

VALIDATION OF SIMULATION SYSTEMS FOR AIRCRAFT ACCEPTANCE TESTING

A. A. WOODFIELD *In* AGARD, Piloted Simulation Effectiveness 4 p Feb. 1992

Copyright Avail: CASI HC A01/MF A03

There is currently a limited role for simulation in flight clearance of sub-systems in civil aircraft. However, the extensive use of simulation for manned space vehicle clearance shows the potential for simulation to join other rigs in flight clearance. There is a serious risk that simulation could prove inadequate if there is no systematic validation program. Simulation is a complex integration of models of vehicles and the environment, physical sensation devices and the pilot. Any of these can be modified to compensate for inadequacies in parts of the simulation. This can be acceptable for training simulators but is not acceptable for clearance activities because the influence of such modifications cannot be predicted in situations that are not going to be tested in flight. These issues are discussed. Author

N92-28649# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.

THE USE OF LOAD ENHANCEMENT FACTORS IN THE CERTIFICATION OF COMPOSITE AIRCRAFT STRUCTURES

J. LAMERIS 22 Feb. 1990 60 p

(Contract OV/RLD-987)

(NLR-TP-90068-U; ETN-92-91432) Avail: CASI HC A04/MF A01

In the full scale durability and damage tolerance tests of composite aircraft structures, the U.S. and European certification requirements demand among other things that the number of cycles applied are statistically significant and that the influence of the environment has been taken into account. Several certification methods which take into account the requirement of having sufficient statistically reliable data are described. A review of the way in which these requirements are interpreted and applied in four composite aircraft certification programs in particular with regard to the application of so called enhancement factors is given. ESA

N92-28687# National Aerospace Lab., Amsterdam (Netherlands). Aerodynamics Div.

LAH-MAIN ROTOR MODEL TEST AT THE DNW

J. W. G. VANNUNEN (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.).), C. HERMANS (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.).), and H.-J. LANGER (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany, F.R.) 10 Aug. 1990 14 p Presented at the 16th European Rotorcraft Forum, Glasgow, Scotland, 18-21 Sep. 1990 Previously announced in IAA as A92-35771

(NLR-TP-90305-U; ETN-92-91446) Avail: CASI HC A03/MF A01

In the context of a feasibility and cost definition study for the A129 LAH, a wind tunnel experiment was executed in the wind tunnel on a dynamically and Mach scaled mode of the main rotor. The tests aimed at getting more reliable answers to the question of which of the proposed rotor configurations would fulfil the stringent flight performance requirements of the new helicopter best. The rotor diameter amounted to 3.5 m. Four different rotor configurations were examined, the variations being either in the blade tip shape or in the twist distribution along the span of the blade. The dynamic characteristics of the various blade configurations were found to agree reasonably well. An exception in this respect should only be made for those blade configurations that have swept back tips. These specific blades exhibit definitely lower torsional frequencies than comparable blades with straight tips. The rotor torque measured on the model rotor correlates well up to 130 kts with the torque as determined during flight tests. Comparing the different rotor configurations considered during the present test, the high twist blade set is found to produce the highest vibration levels at the higher advance ratios. ESA

N92-28714# National Aerospace Lab., Amsterdam (Netherlands). Dept. of Flight Testing and Helicopters.

S-76B CERTIFICATION FOR VERTICAL TAKE-OFF AND LANDING OPERATIONS FROM CONFINED AREAS

J. M. G. F. STEVENS and H. J. G. C. VODEGEL 16 Aug. 1990 20 p Presented at 16th European Rotorcraft Forum, Glasgow, Scotland, 18-21 Sep. 1990 Previously announced in IAA as A92-35760

(NLR-TP-90286-U; ETN-92-91544) Avail: CASI HC A03/MF A01

Data necessary for certification of vertical operations for the Sikorsky S-76B were generated. A computer simulation program was used to calculate two dimensional flight trajectories after an engine failure during takeoff or landing. Based on the initial results of computer simulations, flight tests were carried out during which single engine failure was simulated. Test data were recorded by video on board and on the ground. Calculated and flight test data were in good agreement over the considered range of masses, maneuvers and atmospheric conditions. Procedures for Category A vertical operations with the S-76B were determined with the use of the computer program. ESA

N92-28720*# Kansas Univ. Center for Research, Inc., Lawrence. Flight Research Lab.

IDENTIFICATION OF AERODYNAMIC MODELS FOR MANEUVERING AIRCRAFT Final Report

C. EDWARD LAN and C. C. HU 30 Jun. 1992 101 p

(Contract NAG1-1087)

(NASA-CR-190444; NAS 1.26:190444; KU-FRL-872-5) Avail: CASI HC A06/MF A02

The method based on Fourier functional analysis and indicial formulation for aerodynamic modeling as proposed by Chin and Lan is extensively examined and improved for the purpose of general applications to realistic airplane configurations. Improvement is made to automate the calculation of model coefficients, and to evaluate more accurately the indicial integral. Test data of large angle-of-attack ranges for two different models, a 70 deg. delta wing and an F-18 model, are used to further verify the applicability of Fourier functional analysis and validate the indicial formulation. The results show that the general expression for harmonic motions throughout a range of k is capable of accurately modeling the nonlinear responses with large phase lag except in the region where an inconsistent hysteresis behavior from one frequency to the other occurs. The results by the indicial formulation indicate that more accurate results can be obtained when the motion starts from a low angle of attack where hysteresis effect is not important. Author

N92-28721*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

THERMAL RESPONSE OF RIGID AND FLEXIBLE INSULATIONS AND REFLECTIVE COATING IN AN AEROCONVECTIVE HEATING ENVIRONMENT

D. A. KOURTIDES, S. A. CHIU, D. J. IVERSON, and D. M. LOWE Mar. 1992 81 p

(Contract RTOP 506-43-31)

(NASA-TM-103925; A-92064; NAS 1.15:103925) Avail: CASI HC A05/MF A01

Described here is the thermal performance of rigid and flexible thermal protection systems considered for potential use in future Aeroassist Space Transfer Vehicles. The thermal response of these materials subjected to aeroconvective heating from a plasma arc is described. Properties that were measured included the thermal conductivity of both rigid and flexible insulations at various temperatures and pressures and the emissivity of the fabrics used in the flexible insulations. The results from computerized thermal analysis models describing the thermal response of these materials subjected to flight conditions are included. Author

N92-28771# Aeronautical Research Labs., Melbourne (Australia).
REDUCTION AND ANALYSIS OF F-111C FLIGHT DATA
P. PIPERIAS Dec. 1991 51 p
(AD-A250341; ARL-STRUC-TM-544; DODA-AR-006-633) Avail: CASI HC A04/MF A01

As part of a program to determine inspection intervals for the stiffener runout regions of the upper plates of the wing pivot fittings of RAAF F-111 aircraft, the possible influence on crack growth of stores carried and of low and negative g-spectrum loading has been examined for reconnaissance aircraft, the remaining F-111 fleet, and for aircraft A8-148. Derived gust loading spectra for the same F-111 groups have also been determined. GRA

N92-28802# Naval Postgraduate School, Monterey, CA.
TASKING AND COMMUNICATION FLOWS IN THE F/A-18D COCKPIT: ISSUES, PROBLEMS, AND POSSIBLE SOLUTIONS M.S. Thesis
MARK F. MCKEON Sep. 1991 77 p
(AD-A245977) Avail: CASI HC A05/MF A01

The U.S. Marine Corps is replacing its A-6E TRAM aircraft with the two seat F/A-18D. With the exception of the F-15E Strike Eagle, never has a tactical aircraft been capable of processing such a vast amount of multi-mission data and displaying that fighter/attack information to the aircrew. These vast capabilities have led to some problems in the area of F/A-18D aircrew coordination. This thesis will review communication flows and tasking procedures that exist in many Group Decision Support Systems (GDSS) to develop guidelines that are applicable to tactical aircraft aircrew coordination procedures. These guidelines will then be applied to combat mission essential F/A-18D cockpit communication and tasking procedures that should be executed during various scenarios. Additionally, simulator flight profiles will be postulated to test, evaluate and verify these procedures. This study provides a framework on combat procedures that will not only benefit the Marine Corps' F/A-18D community, but as they start bringing into their inventory the two sea F/A-18E/F, the U.S. Navy as well. Author (GRA)

N92-28901# National Aerospace Lab., Tokyo (Japan). Flight Test Team.
AERODYNAMIC CHARACTERISTICS OBTAINED FROM ALPHA SWEEP TEST OF THE QUIET STOL EXPERIMENTAL AIRCRAFT ASKA
TOSHIO BANDOU May 1991 67 p In JAPANESE
(ISSN 0389-4010)
(NAL-TR-1112; JTN-92-80381) Avail: CASI HC A04/MF A01

Longitudinal aerodynamic characteristics are one of the most important considerations in aircraft design. Using the NAL Short Take Off and Landing (STOL) experimental aircraft, ASKA, an alpha sweep method was adopted instead of using the conventional discrete method to investigate ASKA's longitudinal aerodynamic characteristics. ASKA's longitudinal aerodynamic characteristics are described based on analysis of the test results. In addition, longitudinal aerodynamic coefficients obtained from flight tests are compared with the ASKA's wind tunnel design configuration. ASKA showed a pitch up phenomena during shallow Upper Surface Blowing (USB) flap angles, and also encountered path divergence in the flaps up configuration, being a significant phenomena for a powered lift aircraft. Powered lift aircraft's lift coefficient consists of basic lift due to wing and flaps, direct jet thrust, and supercirculation. This lift build-up is described using calculation results of flight test data. The powered lift factor, a key parameter for powered lift aircraft, is also described. Author (NASDA)

N92-28910*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
BINARY OPTICAL FILTERS FOR SCALE INVARIANT PATTERN RECOGNITION
MAX B. REID, JOHN D. DOWNIE, and BUTLER P. HINE Apr. 1992 12 p
(Contract RTOP 506-51-31)
(NASA-TM-103902; A-92014; NAS 1.15:103902) Avail: CASI HC A03/MF A01

Binary synthetic discriminant function (BSDF) optical filters which are invariant to scale changes in the target object of more than 50 percent are demonstrated in simulation and experiment. Efficient databases of scale invariant BSDF filters can be designed which discriminate between two very similar objects at any view scaled over a factor of 2 or more. The BSDF technique has considerable advantages over other methods for achieving scale invariant object recognition, as it also allows determination of the object's scale. In addition to scale, the technique can be used to design recognition systems invariant to other geometric distortions. Author

N92-28926*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ROTORCRAFT IN-FLIGHT SIMULATION RESEARCH AT NASA AMES RESEARCH CENTER: A REVIEW OF THE 1980'S AND PLANS FOR THE 1990'S
EDWIN W. AIKEN, WILLIAM S. HINDSON, J. VICTOR LEBACQZ, DALLAS G. DENERY, and MICHELLE M. ESHOW (Army Aviation Systems Command, Moffett Field, CA.) Aug. 1991 15 p Presented at the International Symposium on In-Flight Simulation for the 1990's, Braunschweig, Germany, 1-3 Jul. 1991 Sponsored in part by Army Aviation Systems Command, St. Louis, MO
(Contract RTOP 505-59-36)
(NASA-TM-103873; A-91178; NAS 1.15:103873) Avail: CASI HC A03/MF A01

A new flight research vehicle, the Rotorcraft-Aircrew System Concepts Airborne Laboratory (RASCAL), is being developed by the U.S. Army and NASA at ARC. The requirements for this new facility stem from a perception of rotorcraft system technology requirements for the next decade together with operational experience with the Boeing Vertol CH-47B research helicopter that was operated as an in-flight simulator at ARC during the past 10 years. Accordingly, both the principal design features of the CH-47B variable-stability system and the flight-control and cockpit-display programs that were conducted using this aircraft at ARC are reviewed. Another U.S Army helicopter, a Sikorsky UH-60A Black Hawk, was selected as the baseline vehicle for the RASCAL. The research programs that influence the design of the RASCAL are summarized, and the resultant requirements for the RASCAL research system are described. These research programs include investigations of advanced, integrated control concepts for achieving high levels of agility and maneuverability, and guidance technologies, employing computer/sensor-aiding, designed to assist the pilot during low-altitude flight in conditions of limited visibility. The approach to the development of the new facility is presented and selected plans for the preliminary design of the RASCAL are described. Author

N92-29110*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, CA.
IN-FLIGHT SIMULATION STUDIES AT THE NASA DRYDEN FLIGHT RESEARCH FACILITY
MARY F. SHAFER Jul. 1992 20 p Presented at the AIAA Simulation Technology Conference, New Orleans, LA, 12-14 Aug. 1991
(Contract RTOP 505-64-30)
(NASA-TM-4396; H-1833; NAS 1.15:4396) Copyright Avail: CASI HC A03/MF A01

Since the late 1950's, the National Aeronautics and Space Administration's Dryden Flight Research Facility has found in-flight simulation to be an invaluable tool. In-flight simulation has been used to address a wide variety of flying qualities questions, including low-lift-to-drag ratio approach characteristics for vehicles like the X-15, the lifting bodies, and the Space Shuttle; the effects of time delays on controllability of aircraft with digital flight-control systems, the causes and cures of pilot-induced oscillation in a variety of aircraft, and flight-control systems for such diverse aircraft as the X-15 and the X-29. In-flight simulation has also been used to anticipate problems and to avoid them and to solve problems once they appear. Presented here is an account of the in-flight simulation at the Dryden Flight Research Facility and some discussion. An extensive bibliography is included. Author

N92-29180# Battelle Memorial Inst., Columbus, OH.
GENERATION OF SPECTRA AND STRESS HISTORIES FOR FATIGUE AND DAMAGE TOLERANCE ANALYSIS OF FUSELAGE REPAIRS Final Report
DAVID BROEK, SAMUEL H. SMITH, and RICHARD C. RICE Oct. 1991 55 p
(Contract DTRS-57-89-C-00006)
(AD-A250390; DOT/VNTSC-FAA-91-16) Avail: CASI HC A04/MF A01

This report describes a simplified procedure for the development of stress histories for use in the analysis of aircraft repairs. This report concentrates on stress histories for fuselage skin repairs. A description of typical fuselage loadings is provided, and basic fuselage stress histories are described. A method for development of an exceedance diagram for analysis of fuselage skin repairs is detailed. Subsequently, a methodology for generating detailed stress histories is reviewed. Some of the key features are (1) the inclusion of a range of flights of different severities, (2) the inclusion of deterministic loads where they occur, e.g., ground-air-ground cycles, (3) the use of a near-optimum number of stress levels (10-16 positive and negative), (4) the combination of positive and negative excursions of equal frequency, and (5) matching of the total number of flights and cycles with the total exceedance diagram. Two methods of estimating fuselage skin stresses are presented, the first based on static equilibrium requirements and the second based on a limit load analysis. A comparison of the proposed history generation scheme with that of an airframe manufacturer for the KC-135 is also presented. The predicted fatigue crack growth patterns for a hypothetical through crack at a fastener hole are compared for the two history generation schemes at three areas within a fuselage. GRA

N92-29417*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
IMPROVING DESIGNER PRODUCTIVITY
GARY C. HILL Feb. 1992 13 p
(Contract RTOP 505-69-50)
(NASA-TM-103929; A-92081; NAS 1.15:103929) Copyright Avail: CASI HC A03/MF A01

Designer and design team productivity improves with skill, experience, and the tools available. The design process involves numerous trials and errors, analyses, refinements, and addition of details. Computerized tools have greatly speeded the analysis, and now new theories and methods, emerging under the label Artificial Intelligence (AI), are being used to automate skill and experience. These tools improve designer productivity by capturing experience, emulating recognized skillful designers, and making the essence of complex programs easier to grasp. This paper outlines the aircraft design process in today's technology and business climate, presenting some of the challenges ahead and some of the promising AI methods for meeting these challenges. Author

N92-29511# Washington Univ., Seattle. Dept. of Mechanical Engineering.
TEAR STRAPS IN AIRPLANE FUSELAGE
M. KOSAI, A. S. KOBAYASHI, and M. RAMULU Mar. 1992 15 p
(Contract N00014-89-J-1276)
(AD-A248543; UWA/DME/TR-92/68) Avail: CASI HC A03/MF A01

A procedure based on dynamic fracture mechanics is proposed for assessing the effectiveness of tear straps in a rupturing airplane fuselage weakened by a row of multiple site damage (MSD). A large deformation, elastic-plastic finite element model of the rupturing fuselage with an unsymmetrical crack flap is used to demonstrate the existence of a mixed mode 1 and 2 crack tip deformation and a large axial stress preceding the propagating crack. These numerical results were used to evaluate the dynamic crack curving and crack arrest criteria and hence to assess the possibility of crack curving as the crack approaches a tear strap without the presence of MSD. GRA

N92-29616# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
RESULTS OF A FLIGHT SIMULATOR EXPERIMENT TO ESTABLISH HANDLING QUALITY GUIDELINES FOR THE DESIGN OF FUTURE TRANSPORT AIRCRAFT
J. A. J. VANENGELEN 8 Jul. 1988 18 p Presented at the AIAA Flight Mechanics Conference, Minneapolis, MN, 15-17 Aug. 1988
(NLR-MP-88044-U; GARTEUR-TP-051; ETN-92-91514) Avail: CASI HC A03/MF A01

An experiment on a flight simulator is presented. The main results are discussed and compared with the contemporary handling qualities criteria used to design the flight control system. The experiment was defined and executed in moving base flight simulator. Emphasis of this experiment was put on longitudinal handling qualities. Test pilots evaluated 2 primary and 2 backup systems during a 3 day period in 2 levels of environment disturbances. Fully electrical fly by wire flight control systems stabilize the aircraft and enable the pilot to directly control a predetermined flight parameter. The necessary control surface deflection is determined by an onboard computer. For such advanced aircraft it is imperative to investigate whether existing handling qualities criteria can still be used for the design of primary and backup system, and particularly, whether guidelines are required to cover the change introduced when a failure occurs and the flight control system reverts to a backup system with different characteristics. ESA

N92-29650# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Aircraft Div.
CONCURRENT ENGINEERING IN DESIGN OF AIRCRAFT STRUCTURES
J. KRAMMER, O. SENSBURG, J. VILSMEIER, and G. BERCHTOLD 27 Sep. 1991 36 p Presented at the 73rd AGARD Structures and Materials Panel Meeting, San Diego, CA, 7-11 Oct. 1991
(MBB-FE-2-S-PUB-472; ETN-92-91500) Copyright Avail: CASI HC A03/MF A01

The concurrent engineering idea in design of aircraft structures is explained and its meaning is depicted by showing several examples from the design and manufacturing process for new airplanes. Time and cost savings can be achieved if the concurrent engineering philosophies are also applied very early to cover reliability and supportability aspects. ESA

N92-30209*# Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering and Mechanics.
NONLINEAR ANALYSES OF COMPOSITE AEROSPACE STRUCTURES IN SONIC FATIGUE Progress Report, 16 Dec. 1991 - 15 Jun. 1992
CHUH MEI 15 Jun. 1992 13 p
(Contract NAG1-1358)
(NASA-CR-190565; NAS 1.26:190565) Avail: CASI HC A03/MF A01

The primary research effort of this project is the development of analytical methods for the prediction of nonlinear random response of composite aerospace structures subjected to combined acoustic and thermal loads. The progress, accomplishments, and future plans of three random response research topics are discussed, namely acoustics-structure interactions using boundary/finite element methods, nonlinear vibrations of beams and composite plates under harmonic and random excitations, and numerical simulation of the nonlinear response of composite plates under combined thermal and acoustic loading. Author

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A92-44922
EICAS IN AN INTEGRATED COCKPIT
JANALEE M. KOSOWSKI (Rockwell International Corp., Cedar Rapids, IA) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 1. Columbus, OH, Ohio State University, 1991, p. 166-171. refs

The primary objective of all the information that is available in the modern commercial cockpit is to fly the aircraft safety by providing the pilot with the pertinent information needed, when it is needed. The secondary objective is to operate the aircraft efficiently. Because of these objectives, the goal of EICAS (Engine Indication Crew Alerting System) is to assist the pilot in assimilating, interpreting, prioritizing, and acting upon the large amount information that is available. In the design phase of an EICAS development program, careful attention must be paid to the various methods used to present information to the pilot. Since the largest portion of all air traffic accidents are attributed to 'pilot error', careful attention to human factors during the design phase of these cockpit information systems will help reduce the potential for these types of errors. Author

A92-44923
ELECTRONIC PRESENTATION OF INSTRUMENT APPROACH INFORMATION
MARK G. MYKITYSHYN, JAMES K. KUCHAR, and R. J. HANSMAN, JR. (MIT, Cambridge, MA) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 1. Columbus, OH, Ohio State University, 1991, p. 172-177. refs
(Contract FAA-ADS-210; DTRS-57-88-C-0078)

Experiments were designed to study several human factors issues associated with the presentation of high density Instrument Approach Plate (IAP) navigation information to the pilot that are induced by the capabilities, flexibilities, and limitations of electronic systems. The experiments were designed to address issues that include the impact of presentation modalities on pilot preference and information retrieval performance. Preliminary results indicate that there appears to be no loss of performance and possibly a limited gain in performance when the IAP information is presented electronically. R.E.P.

A92-44929
THE STANDARDIZATION OF MILITARY HEAD-UP DISPLAY SYMBOLOGY
LISA F. WEINSTEIN and WILLIAM R. ERCOLINE (Krug Life Sciences, San Antonio, TX) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 1. Columbus, OH, Ohio State University, 1991, p. 210-215. refs

Although initially intended for the presentation of landing and weapons delivery information, the HUD has evolved into a flight instrument that researchers and pilots claim is successfully replacing many of the traditional panel instruments. Since the Attitude Awareness Workshop of 1985, USAF had conducted numerous research projects to determine the most effective way to integrate the HUD with the other mission-essential instrument displays. The requirement to use the HUD for instrument flight, as well as a need to determine the optimal layout for the HUD symbols, has prompted a significant portion of that research. This paper summarizes many of the research efforts conducted, conclusions reached, and issues yet to be resolved. In addition, the paper outlines the current USAF position for using the HUD. Suggested standardization guidelines based on empirical findings are discussed, including: the use of vertical and horizontal asymmetry for pitch-ladder configurations, quickening, and counter-pointers for airspeed and altitude indicators. Current research efforts that will be completed in the coming year are also described. These efforts include simulator studies and inflight validation. Author

A92-45374
RADIOALTIMETER RWL-750 [RADIOWYSOKOSCIOMIERZ RWL-750]
ANDRZEJ ZAKRENT (Instytut Lotnictwa, Warsaw, Poland) Instytut Lotnictwa, Prace (ISSN 0509-6669), no. 128, 1992, p. 38-60. In Polish. refs

The principle of operation of a radioaltimeter with a continuous frequency-modulated wave as well as sources of errors of these devices are discussed. Construction of a new radioaltimeter, type RWL-750, is described with particular regard to the interference eliminating system. The original impulse selector considerably simplifies the radioaltimeter signal processing system. Results of in-flight tests of radioaltimeter RWL-750 prototyes are presented. Author

A92-45449
A SIMULATOR STUDY OF A FLIGHT REFERENCE DISPLAY FOR POWERED-LIFT STOL AIRCRAFT
KEIJI TANAKA, HIROYASU KAWAHARA, MASARU NAKAMURA, and YUSHI TERUI (National Aerospace Laboratory, Chofu, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 805-814. refs
(SAE PAPER 912067) Copyright

The display design was aimed at providing pilots with new control cues for keeping its flight safety in low-speed and high-power approach. The display utilizes the angle of attack, pitch angle, and airspeed to indicate the flight reference for maintaining the flight safety margins. The display integrates the flight reference into an analogue airspeed scale. Results of the piloted simulation confirmed that performance of the display was satisfactory for both flight reference tracking and safety margin monitoring, and proper values of coefficients of the display equations were obtained. Author

A92-46227
A HIGH-PERFORMANCE LLLTV CCD CAMERA FOR NIGHTTIME PILOTAGE
GEORGE M. WILLIAMS, JR. (ITT Defense, ITT Electro-Optical Products Div., Roanoke, VA) IN: Electron tubes and image intensifiers; Proceedings of the Meeting, San Jose, CA, Feb. 10, 11, 1992. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1992, p. 14-32. refs
Copyright

An intensified CCD is shown to provide optimal performance available for low light level TV application by eliminating all fiberoptic-to-fiberoptic interfaces and improving gain and resolution. Fabricating the fiberoptic taper into the vacuum of the image tube allows for only one optical coupling - at the CCD surface. During the fabrication, the fiberoptic taper pore size and orientation is maximized to provide optimal MTF and reduce more patterns. The high resolution and high sensitivity overcomes the shortcomings that normally prohibit the use of intensified CCD cameras while providing imagery comparable to that of the Aviator Night Vision Imaging System. C.D.

A92-46243
FIBRE OPTIC ROTARY POSITION SENSORS FOR VEHICLE AND PROPULSION CONTROLS
PETER T. GARDINER (Smiths Industries Aerospace & Defence Systems, Ltd., London, England) IN: Integrated optics and optoelectronics II; Proceedings of the Meeting, San Jose, CA, Sept. 17-19, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1991, p. 200-210.
Copyright

The requirements for displacement sensing and the way in which fiber-optic sensing technology can be harnessed to meet these requirements are examined. A particular design technique, a WDM digital encoding structure, is reviewed. A schematic of a typical aircraft control system is shown which illustates where displacement sensors are needed, both for pilot input and for positional feedback in actuators. Parameters include: point measurement, high precision (0.1 resolution, +/- 0.5 percent accuracy), absolute measurement (no recalibration after power down, compact rugged package, and interchangeability). The device can provide an unambiguous absolute reading of physical parameters, immune to source fluctuations and varying losses in the system. C.A.B.

A92-46244* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FIBER OPTIC CONTROLS FOR AIRCRAFT ENGINES - ISSUES AND IMPLICATIONS
SAMHITA DASGUPTA, GARY L. POPPEL, and WILLIAM P. ANDERSON (GE Aircraft Engines, Cincinnati, OH) IN: Integrated optics and optoelectronics II; Proceedings of the Meeting, San Jose, CA, Sept. 17-19, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1991, p. 211-222. refs
(Contract NAS3-25344)
Copyright

Some of the issues involved with the application of fiber-optic controls for aircraft engines in the harsh operating environment are addressed, with emphasis on fiber-optic temperature, pressure, position, and speed sensors. Criteria are established to evaluate the optical modulation technique, the sensor/control unit interconnection, and the electrooptic architecture. Single mode and polarization dependent sensor types, sensors which depend on the reflection and/or transmission of light through the engine environment, and intensity-based analog sensors are eliminated as a possible candidate for engine implementation. Fiber-optic harnesses tested for their optical integrity, temperature stability, and mechanical strength, exhibit a capacity to meet mechanical strength requirements and still gain a significant reduction in cable weight. C.A.B.

A92-46246* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
POTENTIAL FOR INTEGRATED OPTICAL CIRCUITS IN ADVANCED AIRCRAFT WITH FIBER OPTIC CONTROL AND MONITORING SYSTEMS
ROBERT BAUMBICK (NASA, Lewis Research Center, Cleveland, OH) IN: Integrated optics and optoelectronics II; Proceedings of the Meeting, San Jose, CA, Sept. 17-19, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1991, p. 238-250. refs
Copyright

The current Fiber Optic Control System Integration (FOCSI) program is reviewed and the potential role of IOCs in FOCSI applications is described. The program is intended for building, environmentally testing, and demonstrating operation in piggyback flight tests (no active control with optical sensors) of a representative sensor system for propulsion and flight control. The optical sensor systems are to be designed to fit alongside the bill-of-materials sensors for comparison. The sensors are to be connected to electrooptic architecture cards which will contain the optical sources and detectors to recover and process the modulated optical signals. The FOCSI program is to collect data on the behavior of passive optical sensor systems in a flight environment and provide valuable information on installation amd maintenance problems for this technology, as well as component survivability (light sources, connectors, optical fibers, etc.). C.A.B.

A92-46247
THE USE OF OPTICAL SENSORS AND SIGNAL PROCESSING GAS TURBINE ENGINES
IAN DAVINSON (Rolls-Royce, PLC, Derby, England) IN: Integrated optics and optoelectronics II; Proceedings of the Meeting, San Jose, CA, Sept. 17-19, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1991, p. 251-265. refs
Copyright

The paper describes the application of optical measurement techniques to aircraft engine testing, including measurement profiles for turbine blade tip clearance, compressor blade vibration, fan blade profile, turbine blade temperature, and flow diagnostics. The signal and data processing associated with these techniques is emphasized and the prospects for further extending the use of optical methods on ground test and flight engines is discussed. The possibility of applying optical processing techniques is also addressed, with emphsis on high-temperature pressure sensors, efficiency measurements in multistage compressors, improved shaft timing probes, control sensors, and optical signal processing. C.A.B.

A92-46449
THROUGH THE LOOKING GLASS
HARRY HOPKINS Flight International (ISSN 0015-3710), vol. 141, no. 4321, June 3, 1992, p. 27-30.
Copyright

A review is presented of the development that has evolved in electronic flight instrument systems since the first civil color system saw commercial service a decade ago. Attention is given to the development of an electronic library system to integrate various data from navigation agencies, manufacturers and operators. R.E.P.

A92-46736
WIDEBAND CONTROL OF GYRO/ACCELEROMETER MULTISENSORS IN A STRAPDOWN GUIDANCE SYSTEM
PIERRE CONSTANCIS (Societe d'Applications Generales d'Electricite et de Mecanique, Cergy-Pontoise, France) and MICHEL SORINE (INRIA, Le Chesnay, France) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 4, July-Aug. 1992, p. 855-860. Previously cited in issue 23, p. 3614, Accession no. A89-52540. refs
Copyright

A92-46792 National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
AIRDATA CALIBRATION TECHNIQUES FOR MEASURING ATMOSPHERIC WIND PROFILES
EDWARD A. HAERING, JR. (NASA, Flight Research Center, Edwards, CA) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 632-639. Previously announced in STAR as N90-14228. refs
(Contract RTOP 505-68-31)
Copyright

The research airdata system of an instrumented F-104 aircraft has been calibrated to measure winds aloft in support of the Space Shuttle wind measurement investigation at the National Aeronautics and Space Administration Ames Research Center Dryden Flight Research Facility. For this investigation, wind measurement accuracies comparable to those obtained from Jimsphere balloons were desired. This required an airdata calibration more accurate than needed for most aircraft research programs. The F-104 aircraft was equipped with a research pilot-static noseboom with integral angle-of-attack and flank angle-of-attack vanes and a ring-laser-gyro inertial reference unit. Tower fly-bys and radar acceleration-decelerations were used to calibrate Mach number and total temperature. Angle of attack and angle of side slip were calibrated with a trajectory reconstruction technique using a multiple-state linear Kalman filter. The F-104 aircrat and instrumentation configuration, flight test maneuvers, data corrections, calibration techniques, and resulting calibrations and data repeatability are presented. Recommendations for future airdata systems on aircraft used to measure winds aloft are also given. Author

A92-47538
COMMON AIRBORNE INSTRUMENTATION SYSTEM (CAIS)
RAYMOND J. FAULSTICH (U.S. Navy, Naval Air Test Center, Patuxent River, MD) IN: ITC/USA/'91; Proceedings of the International Telemetering Conference, Las Vegas, NV, Nov. 4-7,

1991. Research Triangle Park, NC, Instrument Society of America, 1991, p. 471-478.
Copyright
The principal design features and the main components of the CAIS system, which is being developed to meet the flight test needs of the Air Force, Army, and Navy into the 21st century, are described. The CAIS is conceived as a time-division multiplexed data acquisition system comprised of a standard modular complement of hardware and software and intended for use on both existing and future aircraft. CAIS will not be airframe or weapon system dependent nor will its use be restricted to any test and evaluation activity. The proposed system architecture insures CAIS longevity through its openness and flexibility to accomodate future requirements. V.L.

A92-47560
MODERN TECHNIQUES FOR MONITORING AIRBORNE TELEMETRY
HAIM BERGER and JACOB SCHECHTER (Israel Aircraft Industries, Ltd., Beer Yaakov) IN: ITC/USA/'91; Proceedings of the International Telemetering Conference, Las Vegas, NV, Nov. 4-7, 1991. Research Triangle Park, NC, Instrument Society of America, 1991, p. 693-703.
Copyright
A new integration concept for telemetry systems is proposed whereby various sensors, buses, and distributed processing subsystems are integrated into a single serial bus using a master/slave configuration. The approach is based on the use of the PCM Frame formatter (PFF) VLSI chip, which can be installed in each subsystem, CPU board, or PCM multiplexer. The PFF can operate as a stand-alone device in a single acquisition system or be networked in a master/slave configuration. The advantages of the integrated method are discussed. V.L.

A92-48041
FIBER-OPTIC POSITION TRANSDUCERS FOR AIRCRAFT CONTROLS
WALTER L. GLOMB, JR. (United Technologies Research Center, East Hartford, CT) IN: Fiber optic and laser sensors VIII; Proceedings of the Meeting, San Jose, CA, Sept. 17-19, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1991, p. 162-164. refs
Copyright
Results of 15-year development of fiber-optic position transducers for aircraft controls are reviewed. Special attention is given to the performance requirements for position transducers and the variety of presently available fiber-optic position transducer technologies (including digital optical code plates, analog optical code plates, chirped diffraction gratings, macrobend loss coils, polarizers, interferometers, and optically powered electronic sensors). The performances of these devices are compared and flight test experience is reviewed. I.S.

A92-48042
APPLICATION OF ANALOG FIBER OPTIC POSITION SENSORS TO FLIGHT CONTROL SYSTEMS
GLEN E. MILLER (Boeing Aerospace and Electronics High Technology Center, Seattle, WA) IN: Fiber optic and laser sensors VIII; Proceedings of the Meeting, San Jose, CA, Sept. 17-19, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1991, p. 165-173. refs
Copyright
The relative advantages and disadvantages of analog and digital fiber-optic sensors as they apply to flight controls are examined. It is concluded that, if it were not for high connector loss, several existing analog sensor designs would be satisfactory. A novel analog sensor is described, which incorporates corrections of several deficiencies commonly associated with fiber-optic analog sensors. I.S.

A92-48043
MULTI-ANALOG TRACK FIBER COUPLED POSITION SENSOR
RAYMOND W. HUGGINS (Boeing Aerospace and Electronics High Technology Center, Seattle, WA) IN: Fiber optic and laser sensors VIII; Proceedings of the Meeting, San Jose, CA, Sept. 17-19, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1991, p. 174-180. refs
Copyright
A high-precision fiber-coupled resolver is described which incorporates a new mechanical analog encoding concept: the resolver has three variable modulus (6, 10, 15) analog tracks encoded using a weighted number system. The resolver uses a simple optical system and wavelength division multiplexing and is capable of 0.1 deg resolution, while requiring only 3 percent analog stability. Degradation characteristics of the resolver compare favorably with those of an analog sensor. I.S.

A92-48044
FIBER OPTIC SPEED SENSOR FOR ADVANCED GAS TURBINE ENGINE CONTROL
DEEPAK VARESHNYA, JOHN L. MAIDA (Teledyne Ryan Electronics, San Diego, CA), and MARK A. OVERSTREET (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) IN: Fiber optic and laser sensors VIII; Proceedings of the Meeting, San Jose, CA, Sept. 17-19, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1991, p. 181-191. refs
Copyright
A fiber optic speed sensor (FOSS) has been developed, bench tested and rig tested in a real turbine airflow environment. The FOSS employs an innovative design using a pressure tube and fiber optic microbend transducer in order to capture turbine blade pass wake frequency. The blade pass frequency can be converted by a signal processor into turbine rotational speed. The FOSS offers unique potential to meet future requirements for performance (0 to 25 KHz) and environmental tolerance (1200 F temperatures and EMI/EMP threats). Future efforts include development of the signal processor and environmental/durability testing focused on developing reliable, long life operation in the hostile environment of an advanced gas turbine engine. Author

A92-48046
WAVELENGTH ENCODED FIBER OPTIC ANGULAR DISPLACEMENT SENSOR
WILLIAM B. SPILLMAN, JR., ROBERT E. RUDD, III, FREDERICK G. HOFF, DOUGLAS R. PATRIQUIN, and JEFFREY R. LORD (Simmonds Precision Aircraft Systems, Vergennes, VT) IN: Fiber optic and laser sensors VIII; Proceedings of the Meeting, San Jose, CA, Sept. 17-19, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1991, p. 197-203. refs
Copyright
The fiber-optic angular displacement sensor which will be employed in new (i.e., introduced after 1995) commercial aircraft is described with special attention given to the theory of sensor operation. The device utilizes the wavelength filtering properties of diffraction gratings that are fabricated to have periods that vary along the grating length. The diffraction grating is attached to the interior of a rotatable element; rotation of the element or anything to which it is attached has the result that the bandpass wavelength of the sensor is modulated due to the change in the grating segment being illuminated. The sensor performance was quantified experimentally, and a comparison is made between this sensor and the existing sensor technology. I.S.

A92-48047
FIBER-OPTIC PRESSURE SENSOR SYSTEM FOR GAS TURBINE ENGINE CONTROL
LAURENCE N. WESSON, NELLIE L. CABATO, NICHOLSON L. PINE (Aurora Optics, Inc., Blue Bell, PA), and VICTOR J. BIRD (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) IN: Fiber optic and laser sensors VIII; Proceedings of the Meeting, San Jose, CA, Sept. 17-19, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1991, p. 204-213. Research supported by General Motors Corp. refs
Copyright
The design and the principles of operation of a high-performance fiber-optic pressure sensor system being developed for

gas-turbine-engine control are described. The system consists of four sensors, which convert differential pressure into bending stress in transparent plates; the bending stress is then measured by its effect on polarized light transmitted through the plates. The sensors are designed for accurate on-engine operation at temperatures from -55 to +800 C. The sensor design employs fused silica and Inconel 718, and the fiber cable materials include metal-coated fiber, ceramics, and stainless steel. I.S.

A92-48427

MODULAR AVIONICS - A COMMERCIAL PERSPECTIVE

JOHN R. TODD (Douglas Aircraft Co., Long Beach, CA) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 36-42.

Copyright

Modular avionics are in the process of supplanting traditional LRU (line replaceable unit) based avionics on new military aircraft and will see initial applications on commercial transport aircraft in the mid to late 1990s. The author discusses the major considerations which must be addressed for modular avionics on commercial transport aircraft as well as the needs of commercial versus military modular avionics systems. Douglas Aircraft Company's work in commercial modular avionics is summarized and some thoughts on architectures and implementation are provided. I.E.

A92-48473

RAPID SYSTEMS INTEGRATION OF NAVIGATION AVIONICS

LARRY ZETZL (U.S. Navy, Naval Avionics Center, Indianapolis, IN), ANDREW FULLER (SofTech, Inc., Fairborn, OH), and ROGER ANDREWS (Merit Technology, Beavercreek, OH) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 394-399.

The authors illustrate the techniques and philosophies of using simulations as a tool to help reduce the cost and schedule associated with navigation system integration. The ES-3A navigation integration is used to illustrate specific implementation considerations and lessons learned. The approach for this project was to reuse generic aircraft flight simulation software developed under previous programs and add avionics modules unique to this platform as needed. It is concluded that the DASL (Digital Avionics System Laboratory) has been a valuable asset in testing and integrating the ES-3A navigation and steering software. The lab offered a dynamic environment in which to test the entire navigation effort of the flight computer in high-risk situations which could not be tested during flight test. The environment made it possible to prove the fault-tolerance of the navigation and steering software prior to flight test. I.E.

A92-48475

DESIGN AND IMPLEMENTATION OF A GENERIC KALMAN FILTER IN ADA

LESLIE HYLL and LARRY GEARHART (TRW Dayton Engineering Laboratory, OH) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 408-414. Research sponsored by U.S. Navy. refs

(Contract F33615-87-D-1451)

Copyright

The Sandia Inertial Terrain-Aided Navigation (SITAN) system provides a means of autonomous and semi-passive navigation which integrates a stored terrain model with an inertial reference and and terrain sensors. The authors define the approach taken in the ITB (Integrated Test Bed) project to implement SITAN in Ada, to highlight the core software-a generic Kalman filter package-and to show the relevance of the approach to upgrading and adapting the implementation. Several key ideas of software design are emphasized. A design for a generic Ada Kalman filter is presented which is relevant to general Kalman filtering applications. I.E.

A92-48477

AN INTEGRATED NAVIGATION SYSTEM MANAGER USING FEDERATED KALMAN FILTERING

S. A. BROATCH and A. J. HENLEY (GEC Avionics, Ltd., Guidance Systems Div., Rochester, England) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 422-426. Research supported by Ministry of Defence Procurement Executive. refs

Copyright

A federated Kalman filter architecture has been developed in which the Kalman filter processing is distributed among the navigation sensors to be integrated. Each navigation sensor with its Kalman filter can, in conjunction with the reference INS (Inertial Navigation System), be consdiered as a subsystem which functions as an independent manager. A central data fusion function is used to integrate the information from these navigators. Such a federated architecture can offer a number of advantages over one with a single central Kalman filter. These advantages include improved failure detection and correction, improved redundancy management, and lower costs for system integration. GEC Avionics has developed a system for the integration of INS with GPS (Global Positioning System) and TRN (Terrain Referenced Navigation), together with other navigation aids. Results are presented to demonstrate the performance and the benefits of using a federated approach. I.E.

A92-48501

ABSOLUTE FIBER OPTIC PRESSURE TRANSDUCER FOR AIRCRAFT AIR DATA MEASUREMENT

S. E. REED and J. W. BERTHOLD (Babcock & Wilcox, Alliance, OH) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 591-603. refs

Copyright

The authors present the design rationale for a total pressure fiber optic transducer under development for planned flight test. Pressure sealing problems for absolute pressure transduction are discussed. Information is given on the microbend fiber optic sensor approach used to measure diaphragm deflection, and requirements for microbend sensor thermal compensation. Wavelength division multiplexing (WDM) approaches are described to self-reference the fiber optic sensors so that the transducer output is insensitive to interconnect cable bending and connector mating/demating. Requirements and constraints imposed by the WDM methods are discussed, along with the impact on overall transducer operation. Preliminary performance data are presented on a prototype transducer incorporating the features necessary to achieve a stable, repeatable, and accurate output. I.E.

A92-48567

THE IMPORTANCE OF IMPLICIT AND EXPLICIT KNOWLEDGE IN A PILOT'S ASSOCIATE SYSTEM

DAVID L. PERSCHBACHER, KEITH R. LEVI (Honeywell Systems and Research Center, Minneapolis, MN), and MARK HOFFMAN (ISX Corp., Marietta, GA) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 1158-1163. refs

(Contract F33615-88-C-1739)

It is pointed out that fielding an operational pilot's associate (PA) will require both implicit and explicit representations of knowledge. Speed and memory performance requirements for PA will be aided by the use of implicit representations of knowledge. Acquiring and maintaining the large knowledge bases for PA will, by contrast, be aided by having explicit knowledge representations. Such explicit representations are being investigated in a 10 person-year research project sponsored by the Wright Research and Development Center. A critical contribution of this research has been to develop concepts that make machine learning applicable to real-time control and execution systems such as pilot's associate. The authors describe how machine learning techniques can automatically transform explicit representations into the implicit representations required by PA. I.E.

A92-49022#
EXPERIMENTAL PYROMETER SYSTEM FOR A GAS TURBINE ENGINE
EDWARD A. FISHER (GE Aircraft Engines, Cincinnati, OH) and TIMOTHY J. LEWIS (USAF, Wright-Patterson AFB, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 7 p. Research sponsored by USAF. refs
(AIAA PAPER 92-3482) Copyright

The design and testing of an advanced two-color optical pyrometer (ATCOP) as well as the associated processing algorithms and hardware are summarized. The ATCOP which is based on fiber-optics, digital filtering, and the Ada programming language shows the feasibility of real-time processing of noisy turbine blade temperature signals for engine control and diagnostics. Temperature profiles of individual turbine blades are displayed on the system's monitor. Hot or cold turbine blades are detected through recognizing any significant deviation from the repetitive blade temperature pattern. It is shown how the pyrometer system can be integrated with an aircraft engine digital control unit. O.G.

N92-28376# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Avionics Panel.
APPLICATIONS OF ASICS TO AVIONICS
Feb. 1992 49 p
(AGARD-AG-329; ISBN-92-835-0657-X) Copyright Avail: CASI HC A03/MF A01

An overview of how Application Specific Integrated Circuits (ASICs) can be a key factor in avionics systems is presented. The technical capabilities and possibilities of ASICs in avionics applications are discussed along with the essential characteristics and various types of ASICs that are available. The computer aided design (CAD) tools necessary for the rapid development of ASICs are discussed. Two specific examples of applications are cited: (1) the imbedded computers necessary for airborne radar digital signal processing; and (2) the ASIC role in image processing for aircraft cockpits.

N92-28377# Thomson Composants, Saint Egreve (France).
WHAT IS AN ASIC?
J. M. BRICE and J. REDOLFI *In* AGARD, Applications of ASICs to Avionics 7 p Feb. 1992
Copyright Avail: CASI HC A02/MF A01

Since the emergence of the first ASICs in 1975, many advances have occurred in this field. This has resulted in highly complex digital ASICs and very high speed analog circuits. This strong evolution did not really change the nature of the four ASIC families: full custom circuits, standard cells, programmable devices, and PLD's. Author

N92-28379# Micro Circuit Engineering Ltd., Tewkesbury (England).
APPLICATIONS OF SILICON HYBRID MULTI-CHIP MODULES TO AVIONICS
E. S. ECCLES *In* AGARD, Applications of ASICs to Avionics 14 p Feb. 1992
Copyright Avail: CASI HC A03/MF A01

Silicon-based multi-chip modules (MCMs) are an inevitable byproduct of reduced feature size and higher speed integrated circuit (IC) devices. Early versions are available and are being exploited in military and high performance commercial applications. Their use will proliferate rapidly over the next four years and is likely to extend the use of monolithic ICs into performance areas which were previously inaccessible. Author

N92-28380# Thomson-CSF, Montrouge (France). Direction Recherche et Technologie.
A RADAR SIGNAL PROCESSING ASIC AND A VME INTERFACE CIRCUIT
A. CHOCHOD *In* AGARD, Applications of ASICs to Avionics 6 p Feb. 1992
Copyright Avail: CASI HC A02/MF A01

The purpose of this circuit is to perform real time signal processing for radar applications such as a missile seeker. There are two operating modes (standard and sample accumulation) and a variety of options through user selectable parameters and control logic (i.e. detection with global, local, or fixed threshold). Author

N92-28644# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
A SIMPLE AND LOW COST SYSTEM TO MEASURE DELAY TIMES IN PNEUMATIC SYSTEMS
S. STORMVANLEEUWEN 19 May 1990 19 p
(NLR-TP-90174-U; ETN-92-91438) Avail: CASI HC A03/MF A01

A methodology to measure pneumatic delay times based on the determination of the complex transfer function of the pressure line in the frequency range of interest is described. From the transfer function, the delay time as a function of the frequency can be calculated. The transfer function is established by measuring the amplitude and phase response of the pressure system at a number of discrete frequencies. The equipment to generate a pneumatic stimulus and the equipment to determine the amplitude and phase response is described. ESA

N92-28654# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
POTENTIAL APPLICATIONS OF LASER DOPPLER ANEMOMETRY FOR IN-FLIGHT MEASUREMENTS
H. W. JENTINK 9 May 1990 32 p
(NLR-TP-90163-U; ETN-92-91437) Avail: CASI HC A03/MF A01

The application of laser anemometry for flight testing and other aircraft related measurements is addressed. The laser anemometry technique and previous work in this field are reviewed and applications are described. A comparison of possibilities of laser anemometry with conventional techniques shows some unique advantages of laser anemometry. ESA

N92-29222# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
DEVELOPMENT OF A FLIGHT INFORMATION SYSTEM USING THE STRUCTURED METHOD M.S. Thesis
YEONG-LAE KWAK Mar. 1992 106 p
(AD-A248207; AFIT/GCS/ENG/92M-03) Avail: CASI HC A06/MF A02

This thesis documents the development of a database system for the Flight Information System (FIS) of the Korean Air Force. The scope of the FIS is too large to be covered by this thesis. Thus, this thesis covers only the core part of the FIS due to the limitation of time and man-power. This thesis uses the structured method. Structured analysis and structured design techniques are the two techniques most used. This thesis focused not only the development of the FIS but also the application of the software development method, the structured method, and its tools such as DFD, DD, ERD, and so on. Also, the use of ORACLE was an important part of this thesis too. GRA

N92-29870# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Abt. Flaechenflugzeuge.
SENSOR FAULT DETECTION ON BOARD AN AIRCRAFT WITH OBSERVER AND POLYNOMIAL CLASSIFIER Ph.D. Thesis - Technische Univ. [SENSORFEHLERERKENNUNG IN FLUGZEUGEN MIT BEOBACHTER UND POLYNOMKLASSIFIKATOR]
JOERG J. BUCHHOLZ Aug. 1991 65 p In GEORGIAN
(ISSN 0939-2963)
(DLR-FB-91-34; ETN-92-91390) Avail: CASI HC A04/MF A01; DLR, Wissenschaftliches Berichtswesen, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC

A sensor fault detection method for the airspeed vector of an aircraft is described. A nonlinear estimator uses a mathematical aircraft motion model and a few measured signals to generate an estimate of the airspeed vector to be monitored. This reference signal and the measurement signal are fed into a learning pattern recognition algorithm, which determined the state of the sensor from the differences between the two signals. In a practical realization, the classifier is parallelized, implemented on a transputer network, and verified using flight test data. ESA

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.

A92-44898
FUEL REGRESSION MECHANISM IN A SOLID FUEL RAMJET
ILAN HADAR and ALON GANY (Technion - Israel Institute of Technology, Haifa) Propellants, Explosives, Pyrotechnics (ISSN 0721-3115), vol. 17, no. 2, May 1992, p. 70-76. refs
Copyright

A model relating the combustion characteristics, particularly the regression rate, to the fuel properties in a solid fuel ramjet (SFRJ), is presented. The analysis is based on inspecting the different phenomena (e.g., chemical kinetics and heat transfer) involved in the fuel decomposition process in order to determine the rate controlling steps, and modeling the important mechanisms. Model predictions were compared to experimental findings for four polymeric fuels, showing excellent qualitative agreement in classifying different fuels, as well as good quantitative predictions of the fuel regression rates. The model can serve as a useful tool for the selection of appropriate fuels, as well as for preliminary design of the engine and mission profile prior to static firings of the final SFRJ prototype. Author

A92-45306
VSTOL ENGINE DESIGN EVOLUTION - GROWTH OF THE PEGASUS ENGINE FOR HARRIER
A. B. STREET (Rolls-Royce, PLC, Bristol, England) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. II.3.1-II.3.11.
Copyright

The paper traces the evolution of the Pegasus engine since it entered service in 1969 powering the Harrier aircraft. The operational background of the Harrier/AV8 family of aircraft was used to define a demonstrator program primarily aimed at improving performance. This XG15 demonstrator program for the Pegasus 11-61 was successfully completed in 1987 followed by durability demonstrations in early 1988. The results formed the basis of the improved F402-RR-408 engine, offering reduced life cycle costs at higher thrust according to prevailing operational requirements. The main objectives of the XG-15 and 11-61 include the following: 15-percent increase in lift thrusts at 15 C, flat rating of lift thrusts to 32-C conditions, increases in combat thrust at low altitude of at least 20 percent minimal weight increase, double hot end life, and improved modularity and maintainability. The Pegasus 11-61 compressor, combustor, HP turbine, and exhaust system are also discussed. C.A.B.

A92-45307
CURRENT TECHNOLOGY PROPULSION SYSTEMS MEET THE STOVL WINDOW OF OPPORTUNITY
JOHN R. SPRAGUE and JOSEPH A. WAZYNIAK (Pratt & Whitney Group, West Palm Beach, FL) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. II.4.1-II.4.8. refs
Copyright

A review of the STOVL propulsion system technologies and their availability is presented, and a demonstrator engine flight clearance program is developed. It is shown that opportunities exist for the production of a cost-effective mission-flexible weapons system to replace the AV-8B and F/A 18 aircraft and as a flexible component of the Air Force's multirole fighter inventory. Based on the ASTOVL and PW5000STOVL evaluation studies carried out over the past four years, a viable STOVL propulsion system based on a derivative of the PW5000 prototype engine can be flown in the mid to late 1990s. It is argued that the derivative engines with the infusion of IHPTET program technologies developed during the STOVL demonstrator and full-scale engine development programs can evolve into a production propulsion system that exceeds the requirements and capabilities of the engines it replaces. C.A.B.

A92-45316* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
HOT GAS INGESTION CHARACTERISTICS AND FLOW VISUALIZATION OF A VECTORED THRUST STOVL CONCEPT
ALBERT L. JOHNS, GEORGE H. NEINER, TIMOTHY J. BENCIC (NASA, Lewis Research Center, Cleveland, OH), JOSEPH D. FLOOD, KURT C. AMUEDO, THOMAS W. STROCK, and BEN R. WILLIAMS (McDonnell Aircraft Co., Saint Louis, MO) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. III.4.1-III.4.20. refs
Copyright

The study presents results obtained at the compressor face of a 9.2-percent scale vectored thrust model in ground effects from Phases I and II of a test program to evaluate the hot ingestion phenomena and control techniques, and to conduct flow visualization of the model flowfield in and out of ground effects, respectively. A description of the model, facility, a new model support system, and a sheet laser illumination system are provided. The findings contain the compressor face pressure and temperature distortions, compressor face temperature rise, and the environmental effects of the hot gas. The environmental effects include the ground plane temperature and pressure distributions, model airframe heating, and the location of the ground flow separation. Results from the sheet laser flow visualization test are also presented. C.A.B.

A92-45317
HOT-GAS REINGESTION - ENGINE RESPONSE CONSIDERATIONS
D. D. WILLIAMS (Rolls-Royce, PLC, Bristol, England) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. III.5.1-III.5.13. Research supported by Ministry of Defence Procurement Executive. refs
Copyright

Some of the fundamentals of hot-gas reingestion (HGR) are reviewed in the context of engine stability. Generic time-variant total-temperature distortion descriptors are discussed against a background of external work and of small-and full-scale experience from simulated vertical landings of an augmented Pegasus/Harrier vectored-thrust installation. Results are presented of compression-system-component and overall engine simulations intended to provide guidelines to engine total-temperature distortion sensitivity and stability margin assessment. Total-temperature distortion at engine entry resulting from HGR is found to be highly unsteady due to unsteadiness in the flow upwash field as a result of multiple-jet interactions close to the ground. Repeated tests at correctly simulated aircraft dynamic conditions are needed to establish a proper statistical data base. A methodology for the treatment of the effects of HGR on engine stability is developed. C.A.B.

A92-45321
ASTOVL ENGINE CONTROL

B. J. QUINN (Rolls-Royce, PLC, Bristol, England) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. III.9.1-III.9.6.
Copyright

A possible engine control architecture for future ASTOVL aircraft is identified. The ASTOVL engine powerplant control requirements are more complex than those of the Pegasus engine in the Harrier. The concept of an engine feeding a plenum chamber for which mixed (and hot) gases are supplied to both front and back lift nozzles is difficult installationally because of its long hot front duct and potential hot gas ingestion effects. The engine control system in this approach is relatively conventional apart from the need to divert gases for either lift or propulsion. The lighter and more integrated engine and aircraft approach using the Pegasus-like configuration is shown to have additional control complexity, but has only relatively small fan surge margin consumption through control effects. C.A.B.

A92-45325* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

EXPERIMENTAL AND ANALYTICAL STUDY OF CLOSE-COUPLED VENTRAL NOZZLES FOR ASTOVL AIRCRAFT

JACK G. MCARDLE (NASA, Lewis Research Center, Cleveland, OH) and C. F. SMITH (Sverdrup Technology, Inc., Cleveland, OH) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. III.15.1-III.15.14. Previously announced in STAR as N90-24273. refs
Copyright

Flow in a generic ventral nozzle system was studied experimentally and analytically with a block version of the PARC3D computational fluid dynamics program (a full Navier-Stokes equation solver) in order to evaluate the program's ability to predict system performance and internal flow patterns. Measurements showed about 5.5-percent flow-turning loss, reasonable nozzle performance coefficients, and a significant aftward axial component of thrust due to flow turning more than 90 deg. Flow behavior into and through the ventral duct is discussed and illustrated with paint streak flow visualization photographs. PARC3D flow visualization images are shown for comparison with the paint streak photographs. Modeling and computational issues encountered in the analytical work are discussed. Author

A92-45430

IMPACT RESPONSE OF COMPOSITE UHB PROPELLER BLADES

NOBUO TAKEDA (Tokyo, University, Japan), YOSHIFUMI KAWAKAMI, and REIMON KOBAYASHI (Sumitomo Precision Products Co., Ltd., Amagasaki, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 607-617. refs
(SAE PAPER 912046) Copyright

Thirteen kinds of composite plate specimens, including hybrid laminates composed of CFRP and GFRP, were studied by impact testing in cantilever support conditions in order to evaluate their suitability for UHB propeller blades. Teflon projectiles weighing 37 g collided with the specimens at speeds ranging from 20 m/s to 150 m/s. The direction of the projectiles was varied to investigate the effect of impact direction on the specimen response. The strain time histories of the rectangular plate specimens and flat blades were measured and compared with calculations made using the FEM program DYNA3D. As a result of these studies, a hybrid laminate as tough as GFRP was selected as a candidate for the shell material of propeller blades. C.D.

A92-45431

AN ANALYSIS OF THE EFFECT OF CENTRIFUGAL FORCE ON THE IMPACT RESISTANCE OF COMPOSITE FAN BLADES FOR TURBO-FAN ENGINES

TOSHIO MIYACHI, HIDEHITO OKUMURA, and KUNIHIKO OHTAKE (National Aerospace Laboratory, Tokyo, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 619-626. refs
(SAE PAPER 912047) Copyright

In the context of a study of the impact-resistance capacity of composite-material blades for turbofan engines, attention has been given to the effect of centrifugal loading on blade structural response to impact. FEM was used to investigate the bird-strike-generated transient deformations of six different fan-blade types employing various material systems and dimensions. While centrifugal forces significantly reduced the global deformations of the heavier blades studied, local deformations were virtually unaffected. In the case of lighter blades, even the global effects of centrifugal force were negligible. O.C.

A92-45432

FINITE ELEMENTS ANALYSIS OF FLEXURAL EDGE WAVE FOR COMPOSITE FAN BLADES

HIDEHITO OKUMURA, TOSHIO MIYACHI, MASAHIRO FUKUDA, TAKASHI NAKAMURA, and KUNIHIKO OHTAKE (National Aerospace Laboratory, Tokyo, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 627-634. refs
(SAE PAPER 912048) Copyright

The paper presents a geometrically nonlinear finite element analysis of the dynamic behavior of flexural edge waves of a composite jet-engine fan-blade model. It is shown that computer graphics technology was very efficient to visualize the mode of the edge wave generation and propagation. Results of computer simulation of a composite fan blade subjected to local impact loading with foreign objects (such as gravel, hailstone, or nuts and bolts) confirmed the existence of flexural edge wave in the region of the leading edge and the trailing edge. I.S.

A92-45434

ELECTRIC POWER GENERATING SYSTEM FOR THE BOEING 777 AIRPLANE

JOHN BURNS (Sundstrand Electric Power Systems, Rockford, IL) and CARL TENNING (Boeing Commercial Airplane Group, Seattle, WA) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 645-656.
(SAE PAPER 912050) Copyright

The electric power generating system of the Boeing 777 is described. An overview is given of the main system, including the generators, flight deck controls, and fault protection. The backup electric system and flight deck controls, category IIIb autoland, additional electric services for extended twin operations, simultaneous operation on APU generator and external power, provisions for a second external power receptacle, automatic load shedding and restoration, and simplification of bus fault protection are addressed. The equipment is described, including the integrated drive generator, thermal, disconnect, case venting, APU generator, control units built-in test equipment, and integrated drive generator oil level sensing. C.D.

A92-45435

270-VDC/HYBRID 115 VAC ELECTRIC POWER GENERATING SYSTEM TECHNOLOGY DEMONSTRATOR

R. E. NIGGEMANN, S. PEECHER, and G. ROZMAN (Sundstrand Aerospace, Rockford, IL) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 657-663. refs
(SAE PAPER 912051) Copyright

The 270-Vdc/hybrid 115-Vac electrical power generating and distribution systems technology for future aircraft applications is presently being investigated. This paper describes a single-channel, 120-kW hybrid system and presents some typical performance data. The dc bus supplies a 30-kVA, 400-Hz, 115-Vac inverter; constant power load banks of up to 150 kW; and a resistive load bank of up to 90 kW. System simulation studies indicated the potential for unstable operation due to the negative impedance of the constant power load in conjunction with the source ripple filter and the load EMI filters. Author

A92-45441

AUXILIARY POWER UNITS FOR CURRENT AND FUTURE AIRCRAFT

COLIN RODGERS (Sundstrand Power Systems, San Diego, CA) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 717-730. refs

(SAE PAPER 912059) Copyright

The effects on gas turbine turbojet propulsion auxiliary power unit (APU) design of the rapid expansion of commercial aviation, improvements in prime propulsion gas turbine technologies, and the trend to all-electric APU output are discussed. Candidate APU design solutions for coping with these trends are presented. Expected technological improvements for the next century are considered. C.D.

A92-46426

HIGH-SPEED FLIGHT PROPULSION SYSTEMS

S. N. B. MURTHY, ED. (Purdue University, West Lafayette, IN) and E. T. CURRAN, ED. (USAF, Wright Laboratory, Wright-Patterson AFB, OH) Washington, DC, American Institute of Aeronautics and Astronautics, Inc. (Progress in Astronautics and Aeronautics. Vol. 137), (ISSN 0079-6050), 1991, 544 p. For individual items see A92-46427 to A92-46435.

(ISBN 1-56347-011-X) Copyright

Various papers on high-speed flight propulsion systems are presented. The topics addressed are: propulsion systems from takeoff to high-speed flight, propulsion system performance and integration for high Mach air-breathing flight, energy analysis of high-speed flight systems, waves and thermodynamics in high Mach number propulsive ducts, turbulent free shear layer mixing and combustion, turbulent mixing in supersonic combustion systems, mixing and mixing enhancement in supersonic reacting flowfields, study of combustion and heat-exchange processes in high-enthalpy short-duration facilities, and facility requirements for hypersonic propulsion system testing. C.D.

A92-46427

INTRODUCTION

E. T. CURRAN (USAF, Wright Laboratory, Wright-Patterson AFB, OH) IN: High-speed flight propulsion systems. Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1991, p. 1-20. refs

Important problems in high-speed flight propulsion systems are surveyed. Major technological challenges in low-speed engines and high-speed propulsion are examined. The integration of the aerodynamic, structural, and propulsion elements of an aircraft to achieve optimum performance is discussed. C.D.

A92-46429

PROPULSION SYSTEM PERFORMANCE AND INTEGRATION FOR HIGH MACH AIR BREATHING FLIGHT

F. A. HEWITT and M. C. JOHNSON (Rolls-Royce, PLC, Bristol, England) IN: High-speed flight propulsion systems. Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1991, p. 101-142. Research supported by ESA. refs

Copyright

Factors involved in the interactions between the intakes, nozzles, and powerplants of high Mach number air-breathing aircraft are discussed. Vehicle dynamic pressure and trajectory, air intake pressure recovery, propulsion from takeoff, burner and nozzle relative scale effects, nozzle area variability, and supersonic combustion are addressed. C.D.

A92-47692

BASIC ANALYSIS OF COUNTER-ROTATING TURBINES

JUN-XIAN CAI (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 13, no. 1, Jan. 1992, p. A57-A63. In Chinese. refs

A comprehensive basic analysis for various counterrotating turbines is given with a blade element assumption. All possible typical schemes of counterrotating turbine stages are enumerated. A typical three specifications of each moving blade for blade element, such as impulse, reactive, and absolute axial intake, is suggested. Their performances of specific work, load distribution, between counterrotating shafts, and efficiency are analyzed for different shaft rotating speed ratios. It is concluded that the load capacity per unit engine length of a counterrotating turbine can be much higher than that of a common turbine without efficiency penalty. Author

A92-47697

STUDY ON TWO VARIABLE CONTROL PLAN FOR TWIN SPOOL TURBOJET ENGINE

JIA-ZHEN ZHANG, KAI HUA, and XIAN HUANG (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 13, no. 1, Jan. 1992, p. A101-A105. In Chinese. refs

A two-variable control plan for a twin-spool turbojet engine under maximum state is discussed in this paper. The performance of the engine adopting two-variable control plan is calculated with a nonlinear simulation programs. The results show that engine performance with a two-variable control plan is better than that with a single variable plan. When the control plan including equal low pressure rotating speed and equal turbine temperature is adopted, the surge margin of high pressure compressor is reduced. Some problems met in practice for two-variable control system of engine are analyzed. Author

A92-47791

CONCEPT OF A ONE-DIMENSIONAL MODEL OF THE DYNAMIC BEHAVIOR OF A GAS TURBINE [KONCEPCJA JEDNOWYMIAROWEGO MODELU DO BADANIA WLASNOSCI DYNAMICZNYCH TRUBINY GAZOWEJ]

KONRAD SWIRSKI, JANUSZ LEWANDOWSKI, and ANDRZEJ MILLER (Warsaw University of Technology, Poland) Politechnika Slaska, Zeszyty Naukowe, Mechanika (ISSN 0434-0817), no. 107, 1992, p. 399-404. In Polish. refs

An approach to the modeling of the dynamic behavior of a gas turbine is proposed whereby the process of working medium accumulation in the flow path of a gas turbine is described in terms of a continuous one-dimensional model. The turbine (compressor) stage is treated as a channel of varying length and cross section. The numerical solution is based on a two-step Lax-Wendroff scheme combined with iterations in the turbine (compressor) sections. V.L.

A92-48021

THE IMPACT OF ADVANCED MATERIALS ON SMALL TURBINE ENGINES

JOHN L. MASON (Allied-Signal Aerospace Co., Torrance, CA) Cliff Garrett Turbomachinery Award Lectures, 8th, Dayton, OH, Apr. 23, 1991. 16 p. refs

(SAE PAPER 911207; SAE SP-871) Copyright

The impact of anticipated new turbine materials and processes on the small gas turbine of the late 20th and early 21st century is presented. The materials are evaluated in terms of improvement potential, likelihood of successful initiation, and barriers thereto. Attention is given to evaluation criteria, tradeoffs, and various engine studies focusing on the NASA/Army Small Engine Component Technology studies of the mid-1980s. R.E.P.

A92-48268

AN EXPERIMENTAL INVESTIGATION ON AFT BYPASS SUPERSONIC INLET PERFORMANCE AT HIGH ANGLE OF ATTACK AND YAW

KEYUN ZHAO (31st Research Institute, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), no. 3, June 1992, p. 35-40. In Chinese.

The experimental results obtained with an aft bypass supersonic inlet model during wind tunnel testing are presented. Attention is focused on inlet performance at high angle of attack and yaw. It is shown that the total pressure measurement under the mixing condition at dump chamber entrance is feasible and the pressure recovery measured is satisfactory. R.E.P.

A92-48481

AN ARTIFICIAL INTELLIGENCE APPROACH FOR THE VERIFICATION OF REQUIREMENTS FOR AIRCRAFT ELECTRICAL POWER SYSTEMS

ROBERT GLASS, WALEED SAID, and JAMES THOM (Sundstrand Aerospace, Rockford, IL) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 455-461. refs

Copyright

An expert system shell called Expert Electric Power Simulator (EXEPS) has been implemented for use in verifying the requirements of aircraft electrical power generating systems (EPGS). The requirements are modeled as rules for the inference engine of the shell. Behavioral models of each of the components of the EPGS are used to simulate the hardware response of the system. The combination of rules and behavioral models provide a simulation of the response of the EPGS to external events. By monitoring the system response, errors in the requirements specification can be found. I.E.

A92-48743*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

OPERATING CHARACTERISTICS AT MACH 4 OF AN INLET HAVING FORWARD-SWEPT, SIDEWALL-COMPRESSION SURFACES

JULIE A. HUDGENS (Analytical Services and Materials, Inc., Hampton, VA) and CARL A. TREXLER (NASA, Langley Research Center, Hampton, VA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 11 p. refs

(AIAA PAPER 92-3101)

A three-dimensional, forward-swept sidewall-compression inlet has been tested in the Mach 4 Blowdown Facility at the NASA Langley Research Center to examine parameters that affect inlet starting, operability, and performance. The inlet was designed to simultaneously provide good starting and mass capture characteristics through the combination of forward-swept sidewalls and the aft placement of the downstream cowl. Parametrics examined included top surface compression, geometric contraction ratio, sidewall compression angle, boundary-layer thickness on the vehicle undersurface, and cowl position. To simulate combustion effects on inlet operation, the inlet was mechanically back pressured to determine maximum achievable combustor-to-inlet pressure ratio prior to inlet unstart. Inlet operability and performance are shown in terms of inlet starting (pulsed and self-starting) and unstarting characteristics, inlet static pressure distributions, combustor back pressure limits, mass capture, and flow uniformity. Author

A92-48790#

PULSE JET ONE-WAY VALVE PERFORMANCE

JOHN L. LOTH, LEON MONTGOMERY (West Virginia University, Morgantown), and RAVI CHANDRAN (Manufacturing and Technology Conversion International, Inc., Baltimore, MD) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 7 p. Research supported by Manufacturing and Technology Conversion International, Inc. and DOE. refs

(AIAA PAPER 92-3169) Copyright

To achieve pulsed combustion compression requires the use of either a mechanical flapper valve, like in the V-1 'buzz bomb', or an aerodynamic one-way valve called a 'rectifier' or 'aerovalve'. The aerodynamic characteristics of flow separation and or vortex conservation of angular momentum are here used to produce aerovalve diodicity, defined as the steady flow ratio of forward/reverse flow at same delta-P. Several patents on such aerovalves have been filed in the decade following World War II. One of the simplest effective aerovalves is the Kentfield sharp edge throat venturi. During pulse combustion, the time averaged reverse-to-forward flow is calculated to determine the valve leakage. The effects which valve geometry, wave shape, flow choking and temperature ratio have on valve diodicity and leakage are discussed. The time-averaged net forward flow is controlled by the combustor power level. This ratio is used to determine the maximum forward flow rate, which defines the minimum throat area of the aerovalve. Author

A92-48801#

DESIGN AND TEST OF AN ACTIVE TIP CLEARANCE SYSTEM FOR CENTRIFUGAL COMPRESSORS

M. M. WEIMER (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 10 p.

(AIAA PAPER 92-3189) Copyright

The Active Tip Clearance System (ATCS) discussed herein meets the industry's needs for a fast-response, active, closed-loop, tip clearance system for both turbines and compressors. The system is based around an electromagnetic actuator which provides variable, flexible clearance control. The ATCS is incorporated into an Allison 250-C30 centrifugal compressor to validate its performance. Results of the testing indicate compressor aerodynamic efficiency improvements of one percent. The ATCS can control tip clearance to within +/- 0.0005 inches over its required range and system response is approximately 100 ms. The system also avoids blade rub during compressor surge by increasing tip clearance prior to surge. Author

A92-48805#

AERO MECHANICS IN THE TWENTY-FIRST CENTURY

THEODORE FECKE (USAF, Wright Laboratory, Wright-Patterson AFB, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 9 p. refs

(AIAA PAPER 92-3194) Copyright

Recent developments in forced response analysis methods and their application to turbomachinery blades are reviewed. In particular, attention is given to flow defects, unsteady blade loads, and blade response. It is shown that both flow defects and unsteady blade loads can be handled through the use of improved computational fluid dynamics methods. The blade response can be predicted even for composites. It is noted that the major improvement in forced response prediction will be achieved through the integration of computational fluid dynamics and finite element methods. V.L.

A92-48832#

THE INFLUENCE OF SPRAY ANGLE ON THE CONTINUOUS- AND DISCRETE-PHASE FLOWFIELD DOWNSTREAM OF AN ENGINE COMBUSTOR SWIRL CUP

H. Y. WANG, V. G. MCDONELL, and G. S. SAMUELSEN (California, University, Irvine) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 11 p. Research supported by GE Aircraft Engines. refs

(AIAA PAPER 92-3231) Copyright

A production gas turbine engine (CFM56) combustor swirl cup assembly, featuring co-axial counter-swirling air streams, was studied at atmospheric pressure and nonreacting conditions. Two simplex atomizers of spray angles 45 and 90 deg were employed with the swirl cup, and the influence of spray angle on the continuous phase (gas phase in the presence of spray) flowfield and droplet dispersion was evaluated by comparing the droplet size, velocity and data rate. A two-component phase Doppler interferometer was used to measure droplet size and velocity, and the continuous-phase velocity. This study reveals that for this flow configuration and liquid loading rate (6 percent) (1) the presence of the swirl cup and swirling air tends to reduce differences in mean droplet size due solely to the different atomizer characteristics, (2) spray angle has little influence on droplet dispersion, and (3) the influence of spray angle on the gas-phase *flowfield is negligible.* Author

A92-48855#

PREDICTION OF A HIGH BYPASS RATIO ENGINE EXHAUST NOZZLE FLOWFIELD

R. J. G. NORTON and J. P. KINGSLEY (Rolls-Royce, Inc., Atlanta, GA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 13 p. refs
(AIAA PAPER 92-3259) Copyright

A generalized grid generation and flow solver system was developed which can be used to predict the aerodynamic performance of a typical high-bypass-ratio engine exhaust system including the support structures. Cold flow test measurements in the exhaust system were compared with predictions at the engine scale. Excellent agreement between test data and predictions was obtained using a very coarse grid, showing most of the major physical phenomena observed. I.S.

A92-48856#

A STUDY ON THE IMPACT OF SHROUD GEOMETRY ON EJECTOR PUMPING PERFORMANCE

RONALD J. LUFFY (GE Aircraft Engines, Cincinnati, OH) and A. HAMED (Cincinnati, University, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 9 p. refs
(AIAA PAPER 92-3260) Copyright

Current understanding of convergent-divergent ejector nozzles enables thrust augmentation predictions for certain configurations, but the effect of ejector shroud geometry on the ejector secondary flow rates has not been investigated. The present study was conducted to experimentally investigate the effect of the shroud geometry near the ejector slot on the secondary flow. Two geometric parameters were varied in the rectangular, single throat slot test ejector. Secondary flow and pressure distribution measurement for the different geometries are presented. The results indicate that the nozzle geometry near the ejector slot significantly affects the ejector's secondary flow pumping characteristics. Author

A92-48858*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

COMPARATIVE INVESTIGATION OF MULTIPLANE THRUST VECTORING NOZZLES

F. CAPONE (NASA, Langley Research Center, Hampton, VA), P. SMERECZNIAK, D. SPETNAGEL (McDonnell Aircraft Co., Saint Louis, MO), and E. THAYER (Pratt & Whitney Group, West Palm Beach, FL) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 14 p. refs
(AIAA PAPER 92-3263)

The inflight aerodynamic performance of multiplane vectoring nozzles is critical to development of advanced aircraft and flight control systems utilizing thrust vectoring. To investigate vectoring nozzle performance, subscale models of two second-generation thrust vectoring nozzle concepts currently under development for advanced fighters were integrated into an axisymmetric test pod. Installed drag and vectoring performance characteristics of both concepts were experimentally determined in wind tunnel testing. CFD analyses were conducted to understand the impact of internal flow turning on thrust vectoring characteristics. Both nozzles exhibited drag comparable with current nonvectoring axisymmetric nozzles. During vectored-thrust operations, forces produced by external flow effects amounted to about 25 percent of the total force measured. Author

A92-48859#

SCALE MODEL TEST RESULTS OF A MULTI-SLOTTED VECTORING 2DCD EJECTOR NOZZLE

J. G. DOONAN and A. P. KUCHAR (GE Aircraft Engines, Cincinnati, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 12 p. refs
(AIAA PAPER 92-3264) Copyright

The performance and air-handling characteristics of a *multislotted advanced two-dimensional convergent-divergent* (2DCD) vectoring ejector nozzle were evaluated using scale model cold flow static tests. The ejector exhaust system concept incorporated four ejector cooling slots on each of the upper and lower secondary flaps, and a unique secondary flow control system was used to allow independent throttling and metering of the flow to each of the eight ejector slots. The air-handling characteristics were determined for the unvectored and vectored 2DCD ejector nozzle configurations. It was found that, in general, minimal degradation of the overall air-handling capability took place for the vectored configurations. However, for certain operating conditions, the upstream ejector slots experienced a tendency to backflow. I.S.

A92-48878#

A SCRAMJET NOZZLE EXPERIMENT WITH HYPERSONIC EXTERNAL FLOW

SHIGEYA WATANABE (National Aerospace Laboratory, Chofu, Japan) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 10 p. refs
(AIAA PAPER 92-3289) Copyright

The effect of the interaction of an engine exhaust with a hypersonic external flow on the performance of a scramjet nozzle was investigated in tests carried out in the NAL hypersonic wind tunnel with freestream Mach number of 7.1, whose freestream constitutes the external flow. Room-temperature air was used as the simulated engine exhaust flow. Model surface pressure and Pitot pressure distributions in the flowfields were measured, and flow visualization was performed using several techniques. It was found that the external flow restrains the outward expansion of the exhaust and delays the boundary layer separation on the ramp side regions and near the ramp aft end. The spanwise expansion of the exhaust flow can be greatly restrained by using long side fences. I.S.

A92-48879#

EXPERIMENTAL VALIDATION OF SCRAMJET NOZZLE PERFORMANCE

TOHRU MITANI, KOICHIRO TANI, SHIGERU SATO, HIROSHI MIYAJIMA (National Aerospace Laboratory, Kakuda, Japan), MASASHI MATSUMOTO, and SHOUHACHI YASU (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 8 p. refs
(AIAA PAPER 92-3290) Copyright

Thrust by scramjet nozzles was measured using high temperature gas flow with a Mach No. of 2.5 and a total temperature of 3100 K produced by combustion of monomethyl hydrazine (MMH) and nitrogen tetraoxide (NTO). Wall pressure on the nozzles was monitored at more than 150 points to estimate the pressure force on the nozzles. In order to validate experimental technique and numerical codes, a series of cold nitrogen (N2) flow tests was also conducted using the same nozzle. An inviscid two-dimensional kinetic code was able to reproduce nozzle performance of cold N2 flow within a discrepancy of 6.6 percent. The calculation also agreed with the experimental results of hot MMH/NTO flow within an error of 3.6 percent, if the energy release loss in the gas generator. Kinetic, two-dimensional and friction losses in scram nozzles were identified for the nozzle, and effects of scale on performance on a scramjet nozzle for H2-fuel engines are discussed. Author

A92-48904#

A SIMPLIFIED REAL-TIME ENGINE MODEL FOR DEVELOPING AEROENGINE CONTROL SYSTEM

SHAOJI ZHANG (Shenyang Aeroengine Research Institute, People's Republic of China) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July

6-8, 1992. 6 p. refs
(AIAA PAPER 92-3321) Copyright

Based on a detailed nonlinear engine model, a simplified transient mathematical aeroengine model is developed for use in real-time simulations for developing engine control systems. The model is shown to be accurate to within 3 percent, flexible enough for use with different engines, and convenient for programming in C and FORTRAN. Simultation results are presented for a two-spool turbojet engine. V.L.

A92-48911#
SPECIFYING EXHAUST NOZZLE CONTOURS IN REAL-TIME USING GENETIC ALGORITHM TRAINED NEURAL NETWORKS
KEVIN W. WHITAKER, RAVI K. PRASANTH, and ROBERT E. MARKIN (Alabama, University, Tuscaloosa) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 9 p. refs
(AIAA PAPER 92-3328) Copyright

The objective of the study was to investigate the possibility of using genetic algorithms to train a neural network to design, in real-time, thrust vectoring nozzle contours. It is demonstrated that this approach provides a viable real-time alternative for designing thrust vectoring nozzle contours. Thrust vectors up to 20 deg have been obtained with an average error of 0.0914 deg. The robustness of the genetic algorithms is shown to be well suited for minimizing global errors. V.L.

A92-48940*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
HIGH SPEED ROTORCRAFT PROPULSION CONCEPTS TO CONTROL POWER/SPEED CHARACTERISTICS
J. L. BETTNER, J. M. HAWKINS, and C. S. BLANDFORD (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 21 p. Research supported by NASA. refs
(AIAA PAPER 92-3367) Copyright

Recent NASA sponsored rotorcraft airframer studies have demonstrated the desire for constant power over a wide range of output speed for turboshaft propulsion systems. This study interrogated several different concepts aimed at maintaining constant power over a speed variation from 100-50 percent with minimum increase in fuel consumption. The baseline engine was an advanced technology 8000 shp, fixed turbine geometry, turboshaft engine. The concepts investigated included variable geometry turbines, variable geometry compressors, power transfer from the HP to LP shafts, counterrotating power turbine with a combiner gearbox, and variable speed transmission integrated with the baseline turboshaft engine. The concept that best satisfies the program objectives with superior engine performance and with the least technical risk is the baseline (fixed geometry turbines) turboshaft engine integrated with the variable speed transmission. Author

A92-48979#
FAILURE MODEL DEVELOPMENT FOR AN INTEGRALLY BLADED TURBINE WHEEL
ROBERT G. TRYON and THOMAS A. CRUSE (Vanderbilt University, Nashville, TN) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 13 p. refs
(AIAA PAPER 92-3420) Copyright

The application of probabilistic structural analysis methods to the low-cycle fatigue life of an integrally bladed high-pressure turbine wheel is described. The variation in the primary and secondary flow parameters, the uncertainty of the complex mission loading, and the scatter in the material data are considered. The analysis incorporates standard modeling techniques currently used in the deterministic analysis of the low-cycle fatigue life. A risk management capability is developed using Monte Carlo simulation and computationally efficient closed form solutions of the engine modes. V.L.

A92-48984*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ANALYSIS OF A HYDROCARBON SCRAMJET WITH AUGMENTED PREBURNING
GREGORY A. MOLVIK, JEFFREY V. BOWLES, and LOC C. HUYNH (NASA, Ames Research Center, Moffett Field, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 16 p. refs
(Contract NCC2-498; NCC2-746)
(AIAA PAPER 92-3425) Copyright

This paper presents the results of a feasibility study of a hydrocarbon scramjet design utilizing an augmented preburner upstream of the main fuel injector locations. The combustor design evaluated here is for a small hypersonic research vehicle. It consists of a preburner into which a small amount of fuel is burned with on-board liquid oxygen and injected into the main airflow, upstream of the main fuel injector locations, thus ensuring that combustion is present and uninterrupted. Two degrees of analysis are presented including a one-dimensional cycle analysis and a complete computational fluid dynamic analysis with finite-rate chemistry and a two-equation turbulence model. Comparison of these analyses show good agreement when the CFD-predicted fuel consumption schedule is used in the cycle analysis. Author

A92-49014#
A DISTRIBUTED VAPORIZATION TIME-LAG MODEL FOR GAS TURBINE COMBUSTOR DYNAMICS
JAYESH M. MEHTA, P. MUNGUR, W. DODDS (GE Aircraft Engines, Cincinnati, OH), and L. DODGE (Southwest Research Institute, San Antonio, TX) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 14 p. refs
(AIAA PAPER 92-3465) Copyright

A linear combustion instability prediction code incorporating fuel vaporization effects has been developed and exercised to predict/interpret the acoustic behavior of the combustor. The paper first describes an enhanced thermoacoustic model featuring a fuel vaporization physical submodel. It is followed by numerical experiments which describe fuel vaporization effects on combustion instability. The numerical experiments replicate some of the observed engine operating experiences such as: the use of more volatile fuel reduces howl amplitude; altering fuel nozzles alters the howl characteristics; and increased combustor inlet temperature results in reduced howl. Author

A92-49019#
NAVAL AIRCRAFT/ENGINE MISSION PAYOFF ANALYSES
JOSEPH DEMARTINO (U.S. Navy, Naval Air Warfare Center, Trenton, NJ) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 5 p. refs
(AIAA PAPER 92-3473)

A 'quick-look' method has been developed which illustrates advancements in powerplant performance obtained through efforts associated with the Integrated High Performance Turbine Engine Technology program in terms of a specific aircraft's mission-capabilities improvement. Attention is given to the cases of the F/A-18 and P-3 aircraft: where (1) there has been a percentage increase in thrust/weight due to improved materials, component efficiencies, pressure ratios, combustion temperatures, and airflows; and (2) the total amount of fuel required for a mission with the improved engines is calculated and compared with that typical of the existing powerplants. O.C.

A92-49020#
TURBOSHAFT/TURBOPROP CYCLE SENSITIVITY ANALYSIS
JAMES D. PELUSO (U.S. Navy, Naval Air Warfare Center, Trenton, NJ) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 7 p. refs
(AIAA PAPER 92-3476)

An analysis of turboshaft/turboprop engine systems was conducted to determine the sensitivities of specific fuel consumption (SFC) and power to weight ratio (SHP/WT) to variations in engine component performance. Cycle pressure ratio and component efficiencies were found to be the most influential parameters on SFC. SHP/WT was most significantly affected by variations in turbine inlet temperature. It was found that system performance sensitivity of large engines is less than that of small engines. Also, system performance was found to become less sensitive to changes in component performance with increasing levels of technology. Author

A92-49021#

ENGINE FAN BLADE LOW CYCLE FATIGUE TESTING

DY D. LE (U.S. Navy, Naval Air Warfare Center, Trenton, NJ) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 7 p. refs

(AIAA PAPER 92-3478)

Spin testing of high-bypass turbofan engine fan blades discovered that disk bushings at the blade attachment location frequently backed out during operation causing a deep groove to wear into the attachment tang of the blade. Their movement was the result of insufficient interference fit between the fan disk and bushing. Finite element analysis and microscopic examination of the fan blade fracture surface show that the wear groove acts as a stress riser and the site for crack initiation and propagation. Weibull analysis shows that the wear groove significantly reduces the jet engine fan blade LCF life. Author

A92-49023#

DESIGN ISSUES IN A FIBER OPTIC SENSOR SYSTEM ARCHITECTURE FOR AIRCRAFT ENGINE CONTROL

SAMHITA DASGUPTA (GE Aircraft Engines, Cincinnati, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 9 p. refs

(AIAA PAPER 92-3483) Copyright

Advanced aircraft propulsion systems must meet increasingly challenging performance requirements and endure more rigorous thermal environmental constraints. The use of fiber optic technology provides extended environmental and performance capability, electromagnetic immunity without weight penalties, and also provides high speed data transmission capability. A number of design issues in a fiber optic control system such as overall size of the electrooptics, the update rate, and accuracy were investigated. An approach to the design of a size and update rate optimized fiber optic architecture for a set of engine control sensors is presented. The proposed architecture utilizes a set of spectral modulation sensors which are interfaced to a common light source, and a detector set for each sensor. The detection circuitry can be integrated on the same substrate. The sensor set includes pressure, temperature, position and speed sensors. Author

A92-49024#

INTELLIGENT ENGINE CONTROL (IEC)

SHRIDER ADIBHATLA, HAROLD BROWN (GE Aircraft Engines, Cincinnati, OH), and ZANE GASTINEAU (USAF, Wright Laboratory, Wright-Patterson AFB, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 8 p. refs

(AIAA PAPER 92-3484) Copyright

Intelligent Engine Control (IEC) is a program aimed at the assessment, design, and evaluation of advanced model based control modes to quantify their effect on engine performance, operability and survivability. IEC addresses the Integrated, High Performance Turbine Engine Technology goal of increasing engine thrust-to-weight ratio by reducing weight and enhancing performance. Unlike current engine controls, IEC provides a control concept with a variety of control modes available at each operating conditions that the optimal mode can be selected for the current system role and operating condition. The IEC concept includes unique control modes for emphasizing engine performance, operability, low observability, reduced redundancy, and others. This paper presents the IEC concept and describes a methodology for the evaluation of control mode. Results of a preliminary evaluation of the special operating modes defined under the IEC program are also presented. Author

A92-49098#

THE EXTERNAL PROPULSION ACCELERATOR - SCRAMJET THRUST WITHOUT INTERACTION WITH ACCELERATOR BARREL

JOSEF ROM and GAVRIEL AVITAL (Technion - Israel Institute of Technology, Haifa) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 12 p. Research supported by Technion - Israel Institute of Technology and Asher Peled Memorial Fund. refs

(AIAA PAPER 92-3717) Copyright

The performance characteristics of the External Propulsion Accelerator are evaluated using the simplified planar oblique shock wave and oblique detonation wave analysis. In this Accelerator the projectile flies in the premixed fuel/oxidizer mixture, its flowfield is dominated by the interaction between the shock wave generated at the nose of the projectile and the detonation wave generated by a blunt step on the shoulder of the projectile. Thrust is obtained by translating the energy of the high pressure high temperature gases, trapped behind the detonation wave and the contact surface (generated at the intersection of the waves), by expansion on the contracting rear section of the projectile. The characteristics of the flow at the intersection of the shock and detonation waves and the rear expansion are studied using polar diagrams. The pressure distribution on the projectile is calculated in this analysis. The thrust generated on the projectile, as a function of the various flow parameters, can be evaluated. It is found that for reasonable values of heat addition in the detonation process a sizable thrust can be generated. Author

A92-49110*# 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 (NASA, Flight Research Center, Edwards, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 25 p. refs

(AIAA PAPER 92-3745) Copyright

An adaptive-performance-seeking control system which optimizes the quasi-steady-state performance of the F-15 propulsion system is discussed. 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 Kalman 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

A92-49111*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

THRUST STAND EVALUATION OF ENGINE PERFORMANCE IMPROVEMENT ALGORITHMS IN AN F-15 AIRPLANE

TIMOTHY R. CONNERS (NASA, Flight Research Center, Edwards, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 21 p. refs

(AIAA PAPER 92-3747) Copyright

Results are presented from the evaluation of the performance seeking control (PSC) optimization algorithm developed by Smith et al. (1990) for F-15 aircraft, which optimizes the quasi-steady-state performance of an F100 derivative turbofan engine for several modes of operation. The PSC algorithm uses onboard software engine model that calculates thrust, stall margin, and other unmeasured variables for use in the optimization. Comparisons are presented between the load cell measurements, PSC onboard model thrust calculations, and posttest state variable model computations. Actual performance improvements using the PSC algorithm are presented for its various modes. The results of using PSC algorithm are compared with similar test case results using the HIDEC algorithm. I.S.

A92-49112#
ANALYTICAL DESIGN AND DEMONSTRATION OF A LOW-COST EXPENDABLE TURBINE ENGINE COMBUSTOR
TIMOTHY C. ROESLER, HUKAM C. MONGIA, and HAROLD L. STOCKER (General Motors Corp., Indianapolis, IN) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 7 p. refs
(AIAA PAPER 92-3754) Copyright

A low-cost 500-lb thrust class combustion system was designed using advanced analytical techniques and was demonstrated to operate successfully without development testing. Empirical methods were used to establish the overall geometry and stoichiometry of the combustion system, and a 3D finite difference reacting flow model was used to refine the design. The 3D code solved the Navier-Stokes equations for a reacting flow field, simulated turbulence using a k-epsilon model, and used a four-step chemical reaction scheme based on the Arrhenius and eddy break-up concepts. The resulting design is shown to meet or exceed all design goals, demonstrating that the use of advanced analytical techniques in the development of new combustion systems yielded significant payoffs, including reduced schedule and development time and reduced risk. I.S.

A92-49113#
GENERATORS INSIDE SMALL ENGINES
NORMAN GOLDBERG (Pacific Scientific, Santa Barbara, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 8 p.
(AIAA PAPER 92-3755) Copyright

While currently most generators rely on an engine gearbox for their power, reliability would be gained from generators' direct driving from the engine shaft; this is especially advantageous in the case of full-authority digital electronic control systems. An account is presently given of the design features and performance characteristics of weight- and space-efficient permanent magnet generators for such engine-driveshaft installations. Recommendations are made for volume apportionments during engine preliminary design. O.C.

A92-49114#
EMERGING TECHNOLOGIES FOR GAS TURBINE ENGINES - U.A.V. SYNERGIES
S. P. DEV (Textron Lycoming, Seymour, CT) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 10 p. refs
(AIAA PAPER 92-3757) Copyright

An evaluation is made of the applicability of emerging gas turbine advanced technologies to unmanned air vehicles (UAVs), as a means of both enhancing UAV performance and increasing the level of confidence in the technologies in question before their use in manned vehicles. The technologies considered encompass metal and ceramic matrix composites, ultrahigh speed alternators, ceramic bearings, and solid lubricants. Attention is given to the synergies implicit in the new technologies' application to UAVs, in virtue of their miniaturization-related advantages. O.C.

A92-49115#
THE NUMERICAL SIMULATION OF THE MAIN FUEL CONTROL UNIT OF GAS TURBINE ENGINES
GIOVANNI TORELLA (Italian Air Force Academy, Naples, Italy) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 12 p. refs
(AIAA PAPER 92-3760) Copyright

A numerical simulation of the main fuel control unit (MFCU) of a gas turbine engine was performed to evaluate the influence of MFCU on the performance and the behavior of the gas turbine engine. Both steady and unsteady engine operations were considered. It is demonstrated that the numerical codes may be used for simulating the MFCU operation and for evaluating control laws necessary for obtaining assigned performance laws. I.S.

A92-49119#
CONCEPTUAL STUDY OF SEPARATED CORE ULTRA HIGH BYPASS ENGINE
Y. SAITO, M. ENDOH, N. SUGAHARA, and K. YAMAMOTO (National Aerospace Laboratory, Chofu, Japan) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 7 p. Research supported by Ishikawajima-Harima Heavy Industries, Ltd., Kawasaki Heavy Industries, Ltd., and Fuji Heavy Industries, Ltd.
(AIAA PAPER 92-3775) Copyright

An application-evaluation study is presented for a novel, 'separated-core' engine configuration for aircraft propulsion in which a turbojet primary or 'core' powerplant furnishes compressed air via pneumatic duct to remotely located secondary propulsors such as an ultrahigh-bypass fan, which are turned by burning fuel in a dedicated combustor/turbine system via reduction gearbox. Attention is fiven to the case of a VTOL transport concept whose secondary propulsors encompass both a pair of cruise-flight turbofans and a set of six vertical-thrust lift-fans; a battery of three core turbojets is used to supply the requisite compressed air to all secondary units. O.C.

A92-49120#
DESIGN AND OFF-DESIGN POINT CHARACTERISTICS OF SEPARATED CORE ULTRA HIGH BYPASS ENGINE (SCUBE)
YUKIO MATSUDA, NANAHISA SUGIYAMA, YOSHIO SAITO, and MASANORI ENDOH (National Aerospace Laboratory, Chofu, Japan) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 8 p. refs
(AIAA PAPER 92-3776) Copyright

Separated Core Ultrahigh Bypass Engine (SCUBE) is an innovative propulsion system suited for subsonic aircraft, especially for VTOL aircraft, and has many advantageous characteristics compared to conventional engines. This paper describes the design- and off-design-point characteristics of SCUBE. SCUBE consists of two units, core engine and fan engine. Performance of core engine and fan engine are investigated under several conditions, and preferable core and fan engines for SCUBE may be defined. Assuming an aircraft with (weight) = 40,000 kg, (lift/drag) = 10 and required cruise thrust = 39.2 kN, design and off-design point characteristics of SCUBE, including transient performance, are described. Even though using engine component data based on the current technology level, the performance of SCUBE is advantageous compared to that of conventional turbofan engines, and no defect exists to realize SCUBE from the viewpoint of performance. Author

A92-49128*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ANALYTICAL AND EXPERIMENTAL STUDIES OF HEAT PIPE RADIATION COOLING OF HYPERSONIC PROPULSION SYSTEMS
R. A. MARTIN, M. A. MERRIGAN, M. G. ELDER, J. T. SENA, E. S. KEDDY (Los Alamos National Laboratory, NM), and C. C. SILVERSTEIN (CCS Associates, Bethel Park, PA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 8 p. Research sponsored by DOE. refs
(Contract NASA ORDER C-30002-M)
(AIAA PAPER 92-3809)

Analytical and experimental studies were completed to assess the feasibility of using high-temperature heat pipes to cool hypersonic engine components. This new approach involves using heat pipes to transport heat away from the combustor, nozzle, or inlet regions, and to reject it to the environment by thermal radiation from an external heat pipe nacelle. For propulsion systems using heat pipe radiation cooling (HPRC), it is possible to continue to use hydrocarbon fuels into the Mach 4 to Mach 6 speed range, thereby enhancing the economic attractiveness of commercial or military hypersonic flight. In the second-phase feasibility program recently completed, it is found that heat loads produced by considering both convection and radiation heat transfer from the combustion gas can be handled with HPRC design modifications. The application of thermal insulation to ramburner and nozzle walls was also found to reduce the heat load by about one-half and to reduce peak HPRC system temperatures to below 2700 F. In addition, the operation of HPRC at cruise conditions of around Mach 4.5 and at an altitude of 90,000 ft lowers the peak hot-section temperatures to around 2800 F. An HPRC heat pipe was successfully fabricated and tested at Mach 5 conditions of heat flux, heat load, and temperature. Author

A92-49139#

COMPENSATING FOR MANUFACTURING AND LIFE-CYCLE VARIATIONS IN AIRCRAFT ENGINE CONTROL SYSTEMS

R. RAVI, K. D. MINTO (GE Control Systems Laboratory, Schenectady, NY), M. GRAFTON, and I. BANSAI (GE Aircraft Engines, Cincinnati, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 10 p. refs

(AIAA PAPER 92-3869) Copyright

The objective is to develop a methodology for designing robust controllers for aircraft engines. Typically, information about engine-to-engine variations due to manufacturing tolerances and time degradation is represented by key parameters in the engine model. These parameters are statistically varied to generate a number of perturbed models from the baseline nonlinear model. This set of perturbed models into the standard norm bounded additive uncertainty form so that existing software can be used to design the controller. In the process, a way was proposed of determining a nominal model which is needed in the design process. The results show that, using these modeling techniques along with modern robust design algorithms like mu synthesis, yield controllers that deliver superior performance as compared to existing classical controllers. While these results pertain mainly to aircraft engine control, the techniques elucidated here carry over to problems where the plant to be controlled is stable and the uncertainty information is available in a similar form. Author

N92-28294# Southwest Research Inst., San Antonio, TX. Engine Fuel and Vehicle Research Div.

HIGH-TEMPERATURE MINIATURIZED TURBINE ENGINE LUBRICATION SYSTEM SIMULATOR Final Report, Sep. 1988 - May 1991

CLIFFORD A. MOSES, PIERRE J. GUTIERREZ, BURL B. BABER, and JOHN P. CUELLAR Feb. 1992 50 p

(Contract F33615-88-C-2816)

(AD-A249259; WL-TR-91-2103) Avail: CASI HC A03/MF A01

A high-temperature miniaturized turbine engine lubrication system simulator was designed and fabricated for the purpose of evaluating limited quantities, 1 quart or less, of candidate Integrated High Performance Turbine Engine Technology candidate lubricants. The computer-controlled simulator can determine a lubricant's functional and tribological properties under a wide variety of operating conditions. Metal test coupons can be added to the system to evaluate a lubricant's corrosive properties. Operating parameters are 10,000 rpm, 100 Ksi Hertz stress bulk oil temperatures to 750 F, bearing temperatures to 8500 F, and hot spots to 9500 F. The simulator also has the capability for inert atmosphere and once through lubrication operation. Validation of the simulator was accomplished with 48-hour test runs using high temperature polyester and polyphenylether lubricants. GRA

N92-28418*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

INTERNAL REVERSING FLOW IN A TAILPIPE OFFTAKE CONFIGURATION FOR SSTOVL AIRCRAFT

JACK G. MCARDLE, BARBARA S. ESKER, and JAMES A. RHODES (McDonnell Aircraft Co., Saint Louis, MO.) Jul. 1992 23 p Proposed for presentation at the 28th Joint Propulsion Conference and Exhibit, Nashville, TN, 6-8 Jul. 1992; sponsored by AIAA, SAE, ASME, and ASEE

(Contract RTOP 505-68-32)

(NASA-TM-105698; E-7086; NAS 1.15:105698; AIAA PAPER 92-3790) Avail: CASI HC A03/MF A01

A generic one-third scale model of a tailpipe offtake system for a supersonic short takeoff vertical landing (SSTOVL) aircraft was tested at LeRC Powered Lift Facility. The model consisted of a tailpipe with twin elbows, offtake ducts, and flow control nozzles, plus a small ventral nozzle and a blind flange to simulate a blocked cruise nozzle. The offtake flow turned through a total angle of 177 degrees relative to the tailpipe inlet axis. The flow split was 45 percent to each offtake and 10 percent to the ventral nozzle. The main test objective was to collect data for comparison to the performance of the same configuration predicted by a computational fluid dynamics (CFD) analysis. Only the experimental results are given - the analytical results are published in a separate paper. Performance tests were made with unheated air at tailpipe-to-ambient pressure ratios up to 5. The total pressure loss through the offtakes was as high as 15.5 percent. All test results are shown as graphs, contour plots, and wall pressure distributions. The complex flow patterns in the tailpipe and elbows at the offtake openings are described with traversing flow angle probe and paint streak flow visualization data. Author

N92-28419*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

FULL NAVIER-STOKES ANALYSIS OF A TWO-DIMENSIONAL MIXER/EJECTOR NOZZLE FOR NOISE SUPPRESSION

JAMES R. DEBONIS Jul. 1992 17 p Proposed for presentation at the 28th Joint Propulsion Conference and Exhibit, Nashville, TN, 6-8 Jul. 1992; sponsored by AIAA, SAE, ASME, and ASEE

(Contract RTOP 537-02-23)

(NASA-TM-105715; E-7109; NAS 1.15:105715; AIAA PAPER 92-3570) Avail: CASI HC A03/MF A01

A three-dimensional full Navier-Stokes (FNS) analysis was performed on a mixer/ejector nozzle designed to reduce the jet noise created at takeoff by a future supersonic transport. The PARC3D computational fluid dynamics (CFD) code was used to study the flow field of the nozzle. The grid that was used in the analysis consisted of approximately 900,000 node points contained in eight grid blocks. Two nozzle configurations were studied: a constant area mixing section and a diverging mixing section. Data are presented for predictions of pressure, velocity, and total temperature distributions and for evaluations of internal performance and mixing effectiveness. The analysis provided good insight into the behavior of the flow. Author

N92-28458# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Propulsion and Energetics Panel.

STEADY AND TRANSIENT PERFORMANCE PREDICTION OF GAS TURBINE ENGINES [PREDICTION DES PERFORMANCES DES MOTEURS A TURBINE A GAZ EN REGIMES ETABLI ET TRANSITOIRE]

May 1992 189 p Lectures held in Cambridge, MA, 27-28 May 1992, in Neubiberg, Fed. Republic of Germany, 9-10 Jun. 1992, and in Chatillon/Bagneux, France, 11-12 Jun. 1992

(AGARD-LS-183; ISBN-92-835-0674-X) Copyright Avail: CASI HC A09/MF A02

Aero-thermodynamic performance prediction methods for gas turbine engines with respect to steady and transient operation are discussed. This includes advanced cycle calculation methods, also taking into account variable cycle engine types. A very important objective is the consideration of installation effects, i.e. Reynolds number and inlet distortions, as well as advanced control concepts for increasing engine surge margins. In addition to these topics, individual papers include practical considerations in designing the engine cycle, dynamic simulation, inlet distortion effects in aircraft propulsion system integration, 'smart' engines, and performance and health monitoring models.

N92-28459# Carleton Univ., Ottawa (Ontario). Dept. of Mechanical and Aerospace Engineering.
OVERVIEW ON BASIS AND USE OF PERFORMANCE PREDICTION METHODS
H. I. H. SARAVANAMUTTOO *In* AGARD, Steady and Transient Performance Prediction of Gas Turbine Engines 18 p May 1992
Copyright Avail: CASI HC A03/MF A02
The basic methods of component matching, which is central to the prediction of gas turbine performance, are outlined. Steady-state prediction of off-design performance must be done at the beginning of an engine development program. This ensures that the engine can satisfy all the mission requirements. The matching techniques can be extended to predict transient performance, which is essential for controls development and to ensure good engine handling. The large amount of computation required demands the use of computer modelling and the role of modelling in the development program and the basic requirements for performance modelling are described. Author

N92-28460# Royal Aerospace Establishment, Farnborough (England). Air Vehicle Performance Dept.
PRACTICAL CONSIDERATIONS IN DESIGNING THE ENGINE CYCLE
M. G. PHILPOT *In* AGARD, Steady and Transient Performance Prediction of Gas Turbine Engines 24 p May 1992 Sponsored by Ministry of Defence
Copyright Avail: CASI HC A03/MF A02
To define the cycle parameters and calculate the performance of a real engine, numerous practical constraints need to be taken into account. These fall into two main categories: the limitations of available component technologies; and the operational considerations that are dependent on aircraft application. The main technology limiters are discussed. How they are incorporated into the cycle definition process is indicated. Operational factors include the extent of the intended flight envelope and the range of the critical flight conditions for which performance must be assured, and the balance to be struck between minimizing fuel consumption, maximizing installed power, and constraining costs of ownership. Taking these technology and operational influences into account, the basic cycle characteristics and approach to cycle choice are examined for three main classes of aircraft: subsonic transports, military combat aircraft, and helicopters. Author

N92-28461# Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Moissy-Cramayel (France). Engineering Div.
STEADY AND TRANSIENT PERFORMANCE CALCULATION METHOD FOR PREDICTION, ANALYSIS, AND IDENTIFICATION
JEAN PIERRE DUPONCHEL, JEAN LOISY, and RENE CARRILLO *In* AGARD, Steady and Transient Performance Prediction of Gas Turbine Engines 21 p May 1992
Copyright Avail: CASI HC A03/MF A02
The detailed design and development of turbofans involves the prediction and identification, by means of test analysis, of the performance of the engine and its components. The thermodynamic simulation and analysis codes integrate existing knowledge and interpretations of the detailed operating procedure of the components of the engine being developed. The relevance of the predicted performance depends on the quality of the representation of the various physical phenomena affecting the characteristics of the components and, consequently, on the incorporation of experimental correlation in the modelling. In this context, the representation of compressor and turbine characteristics is particularly important. We will analyze the ability of corrected parameters to represent MACH similitude at the component inlet under various conditions. Author

N92-28462# Carleton Univ., Ottawa (Ontario). Dept. of Mechanical and Aerospace Engineering.
COMPONENT PERFORMANCE REQUIREMENTS
H. I. H. SARAVANAMUTTOO *In* AGARD, Steady and Transient Performance Prediction of Gas Turbine Engines 10 p May 1992
Copyright Avail: CASI HC A02/MF A02
Component data are essential for modelling the overall performance of gas turbines. The component characteristics are not easily obtained, and much of the data are proprietary and not available in the open literature. Several methods are available for estimating component characteristics and are briefly described. The requirements of users and manufacturers are quite different, but both can produce fully credible performance models. Author

N92-28463# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Mechanical Engineering.
DYNAMIC SIMULATION OF COMPRESSOR AND GAS TURBINE PERFORMANCE
WALTER F. OBRIEN *In* AGARD, Steady and Transient Performance Prediction of Gas Turbine Engines 28 p May 1992
Copyright Avail: CASI HC A03/MF A02
Dynamic performance simulation models are discussed with emphasis on the fundamental principles of the models and the methods used to represent component and stage flow characteristics. Results of several simulations of the dynamic behavior of multistage compressors are shown with comparisons to experimental data. Possibilities for advanced computational techniques for near-real-time simulations of compressors and gas turbines are reviewed. Author

N92-28464*# Cambridge Univ. (England).
INLET DISTORTION EFFECTS IN AIRCRAFT PROPULSION SYSTEM INTEGRATION
J. P. LONGLEY (Cambridge Univ. (England).) and E. M. GREITZER (Massachusetts Inst. of Tech., Cambridge.) *In* AGARD, Steady and Transient Performance Prediction of Gas Turbine Engines 18 p May 1992 Sponsored by NASA. Lewis Research Center; GE; and Rolls-Royce Ltd.
Copyright Avail: CASI HC A03/MF A02
A tutorial survey of inlet flow distortion effects on engine performance and stability is presented. Inlet distortions in aero engines arise through a variety of causes. They can be essentially steady, due to non-axisymmetric intake duct geometry, or time varying, for example from flow separation off the lip of the inlet during maneuvers or shock-induced separation during supersonic flight. Whatever the cause, the result is generally a decrease in performance and, more importantly, a lessening of the stable flow range of the compressor. The distortions are generally three-dimensional. It is an extremely useful simplification to break them, at least conceptually, into radial and circumferential non-uniformities and approach each separately. Purely radial distortions can be treated by the methods that were developed for designing compressors in nominally axisymmetric inlet flow, and this type of distortion will be only briefly discussed. Circumferential non-uniformities, however, introduce additional fluid dynamic features into the analysis of compressor behavior and often have the larger impact on performance and stability. Thus we concentrate mainly on the effects of steady circumferential inlet flow distortion. Author

N92-28465# Technische Univ., Munich (Germany, F.R.). Performance Dept.
CALCULATION OF INSTALLATION EFFECTS WITHIN PERFORMANCE COMPUTER PROGRAMS
J. KURZKE *In* AGARD, Steady and Transient Performance Prediction of Gas Turbine Engines 19 p May 1992
Copyright Avail: CASI HC A03/MF A02
Gas turbine engine components, such as compressors, burners, and turbines are usually tested on rigs prior to installation into an engine. In the engine, the component behavior is different for a variety of reasons. The installation effects are caused by small geometrical differences due to nonrepresentative rig operating temperatures and pressures, by different gas properties and Reynolds numbers and by radial as well as circumferential temperature and pressure profiles at the inlet to the component.

For highly accurate performance predictions these rig-to-engine effects are taken into account. Traditionally the term 'installation' is also used for describing all the differences in engine operation and behavior between testbed and aircraft. Intake and afterbody drag, power offtake and bleed, as well as intake pressure losses and inlet flow distortion have significant impact on airflow, thrust, specific fuel consumption, and compressor stability. Using modern performance synthesis programs all these effects can be simulated. Author

N92-28466*# Massachusetts Inst. of Tech., Cambridge. Gas Turbine Lab.

DYNAMIC CONTROL OF AERODYNAMIC INSTABILITIES IN GAS TURBINE ENGINES

E. M. GREITZER, A. H. EPSTEIN, G. R. GUENETTE, D. L. GYSLING, J. HAYNES, G. J. HENDRICKS, J. PADUANO, J. S. SIMON, and L. VALAVANI *In* AGARD, Steady and Transient Performance Prediction of Gas Turbine Engines 20 p May 1992 Sponsored by NASA. Lewis Research Center; AFOSR; ONR; Pratt and Whitney Aircraft; and Army Aviation Systems Command

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This lecture discusses the use of closed loop control at the component level to enhance the performance of gas turbine engines. The general theme is the suppression of flow instabilities (rotating stall and surge) through use of feedback, either actively or by means of the aeromechanical coupling provided by tailored structures. The basic concepts that underlie active control of turbomachinery instability, and their experimental demonstration, are first described for a centrifugal compressor. It is shown that the mechanism for stabilization is associated with damping of unsteady perturbations in the compression system, and the steady-state performance can thus remain virtually unaltered. Control of instability using a tailored structure is then discussed, along with experimental results illustrating the flow range extension achievable using this technique. A considerably more complex problem is presented by active control or rotating stall where the multi-dimensional features mean that distributed sensing and actuation are required. In addition, there are basic questions concerning unsteady fluid mechanics; these imply the need to resolve issues connected with identification of suitable signals as well as with definition of appropriate wave launchers for implementing the feedback. These issues are discussed and the results of initial successful demonstrations of active control of rotating stall in a single-stage and a three-stage axial compressor are presented. The lecture concludes with suggestions for future research on dynamic control of gas turbine engines. Author

N92-28467# GasTOPS Ltd., Gloucester (Ontario).

ENGINE PERFORMANCE AND HEALTH MONITORING MODELS USING STEADY STATE AND TRANSIENT PREDICTION METHODS

B. D. MACISAAC *In* AGARD, Steady and Transient Performance Prediction of Gas Turbine Engines 21 p May 1992

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The role of computer modelling in the design, development, and validation of a performance monitoring system is discussed. The basic requirements of an engine health monitoring system are discussed in the context of the user environment. A form of model based on stage characteristics provides the basis for describing engine measurements. Faults are modelled in accordance with empirical data obtained from tests conducted at the stage level. The model is used to investigate various parameters that provide unambiguous identification of the fault in question. Fault libraries were developed for field use. Author

N92-28686# Science Applications International Corp., San Antonio, TX. Logistics Technology Div.

TURBINE AIRCRAFT ENGINE OPERATIONAL TRENDING AND JT8D STATIC COMPONENT RELIABILITY STUDY Final Report, 28 Mar. 1990 - 28 Mar. 1991

A. BRUCE RICHTER, MARGARET RIDENOUR-BENDER, and MIKE TSAO Mar. 1992 74 p

(Contract F04606-89-D-0036)

(DOT/FAA/CT-91/10) Avail: CASI HC A04/MF A01

The engine subpanel of the June 1988 International Conference on Aging Airplanes identified the need to study aircraft turbine engine static components for reliability problems resulting from aging effects. This study trended in-flight shutdowns and unscheduled removal rates of JT8D, CF6, and JT3D turbine aircraft engines for the two year period of February 1988 through January 1990. Specific engine components on the JT8D engines of air carriers frequently exceeding the industry norm during the trending period were identified. This review noted the following types of component failures occurring: hard failures, wear and tear/inspection failures, structural failures, diagnostic troubleshooting, and maintenance errors. In addition to specific JT8D engine components being identified, an ultrasonic inspection procedure was developed for the JT8D engine outer combustor case boss. Author

N92-28711# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.

DIFFUSER CASING UPGRADE FOR AN ADVANCED TURBOFAN

G. A. KOOL, R. J. H. WANHILL, and C. E. W. LOOIJE 26 Mar. 1990 14 p Presented at the Conference for Life Assessment and Repair Technology for Combustion Turbine Section Components, Phoenix, AZ, 17-19 Apr. 1990 Prepared in cooperation with Royal Netherlands Air Force, The Hague and Turbine Support Europa, Tilburg, Netherlands

(NLR-TP-90097-U; ETN-92-91531) Avail: CASI HC A03/MF A01

A qualification program for upgrade modification and repair of diffuser casings for an advanced turbofan engine type is addressed. The methodology of setting up the program is described and technical aspects are surveyed, paying special attention to critical upgrade/repair items, capability demonstrations, supporting nondestructive inspection and mechanical and metallurgical testing. ESA

N92-28985*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

ELECTROMECHANICAL SYSTEMS WITH TRANSIENT HIGH POWER RESPONSE OPERATING FROM A RESONANT AC LINK

LINDA M. BURROWS and IRVING G. HANSEN 1992 6 p Proposed for presentation at the 27th Intersociety Energy Conversion Engineering Conference, San Diego, CA, 3-7 Aug. 1992; sponsored by SAE, ACS, AIAA, ASME, IEEE, AIChE, and ANS

(Contract RTOP 906-11-03)

(NASA-TM-105716; E-7113; NAS 1.15:105716) Avail: CASI HC A02/MF A01

The combination of an inherently robust asynchronous (induction) electrical machine with the rapid control of energy provided by a high frequency resonant AC link enables the efficient management of higher power levels with greater versatility. This could have a variety of applications from launch vehicles to all-electric automobiles. These types of systems utilize a machine which is operated by independent control of both the voltage and frequency. This is made possible by using an indirect field-oriented control method which allows instantaneous torque control in all four operating quadrants. Incorporating the AC link allows the converter in these systems to switch at the zero crossing of every half cycle of the AC waveform. This zero loss switching of the link allows rapid energy variations to be achieved without the usual frequency proportional switching loss. Several field-oriented control systems were developed by LeRC and General Dynamics Space Systems Division under contract to NASA. A description of a single motor, electromechanical actuation system is presented. Then, focus is on a conceptual design for an AC electric vehicle. This design incorporates an induction motor/generator together with a flywheel for peak energy storage. System operation and implications along with the associated circuitry are addressed. Such a system would greatly improve all-electric vehicle ranges over the Federal Urban Driving Cycle (FUD). Author

N92-29425*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
EFFECTS OF BLEED AIR EXTRACTION ON THRUST LEVELS ON THE F404-GE-400 TURBOFAN ENGINE
ANDREW J. YUHAS (PRC Kentron, Inc., Edwards, CA.) and RONALD J. RAY Jul. 1992 15 p Presented at the 28th AIAA Joint Propulsion Conference, Nashville, TN, 6-8 Jul. 1992
(Contract RTOP 505-68-30)
(NASA-TM-104247; H-1806; NAS 1.15:104247; AIAA PAPER 92-3092) Avail: CASI HC A03/MF A01

A ground test was performed to determine the effects of compressor bleed flow extraction on the performance of F404-GE-400 afterburning turbofan engines. The two engines were installed in the F/A-18 High Alpha Research Vehicle at the NASA Dryden Flight Research Facility. A specialized bleed ducting system was installed onto the aircraft to control and measure engine bleed airflow while the aircraft was tied down to a thrust measuring stand. The test was conducted on each engine and at various power settings. The bleed air extraction levels analyzed included flow rates above the manufacturer's maximum specification limit. The measured relationship between thrust and bleed flow extraction was shown to be essentially linear at all power settings with an increase in bleed flow causing a corresponding decrease in thrust. A comparison with the F404-GE-400 steady-state engine simulation showed the estimation to be within +/- 1 percent of measured thrust losses for large increases in bleed flow rate. Author

N92-29427*# DieselDyne Corp., Morrow, OH.
A PRELIMINARY DESIGN AND ANALYSIS OF AN ADVANCED HEAT-REJECTION SYSTEM FOR AN EXTREME ALTITUDE ADVANCED VARIABLE CYCLE DIESEL ENGINE INSTALLED IN A HIGH-ALTITUDE ADVANCED RESEARCH PLATFORM
RICHARD P. JOHNSTON Jul. 1992 55 p
(Contract NAS2-131313; RTOP 505-69-14)
(NASA-CR-186021; H-1775; NAS 1.26:186021) Avail: CASI HC A04/MF A01

Satellite surveillance in such areas as the Antarctic indicates that from time to time concentration of ozone grows and shrinks. An effort to obtain useful atmospheric data for determining the causes of ozone depletion would require a flight capable of reaching altitudes of at least 100,000 ft and flying subsonically during the sampling portion of the mission. A study of a heat rejection system for an advanced variable cycle diesel (AVCD) engine was conducted. The engine was installed in an extreme altitude, high altitude advanced research platform. Results indicate that the waste heat from an AVCD engine propulsion system can be rejected at the maximum cruise altitude of 120,000 ft. Fifteen performance points, reflecting the behavior of the engine as the vehicle proceeded through the mission, were used to characterize the heat exchanger operation. That portion of the study is described in a appendix titled, 'A Detailed Study of the Heat Rejection System for an Extreme Altitude Atmospheric Sampling Aircraft,' by a consultant, Mr. James Bourne, Lytron, Incorporated. Author

N92-29659*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
FLIGHT EVALUATION OF AN EXTENDED ENGINE LIFE MODE ON AN F-15 AIRPLANE
LAWRENCE P. MYERS and TIMOTHY R. CONNERS Apr. 1992 29 p
(Contract RTOP 533-02-36)
(NASA-TM-104240; H-1764; NAS 1.15:104240) Avail: CASI HC A03/MF A01

An integrated flight and propulsion control system designed to reduce the rate of engine deterioration was developed and evaluated in flight on the NASA Dryden F-15 research aircraft. The extended engine life mode increases engine pressure ratio while reducing engine airflow to lower the turbine temperature at constant thrust. The engine pressure ratio uptrim is modulated in real time based on airplane maneuver requirements, flight conditions, and engine information. The extended engine life mode logic performed well, significantly reducing turbine operating temperature. Reductions in fan turbine inlet temperature of up to 80 F were obtained at intermediate power and up to 170 F at maximum augmented power with no appreciable loss in thrust. A secondary benefit was the considerable reduction in thrust-specific fuel consumption. The success of the extended engine life mode is one example of the advantages gained from integrating aircraft flight and propulsion control systems. Author

N92-29661*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CONTINGENCY POWER FOR A SMALL TURBOSHAFT ENGINE BY USING WATER INJECTION INTO TURBINE COOLING AIR
THOMAS J. BIESIADNY and GARY A. KLANN (Army Aviation Systems Command, Cleveland, OH.) 1992 10 p Prepared for presentation at the 80th Symposium on Heat Transfer and Cooling in Gas Turbines, Antalya, Turkey, 12-16 Oct. 1992; sponsored in part by AGARD Propulsion and Energetics Panel
(Contract RTOP 505-68-32)
(NASA-TM-105680; AVSCOM-TR-92-C-019; E-7058; NAS 1.15:105680) Avail: CASI HC A02/MF A01

Because of one-engine-inoperative (OEI) requirements, together with hot-gas reingestion and hot-day, high-altitude take-off situations, power augmentation for multiengine rotorcraft has always been of critical interest. However, power augmentation by using overtemperature at the turbine inlet will shorten turbine life unless a method of limiting thermal and mechanical stress is found. A possible solution involves allowing the turbine inlet temperature to rise to augment power while injecting water into the turbine cooling air to limit hot-section metal temperatures. An experimental water injection device was installed in an engine and successfully tested. Although concern for unprotected subcomponents in the engine hot section prevented demonstration of the technique's maximum potential, it was still possible to demonstrate increases in power while maintaining nearly constant turbine rotor blade temperature. Author

N92-29927# Universitaet der Bundeswehr Muenchen, Neubiberg (Germany, F.R.). Fakultaet fuer Luft- und Raumfahrttechnik.
EXAMINATION OF THE MAIN ERROR FACTORS WITH REGARDS TO SECONDARY LOSSES IN COMPRESSION AND TURBINE CASCADES BY VARIATIONS OF THE BLADE PICTURE RATIO Ph.D. Thesis [UNTERSUCHUNG DER WESENTLICHEN EINFLUSSFAKTOREN AUF DIE SEKUNDAERVERLUESTE IN VERDICHTER- UND TURBINENGITTERN BEI VARIATION DES SCHAUELSEITENVERHAELTNISSES]
ROBERT WATZLAWICK 1991 196 p In GERMAN
(ETN-92-91493) Avail: CASI HC A09/MF A03

Extensive experimental examinations were carried out for determining loss correlations. Three various chord lengths were considered for compressor and turbine profile, in order to obtain information on the influence of blade picture ratio. It is shown that the reduced secondary loss coefficient with the blade picture ratio is independent of blade height and chord length for compressor and turbine cascades. For turbines, the profile loss coefficient can be used with good approximation as a parameter for secondary loss coefficients, with regard to the strong interaction of profile boundary layer and channel vortex. This parameter is not suitable for compressor correlations. ESA

08

AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

A92-45319
A PROGRESS REPORT ON ASTOVL CONTROL CONCEPT STUDIES UNDER THE VAAC PROGRAMME

O. P. NICHOLAS (Royal Aerospace Establishment, Bedford, England) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. III.7.1-III.7.14. refs
Copyright

A paper by Nicholas (1987) about the ASTOVL control concept studies under the VAAC program is updated. The experimental flight control system fitted to the VAAC aircraft is described. A broad spectrum of potential STOVL control concepts under consideration is outlined, with emphasis on the longitudinal plane. Attention is given to three broad longitudinal plane control concepts for the STOVL regime: three inceptors controlling pitch, thrust magnitude, and thrust direction; three inceptors controlling pitch, normal thrust component, and longitudinal thrust component; and two inceptors controlling total (aerodynamic plus thrust) normal force and total longitudinal force, with pitch responding as necessary to provide this. It is planned to apply increasing effort to the development of displays to match the characteristics of the different longitudinal control concepts and also to control in the lateral/directional sense. C.A.B.

A92-45320 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

INTEGRATED FLIGHT/PROPULSION CONTROL FOR SUPERSONIC STOVL AIRCRAFT

JAMES A. FRANKLIN, MICHAEL W. STORTZ (NASA, Ames Research Center, Moffett Field, CA), and JAMES R. MIHALOEW (NASA, Lewis Research Center, Cleveland, OH) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. III.8.1-III.8.12. refs
Copyright

A technology program to investigate integrated flight/propulsion control-system design for STOVL fighter aircraft is described. Integrated control systems being developed by U.S. industry for specific STOVL concepts are discussed. Attention is given to NASA involvement in the definition of control concepts, design-methods and flying-qualities criteria, and the evaluation of these concepts and criteria in analytical design studies, in ground-based experiments, and in flight on the Harrier V/STOL research aircraft. Initial fixed-base simulation experiments conducted for two STOVL fighter concepts are discussed. These simulations defined acceptable transition flight envelopes, determined control power used during transition and hover, and provided evaluations of the integration of the flight and propulsion controls to achieve good flying qualities throughout the low-speed flight envelope. C.A.B.

A92-45322

INTEGRATED FLIGHT CONTROL SYSTEMS - ARCHITECTURAL CONSIDERATIONS FOR FUTURE AIRCRAFT CONCEPTS

RICHARD B. SMITH (GEC Avionics, Ltd., Rochester, England) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. III.10.1-III.10.12.
Copyright

The current generation of automatic flight control systems technology is reviewed in relation to the developing operational and logistical requirements, particularly for single crew air superiority vehicles. It is proposed that the requirements for reduced pilot workload and a mean time between mandatory maintenance specification will be met by an integrated vehicle management system concept. The design drivers involved in the development of an integrated approach to automatic vehicle management are reviewed in the context of the overall size and complexity of the task for ASTOVL aircraft. Consideration is given to the issues involved in interfunctional cooperation, system availability and integrity, and weight minimization. A control strategy for integrated flight and propulsion control is outlined. An architectural concept to meet extended off-base availability requirements without first line maintenance intervention is quantitatively justified. A candidate integrated vehicle management system architecture is proposed, and recommendations for the development of the technologies essential to its creation are advanced. C.A.B.

A92-45382

CIVIL DEVELOPMENT AND CERTIFICATION OF A HELICOPTER AUTOMATIC APPROACH AND HOVER SYSTEM ON THE SIKORSKY S-76

SYDNEY E. GURLEY (Sikorsky Aircraft, West Palm Beach, FL) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 111-120. refs
(SAE PAPER 911975) Copyright

A key element of the S-76 helicopter's digital automatic flight control system is a novel approach-and-hover electronic flight instrument system for all-weather search-and-rescue operations. More than 50 such automatic approaches have been made during certification by pilots of varied background and helicopter experience, in conditions that included nocturnal overwater approaches. The system has demonstrated the full range of search-and-rescue-related capabilities in all instrument meteorological conditions. O.C.

A92-45384

ESTIMATION OF SPACEPLANE LATERAL-DIRECTIONAL STABILITY AND CONTROL DERIVATIVES FROM DYNAMIC WIND TUNNEL TEST

MASAAKI YANAGIHARA, SEIZO SUZUKI, SHIGEO KAYABA, and KATSUICHI MUROTA (National Aerospace Laboratory, Chofu, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 131-139. refs
(SAE PAPER 911979) Copyright

Dynamic wind tunnel tests using a 5-percent cable-mounted model of the NAL spaceplane have been performed in the NAL low-speed large scale wind tunnel to identify the aerodynamic model including dynamic effects. During the test performed in March 1991, the lateral-directional motion was excited by aileron and rudder inputs. A flight path reconstruction was applied to the recorded data and a parameter identification study of the reconstructed data was undertaken to extract lateral-directional stability and control derivatives using the least square method. The estimated derivatives were compared with the results of static wind tunnel tests and theoretically estimated dynamic derivatives. They were also evaluated by comparing mathematically simulated time histories calculated using them with the wind tunnel test data. As a result, all major derivatives were estimated well and effectiveness of the dynamic test was shown. Author

A92-45450

IN-FLIGHT SIMULATION OF BACKSIDE OPERATING MODELS USING DIRECT LIFT CONTROLLER

YUKICHI TSUKANO (National Aerospace Laboratory, Chofu, Japan), MASAKI KOMODA (Tokyo Metropolitan Institute of Technology, Japan), NAGAKATU KAWAHATA (Nihon University, Chiba, Japan), and TOSHIHARU INAGAKI (National Aerospace Laboratory, Chofu, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 815-823. refs
(SAE PAPER 912069) Copyright

Effectiveness of a direct lift controller (DLC) for in-flight simulation is discussed. When a model aircraft is operating in backside of power curve, DLC is indispensable. On the basis of this, quick-moving flaps are installed on the variable stability and response airplane of the National Aerospace Laboratory of Japan. Direct lift capability of the flaps are precisely identified. After tailoring adequate feedback/feed forward gains, a model-following system is constructed to simulate backside-operating models by a mother airplane which is operating in frontside. As an application, a flight test result for simulated landing approach in backside range is shown. Author

A92-45488#
RAPID SYNTHESIS FOR EVALUATING MISSILE MANEUVERABILITY PARAMETERS
PAKRAD A. GIRAGOSIAN (Wright Brothers Aerospace Systems, Concord, MA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 141-148. refs
(AIAA PAPER 92-2615) Copyright

Theoretical and semi-empirical algorithms for the preliminary determination of a missile airframe's geometric and mass properties, aerodynamic characteristics, and propulsion parameters to fulfill given maneuverability requirements are presented. The expressions developed apply to a wide range of missile configurations and can be used, with reasonable accuracy, to define some of the more pertinent missile key design and performance parameters on a first-cut basis. Example computations are presented and compared to experimental data. Author

A92-46737
COMPARISON OF SIX ROBUSTNESS TESTS EVALUATING MISSILE AUTOPILOT ROBUSTNESS TO UNCERTAIN AERODYNAMICS
KEVIN A. WISE (McDonnell Douglas Missile Systems Co., Saint Louis, MO) (1990 American Control Conference, 9th, San Diego, CA, May 23-25, 1990, Proceedings. Vol. 1, p. 755-763) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 4, July-Aug. 1992, p. 861-870. Previously cited in issue 11, p. 1707, Accession no. A91-30078. refs
Copyright

A92-46739* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ON-LINE PERFORMANCE EVALUATION OF MULTILOOP DIGITAL CONTROL SYSTEMS
ANTHONY POTOTZKY (Lockheed Engineering and Sciences Co., Hampton, VA), CAROL WIESEMAN, SHERWOOD T. HOADLEY, and VIVEK MUKHOPADHYAY (NASA, Langley Research Center, Hampton, VA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 4, July-Aug. 1992, p. 878-884. Previously cited in issue 21, p. 3317, Accession no. A90-47747. refs
Copyright

A92-46741
APPROACH GUIDANCE IN A DOWNBURST
YIYUAN ZHAO (Minnesota, University, Minneapolis) and A. E. BRYSON (Stanford University, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 4, July-Aug. 1992, p. 893-900. refs
Copyright

A nonlinear feedback law for safe aircraft penetration through downbursts on landing approach is presented. It is based on following a nominal approach path relative to the ground, subject to a minimum airspeed constraint. The guidance design uses a point-mass aircraft model and considers the flight path to be in the vertical plane. The slack variable transformation method is modified to handle the airspeed constraint and apply the nonlinear dynamic inversion technique for the guidance law synthesis. Nonlinear numerical simulation results are presented for three different downburst histories. The main features of the proposed guidance logic are normal behavior when there is no wind, tracking of the nominal path in the presence of downbursts, and insensitivity to different downburst models. Piloting implications and other aspects of landing approach in downbursts are discussed. Author

A92-46742* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PARAMETER IDENTIFICATION OF LINEAR SYSTEMS BASED ON SMOOTHING
M. IDAN and A. E. BRYSON (Stanford University, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 4, July-Aug. 1992, p. 901-911. Research supported by Advanced Rotorcraft Technology, Inc. Previously cited in issue 20, p. 3155, Accession no. A90-45156. refs
(Contract NCC2-106)
Copyright

A92-46749
X-29 H-INFINITY CONTROLLER SYNTHESIS
W. L. ROGERS and D. J. COLLINS (U.S. Naval Postgraduate School, Monterey, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 4, July-Aug. 1992, p. 962-967. refs

H2 and H-infinity controllers have been designed for the unstable longitudinal analog backup mode of the X-29 aircraft. When actuator design limitations are considered, the expected superiority of the H-infinity design over the H2 design is not obtained. The limited performance designs also do not exhibit the precision flight-path control modes that are characteristic of the H-infinity designs. Author

A92-46750
THRUST LAWS FOR MICROBURST WIND SHEAR PENETRATION
MARK L. PSIAKI and KIHONG PARK (Cornell University, Ithaca, NY) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 4, July-Aug. 1992, p. 968-975. Previously cited in issue 23, p. 3621, Accession no. A89-52645. refs
Copyright

A92-46751* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NONLINEAR INVERSION FLIGHT CONTROL FOR A SUPERMANEUVERABLE AIRCRAFT
S. A. SNELL, DALE F. ENNS, and WILLIAM L. GARRARD, JR. (Minnesota, University, Minneapolis) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 4, July-Aug. 1992, p. 976-984. Previously cited in issue 21, p. 3315, Accession no. A90-47661. refs
(Contract NAG1-321)
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A92-46752
INTEGRATED AEROSERVOELASTIC WING SYNTHESIS BY NONLINEAR PROGRAMMING/APPROXIMATION CONCEPTS
E. LIVNE (Washington, University, Seattle), P. P. FRIEDMANN, and L. A. SCHMIT (California, University, Los Angeles) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 4, July-Aug. 1992, p. 985-993. refs
(Contract F49620-87-K-0003)
Copyright

Nonlinear programming/approximation concepts optimization techniques developed for structural synthesis are adapted to the integrated aeroservoelastic wing synthesis problem, in which constraints from several disciplines are taken into account simultaneously and the design space includes structural and control system design variables. Structural, aerodynamic, and control system mathematical models that are suitable for the preliminary design of airplanes are used in an integrated synthesis of wings and their active control systems. The effectiveness and efficiency of the new capability are studied using mathematical models of a remotely piloted vehicle as well as a more complex YF16-type airplane model. Simplified handling quality constraints are added to the set of design requirements. The performance of several complex eigenvalue approximations is examined. Effects of control law structure on the weight and robustness of the resulting aeroservoelastic designs provide new insights into the complex multidisciplinary interactions involved. Author

A92-46761
SYMPTOM OF PAYLOAD-INDUCED FLIGHT INSTABILITY
CHARLES H. MURPHY (U.S. Army, Ballistic Research Laboratory, Aberdeen Proving Ground, MD) Journal of Guidance, Control,

and Dynamics (ISSN 0731-5090), vol. 15, no. 4, July-Aug. 1992, p. 1038-1040. refs

The correlation between spin and side moment is used as a diagnostic for payload-induced instability. The paper reviews the experimental observations and theories that deal with this relation for a variety of moving components. A very simple relation that applies to all moving payloads in steady-state motion is derived, thus validating the diagnostic tool. It is noted that the presence of payload-induced side moment can always be identified by the roll moment for large coning motion. More importantly, the payload side moment can be measured in ground tests by measurement of the spin moment exerted by a payload doing a forced coning motion. L.M.

A92-46765

HANG-GLIDER RESPONSE TO ATMOSPHERIC INPUTS

GUIDO DE MATTEIS (Roma I, Universita, Rome, Italy) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 4, July-Aug. 1992, p. 1048-1050. refs

Copyright

Hang-glider flight in a turbulent atmosphere is presently considered in a framework where, in analogy for conventional aircraft, hang-glider response to atmospheric inputs is characterized in terms of gust-transfer functions and the power spectral densities of the output. Attention is given to longitudinal motion; the gust transfer functions of the longitudinal state variables and of the load factor are determined, and the effects of approximations connected with the modeling of the inputs are discussed in light of characteristic frequencies for the glider in cruise conditions. O.C.

A92-46776

FLIGHT MODEL FOR UNMANNED SIMULATED HELICOPTERS

AMNON KATZ (Alabama, University, Tuscaloosa) and BRETT E. BUTLER (McDonnell Douglas Helicopter Co., Mesa, AZ) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 521-526. refs

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This paper presents flight model for use in simulating computer generated helicopters. Momentum and energy balance is used to define a rotor thrust envelope. The four basic control inputs take the form of thrust components and the sideslip angle. Time integrations are performed for the three center of mass degrees of freedom only. Six degrees of freedom information is derived for the visual displays. The model can inexpensively function in real time and faster than real time. Validity is demonstrated by comparing model performance predictions with published data. Author

A92-46777

RECONSTRUCTION OF FLIGHT PATH IN TURBULENCE

QING CHEN (Braunschweig, Technische Universitaet, Federal Republic of Germany) and YUAN LIN (DLR, Institut fuer Flugmechanik, Braunschweig, Federal Republic of Germany) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 527-531. refs

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In the majority of previous investigations, compatibility checks of measured flight data have been carried out under the assumption of smooth air, neglecting atmospheric turbulence mainly because of its complexity of modeling. Based on the essential view of system theory, this paper proposes an effective strategy to reconstruct the flight path in turbulent air in two steps: (1) as in conventional methods, an error model for sensors, processors and a stationary windfield model are identified from flight maneuvers in smooth air; and (2) retaining some of the first step results pertaining to the inherent characteristics of data measurement and acquisition systems, a data consistency check for flight data in turbulent air is carried out using the same method as that in step 1 above. The two-step procedure eliminates the need for a turbulence model and, thus, yields identification results that are independent of wind model. Furthermore, use of this approach makes it possible to evaluate the precision of onboard wind measurement. The utility of the proposed approach is demonstrated by reconstruction of longitudinal flight path from flight test in turbulence with the research aircraft DORNIER DO128. Author

A92-46794

MAXIMIZING THRUST-VECTORING CONTROL POWER AND AGILITY METRICS

BENJAMIN Z. GAL-OR (Technion - Israel Institute of Technology, Haifa) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 647-651. refs

Copyright

A new set of standard agility comparison maneuvers (SACOM) is proposed for testing the maximization of thrust-vectoring control power during poststall, manned, and unmanned flight tests. An innovative approach is presented to help define and simulate agility in a low cost manner by means of unmanned scaled models. Debated agility metrics are reassessed in light of new developments in multiaxis thrust vectoring. A methodology for measuring and maximizing TV-agility under PST conditions has been identified. Excellent controllability and very rapid nose pointing are easily obtainable during PST-TV maneuvers. TV-agility is an interdisciplinary subject involving a revolution in engineering and pilot education. Author

A92-46802* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

SELF-INDUCED ROLL OSCILLATIONS OF LOW-ASPECT-RATIO RECTANGULAR WINGS

DANIEL LEVIN (NASA, Ames Research Center, Moffett Field, CA) and JOSEPH KATZ (San Diego State University, CA) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 698-702. Previously cited in issue 20, p. 3155, Accession no. A90-45151. refs

(Contract NCC2-458)

Copyright

A92-46810

PITCH RATE/SIDESLIP EFFECTS ON LEADING-EDGE EXTENSION VORTICES OF AN F/A-18 AIRCRAFT MODEL

SHESHAGIRI K. HEBBAR, MAX F. PLATZER (U.S. Naval Postgraduate School, Monterey, CA), and ODILON V. CAVAZOS (U.S. Navy, Naval Air Station, San Diego, CA) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 720-723. Research sponsored by U.S. Navy. Previously cited in issue 06, p. 797, Accession no. A91-19216. refs

A92-46923

AEROMECHANICAL STABILITY OF HINGELESS HELICOPTER ROTORS IN FORWARD FLIGHT

WAI Y. CHAN and INDERJIT CHOPRA (Maryland, University, College Park) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 6-1 to 6-22. refs

(Contract DAAL03-88-C-0002)

The present investigation of hingeless rotors' aeromechanical stability in forward flight uses a simple flap-lag blade model and a pitch-and-roll degree-of-freedom rigid-body fuselage mode, in conjunction with a dynamic inflow modeling of unsteady aerodynamic effects. Parametric studies are conducted to study the aeromechanical stability effects of several design parameters, encompassing forward speed, Lock number, thrust level, structural coupling, pitch-lagcoupling, body pitch and roll degrees of freedom, blade-lag stiffness, and dynamic inflow. Air resonance instability is stabilized for moderate forward speeds, but becomes more unstable at high forward speeds. Higher thrust and Lock number also aggravate this instability. O.C.

A92-46931* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

PERIODIC TRIM SOLUTIONS WITH HP-VERSION FINITE ELEMENTS IN TIME

LIN-JUN HOU and DAVID A. PETERS (Georgia Institute of

Technology, Atlanta) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 18-1 to 18-18. Previously announced in STAR as N91-13449. refs
(Contract NAG1-1027)
Finite elements in time as an alternative strategy for rotorcraft trim problems are studied. The research treats linear flap and linearized flap-lag response both for quasi-trim and trim cases. The connection between Fourier series analysis and hp-finite elements for periodic a problem is also examined. It is proved that Fourier series is a special case of space-time finite elements in which one element is used with a strong displacement formulation. Comparisons are made with respect to accuracy among Fourier analysis, displacement methods, and mixed methods over a variety parameters. The hp trade-off is studied for the periodic trim problem to provide an optimum step size and order of polynomial for a given error criteria. It is found that finite elements in time can outperform Fourier analysis for periodic problems, and for some given error criteria. The mixed method provides better results than does the displacement method. Author

A92-46933
COMPUTATIONAL ASPECTS OF HELICOPTER TRIM ANALYSIS AND DAMPING LEVELS FROM FLOQUET THEORY
N. S. ACHAR and G. H. GAONKAR (Florida Atlantic University, Boca Raton) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 20-1 to 20-14. refs
(Contract DAAL03-87-K-0037)
The computational reliability and time requirement are investigated for a time analysis for periodic initial state and control inputs, as well as eigenanalysis, of the Floquet transition matrix. The trim analysis employs both the shooting method and a weak version of a temporal FEM with mixed formulation of displacements and momenta. In each method, the initial state and control inputs are computed both sequentially and simultaneously; the resulting nonlinear algebraic equations are solved by damped Newton iteration, with an optimally selected damping parameter which virtually eliminates divergence between the two trim analysis methods. O.C.

A92-47777
MATHEMATICAL MODELING OF THE FLIGHT OF PASSENGER AIRCRAFT IN THE CASE OF ENGINE FAILURE [MODELOWANIE MATEMATYCZNE LOTU SAMOLOTU PASAZERSKEGO W STANACH AWARII SILNIKOW]
REALY FLOUTI and JERZY MARYNIAK (Warsaw University of Technology, Poland) Politechnika Slaska, Zeszyty Naukowe, Mechanika (ISSN 0434-0817), no. 107, 1992, p. 135-141. In Polish. refs
The effects of engine failure and fuselage deformation on the flight dynamics of a passenger aircraft with tail-mounted engines are examined, with the IL-62M aircraft used as an example. In the analysis, the aircraft is treated as a rigid body with six degrees of freedom, with allowance for the possibility of the flexural deformation of the tail section. The equations of aircraft motion are derived using Boltzmann-Hamel equations for mechanical systems with holonomic constraints. The motion of the aircraft in the case of engine failure is simulated numerically using fifth- and sixth-order Runge-Kutta-Verner methods. Results of calculations are presented in graphic form. V.L.

A92-47779
CALCULATION OF THE AERODYNAMIC DERIVATIVES OF AIRCRAFT IN THE SUPERSONIC REGION USING THE MACH BOX METHOD [OBLICZANIE POCHODNYCH AERODYNAMICZNYCH SAMOLOTU W ZAKRESIE NADDZWIEKOWYM PRZY ZASTOSOWANIU METODY 'PUDELEK MACHA']
TOMASZ GOETZENDORF-GRABOWSKI (Warsaw University of Technology, Poland) Politechnika Slaska, Zeszyty Naukowe, Mechanika (ISSN 0434-0817), no. 107, 1992, p. 151-157. In Polish. refs
Physical and mathematical models are presented which describe the motion of an aircraft in steady supersonic potential flow of a gas. A numerical method for calculating the aerodynamic parameters is proposed which is referred to as the Mach box method. Results of calculations are presented. V.L.

A92-47783
MODELING OF THE CONTROL SYSTEMS OF ROTARY WING AIRCRAFT (REVIEW) [MODELOWANIE UKLADOV STEROWANIA WIROPLATOW (REFERAT PRZEGLADOWY)]
WIESLAW LUCJANEK and JANUSZ MARKIEWICZ (Warsaw University of Technology, Poland) Politechnika Slaska, Zeszyty Naukowe, Mechanika (ISSN 0434-0817), no. 107, 1992, p. 243-249. In Polish. refs
Methods for controlling the flight of rotary wing aircraft are discussed, as are physical models used for the analysis of flight control systems. In particular, attention is given to some new approaches to rotary wing aircraft control, such as higher harmonic control, individual blade control, fly by wire control, side stick control, voice control, and pilot head movement control. Schemes of tilt rotor control and control mechanisms used in helicopter and airplane mode flights are shown. V.L.

A92-47784
MATHEMATICAL MODELING OF THE EFFECT OF WINDSHEAR ON THE DYNAMICS OF A LANDING AIRCRAFT [MODELOWANIE MATEMATYCZNE WPLYWU ZMIENNEGO RUCHU POWIETRZA NA DYNAMIKE LADUJACEGO SAMOLOTU]
JERZY MARYNIAK and JIMOH PEDRO (Warsaw University of Technology, Poland) Politechnika Slaska, Zeszyty Naukowe, Mechanika (ISSN 0434-0817), no. 107, 1992, p. 257-264. In Polish. refs
The dynamic characteristics of a multiple-engine aircraft during an approach to landing are modeled mathematically. A complete set of nonlinear equations of motion is derived for the aircraft, with three-dimensional variable wind and windshear terms included. Changes of the aerodynamic coefficients due to windshear are computed on the basis of quasi-steady aerodynamics. V.L.

A92-47785
AIRCRAFT STABILIZATION AT LARGE ANGLES OF ATTACK [STABILIZACJA SAMOLOTU NA DUZYCH KATACH NATARCIA]
WIESLAW J. J. MICHALSKI and MARIA ZLOCKA (Warsaw University of Technology, Poland) Politechnika Slaska, Zeszyty Naukowe, Mechanika (ISSN 0434-0817), no. 107, 1992, p. 283-290. In Polish. refs
Based on physical and mathematical modeling, a system of nonlinear equations of motion is obtained for a rigid aircraft with six degrees of freedom. For steady straight horizontal flight at large angles of attack, an optimal control law is synthesized for a quadratic quality criterion. It is shown that the required flight conditions can be maintained using active control based on a certain law. Results of a numerical simulation of the motion of an actively controlled aircraft are presented. V.L.

A92-47786
A NEW METHOD OF HELICOPTER ROTOR BLADE MOTION CONTROL [NOWA METODA STEROWANIA RUCHEM LOPAT WIRNIKOW SMIGLOWCOW]
JANUSZ NARKIEWICZ, WIESLAW LUCJANEK (Warsaw University of Technology, Poland), TOMASZ BARTLER (Aviation Institute, Warsaw, Poland), and JACEK SYRYCZYNSKI (PZL Okecie, Warsaw, Poland) Politechnika Slaska, Zeszyty Naukowe, Mechanika (ISSN 0434-0817), no. 107, 1992, p. 299-303. In Polish. refs
A method of helicopter rotor blade motion control is proposed which makes it possible to reduce the level of vibration. For a

general model of an isolated rotor blade, active optimal control with a quadratic quality index is used. The method is also applicable to other plants with lifting surfaces. V.L.

A92-48160* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NONLINEAR CONTROL DESIGN FOR SLIGHTLY NONMINIMUM PHASE SYSTEMS - APPLICATION TO V/STOL AIRCRAFT
JOHN HAUSER (Southern California, University, Los Angeles, CA), SHANKAR SASTRY (California, University, Berkeley), and GEORGE MEYER (NASA, Ames Research Center, Moffett Field, CA) Automatica (ISSN 0005-1098), vol. 28, no. 4, July 1992, p. 665-679. Research supported by Schlumberger Foundation and Berkeley Engineering Fund. refs
(Contract NAG2-243)
Copyright
The paper describes the application of techniques of exact I/O linearization of nonlinear control systems to the flight control of V/STOL aircraft. It is seen that the application of the theory to this example is not straightforward; in particular, the direct application of the theory yielded an undesirable controller. The situation was remedied by neglecting the coupling between the rolling moment input to the aircraft dynamics and the dynamics along the y-axis. An approximate I/O linearization procedure developed for slightly nonminimum phase nonlinear systems is shown to be effective for V/STOL aircraft. L.M.

A92-48487
THE PROPULSIVE-ONLY FLIGHT CONTROL PROBLEM
DANIEL J. BIEZAD (California Polytechnic State University, San Luis Obispo) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 494-500. refs
Copyright
Attitude control of aircraft using only the throttles is investigated. The long time constants of both the engines and the aircraft dynamics, together with the coupling between longitudinal and lateral aircraft modes, make piloted flight with failed control surfaces hazardous, especially when trying to land. In the present work, the author documents the results of in-flight operation using simulated failed flight controls and ground simulations of piloted propulsive-only control to touchdown. Augmentation control laws to assist the pilot are described using both optimal control and classical feedback methods. Piloted simulation using augmentation shows that simple and effective augmented control can be achieved in a wide variety of failed configurations. I.E.

A92-48488
ANALYSIS OF THE VISTA LONGITUDINAL SIMULATION CAPABILITY FOR A CRUISE FLIGHT CONDITION
BA T. NGUYEN, LYNNE T. HAMILTON-JONES, and DAVID B. LEGGETT (USAF, Wright Laboratory, Wright-Patterson AFB, OH) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 501-507. refs
The Variable Stability In-Flight Simulator Test Aircraft (VISTA) is the next-generation US in-flight simulator for high-performance aircraft currently being developed by the US Air Force. In the present analysis, the authors estimate the range of dynamic response characteristics that the VISTA can simulate for the longitudinal mode of an up-and-away flight condition. The analysis matched the angle-of-attack time response of a low-order model to a linear simulation of the VISTA aircraft for a range of feedback gain sets. The analysis indicates that the VISTA aircraft does not meet the goal for up-and-away short-period mode. VISTA also does not meet the requirement for having less than 70 msec of equivalent time delay between the model and VISTA aircraft response for an aircraft with no time delay. This will have less effect in practice because all modern aircraft have time delay due to actuators and computations from hardware and software. I.E.

A92-48490
F-16 FAILURE DETECTION ISOLATION AND ESTIMATION STUDY
YING-JYI P. WEI and SHAHROKH GHAYEM (General Dynamics Corp., Fort Worth, TX) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 515-521. refs
Copyright
The authors discuss the evaluation of a modified multiple hypothesis FDIE (failure detection, isolation, and estimation) scheme in a high-fidelity nonlinear six-degree-of-freedom F-16 simulation. They present examples of detection of horizontal tail failure at an air combat maneuver entry flight condition, and rudder failure while maneuvering at supersonic speed and low altitude. The simulation results indicate that the FDIE can function properly within a fraction of a second. Thus, further control law reconfiguration and positive pilot alert are possible to benefit the F-16's combat capabilities. I.E.

A92-48491
SIMPLE FLY-BY-WIRE ACTUATOR
GAVIN D. JENNEY (Dynamic Controls, Inc., Dayton, OH) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 522-528. refs
(Contract F33615-86-C-3606)
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The research and development of a simple fly-by-wire (FBW) hydraulic actuator is described. The actuator incorporated a pair of two-position valves for fluid metering. The valves were designed for high response and were driven by a pulse-width-modulated control signal. The actuator was designed to have the nominal force, slew rate, and frequency response of an F-16 Horizontal Tail/Flaperon Integrated Servo Actuator (ISA) when operating with one hydraulic supply system. The simple actuator configuration demonstrated control characteristics and input/output performance characteristics that equal or exceed current FBW actuator configurations (particularly the characteristics of frequency response and threshold). The power input for the control valves (29 W at 100 percent modulation) is consistent with modern direct drive FBW analog control valve power requirements. The response time for the valves was satisfactory for the control of the actuator. I.E.

A92-48492
VARIABLE DISPLACEMENT ELECTRO-HYDROSTATIC ACTUATOR
JOHN A. ANDERSON (Dynamic Controls, Inc., Dayton, OH) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 529-534.
(Contract F33615-86-C-3606)
The author discusses the effects of pump displacement on electro-hydrostatic actuator (EHA) performance characteristics and the possible advantages of using a variable displacement pump in an EHA. Issues discussed are heating, size, and stiffness. It is noted that the EHA offers the possibility of varying the coupling ratio by varying the pump displacement. The variable coupling ratio could be used to increase actuator stiffness, to decrease package size, and to decrease package heating. An EHA employing a variable displacement pump has been designed and built, and the actuator will be tested once assembly of the package is completed. I.E.

A92-48493
C-141 AND C-130 POWER-BY-WIRE FLIGHT CONTROL SYSTEMS
RALPH ALDEN (Lockheed Aeronautical Systems Co., Marietta, GA) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol.

2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 535-539. refs
Copyright
The C-141 RAMTIP (Reliability and Maintainability Technology Insertion Program) project comprises the development, test, and flight evaluation of fly-by-wire/power-by-wire flight controls for the three primary axes, plus spoilers, on the C-141 aircraft. The C-130 TAPM (Technology Application Program Management) project comprises the development, test, and flight evaluation of an electro-hydrostatic actuation (EHA) subsystem in the HTTB (High Technology Test Bed) aileron system. The author describes the systems being investigated and summarizes the laboratory and flight test demonstrations that have been accomplished to date. He also addresses current and planned programs for further development, test installations, and flight demonstrations of power-by-wire primary flight control systems. I.E.

A92-48494
ELECTRIC ACTUATION SYSTEM DUTY CYCLES
CRAIG J. SIMSIC (Lockheed Aeronautical Systems Co., Marietta, GA) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 540-545. refs
Copyright
An important criterion in specifying an electric actuation system (EAS) is the duty cycle to which it must be designed and tested. The author describes the derivation of such a duty cycle in a very fundamental fashion. This fundamental duty cycle would of course be further refined in a real exercise, the treatment becoming as eloquent as the problem demands. The mission profile (altitude and velocity vs. time) of a generic transport aircraft along with actuator force and rate requirements is the starting point for this exercise. From these data, a fundamental duty cycle, load, heat dissipation, and power required are estimated as a function of mission time. This leads to a discussion of EAS circuit design impact and to the derivation of a limited life test duty cycle. I.E.

A92-48495
ROBUST DISCRETE CONTROLLER DESIGN FOR AN UNMANNED RESEARCH VEHICLE (URV) USING DISCRETE QUANTITATIVE FEEDBACK THEORY
D. G. WHEATON, I. M. HOROWITZ, and C. H. HOUPIS (USAF, Institute of Technology, Wright-Patterson AFB, OH) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 546-552. refs
The application of non-minimum phase w-prime-plane discrete MIMO (multiple-input-multiple-output) quantitative feedback theory (QFT) to the design of a three-axis rate-commanded automatic flight control system for a URV is presented. The URV model used is a seven-input three-output state-space system derived from the small-angle perturbation equations of motion. The controllers and prefilters designed provide a three-axis noninteracting rate-commanded automatic flight control law implementation on the Lambda URV. Hybrid nonlinear simulations verify the successful application of discrete QFT. The yaw-rate channel meets all specifications. I.E.

A92-48496
ROBUSTNESS CHARACTERISTICS OF FAST-SAMPLING DIGITAL PI CONTROLLERS FOR HIGH-PERFORMANCE AIRCRAFT WITH IMPAIRED CONTROL SURFACES
B. PORTER (Salford, University, England) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 553-563. refs
Copyright
The robustness characteristics of fast-sampling error-actuated digital set-point tracking PI controllers are established in the case of partially irregular linear multivariable plants. It is shown that the plant-parameter variations tolerable by such fast-sampling error-actuated digital controllers can be expressed very simply in terms of the step-response matrices of the nominal and actual plants. These general results are illustrated by examining the robustness characteristics of a fast-sampling error-actuated digital PI controller for the F-16 aircraft in case the flaperon and elevator suffer various losses in effectiveness. I.E.

A92-48499
MAKING FLY-BY-LIGHT A REALITY
JOHN R. TODD (Douglas Aircraft Co., Long Beach, CA) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 577-584.
Copyright
McDonnell Douglas, Douglas Aircraft Company, has constructed and integrated a fly-by-wire/fly-by-light test and integration facility to aid in the development of advanced design flight control systems. The author describes this facility, its capabilities, and the Douglas fly-by-light development approach. A summary of the Douglas Aircraft Advanced Flight Control Systems Development Program is also provided. I.E.

A92-48608
ADVANCES IN AIRCRAFT MODAL IDENTIFICATION [PROGRES EN IDENTIFICATION MODALE DES AVIONS]
ALAIN GRAVELLE (ONERA, Direction Scientifique des Structures, Chatillon, France) (Entretiens Science et Defense 1992, Paris, France, May 12, 13, 1992) ONERA, TP no. 1992-47, 1992, 11 p. In French. refs
(ONERA, TP NO. 1992-47)
The modal identification of aircraft structures is conducted by ground vibration tests employing the modal adaptation technique. The efficiency of this technique can be enhanced by introducing methods that aid in performing the adaptation, utilizing a modal isolation criterion resulting in a simpler procedure to drive the tests. Association with the use of multidegree-of-freedom identification algorithms would introduce some tolerance in connection with the adaptation deviations, which makes it possible to account for modal couplings. R.E.P.

A92-48737*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THRUST VECTORING CHARACTERISTICS OF THE F-18 HIGH ALPHA RESEARCH VEHICLE AT ANGLES OF ATTACK FROM 0 TO 70 DEG
SCOTT C. ASBURY and FRANCIS J. CAPONE (NASA, Langley Research Center, Hampton, VA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 19 p. refs
(AIAA PAPER 92-3095)
An investigation was conducted to determine the multiaxis thrust-vectoring characteristics of the F-18 High Alpha Research Vehicle (HARV). A 0.10-scale model was modified with hardware to simulate the three-vane thrust vectoring system of the F-18/HARV. This investigation was conducted at Mach numbers ranging from 0.30 to 0.70, at angles of attack from 0 to 70 deg, and nozzle-pressure ratios from 2.0 to approximately 5.0. Results indicate that the thrust vectoring system of F-18/HARV can successfully generate multiaxis thrust vectoring. During vectoring, resultant thrust-vector angles were always less than the corresponding geometric vane deflection angle and were accompanied by large thrust losses. Author

A92-48902*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
SUMMARY OF THE EFFECTS OF ENGINE THROTTLE RESPONSE ON AIRPLANE FORMATION-FLYING QUALITIES
KEVIN R. WALSH (NASA, Flight Research Center, Edwards, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 22 p. refs
(AIAA PAPER 92-3318) Copyright

A flight evaluation as conducted to determine the effect of engine throttle response characteristics on precision formation-flying qualities. A variable electronic throttle control system was developed and flight-tested on a TF-104G airplane with a J79-11B engine at the NASA Dryden Flight Research Facility. Ten research flights were flown to evaluate the effects of throttle gain, time delay, and fuel control rate limiting on engine handling qualities during a demanding precision wing formation task. Handling quality effects of lag filters and lead compensation time delays were also evaluated. Data from pilot ratings and comments indicate that throttle control system time delays and rate limits cause significant degradations in handling qualities. Threshold values for satisfactory (level 1) and adequate (level 2) handling qualities of these key variables are presented. Author

A92-49025#
A THEORETICAL STUDY OF SENSOR-ACTUATOR SCHEMES FOR ROTATING STALL CONTROL
G. J. HENDRICKS and D. L. GYSLING (MIT, Cambridge, MA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 12 p. Research supported by USAF and Pratt & Whitney Group. refs
(AIAA PAPER 92-3486) Copyright

A theoretical study has been conducted to determine the influence of actuator and sensor choice on active control of rotating stall in axial-flow compressors. The sensors are used to detect the small amplitude traveling waves that have been observed at the initiation of rotating stall on several different compressors. Control is achieved by feeding the sensed quantity back to the actuator with a suitable gain and spatial phase shift relative to the measured wave. Actuators using circumferential patterns of jets, intake ports, and movable inlet guide vanes upstream of the compressor, and valves downstream of the compressor were considered. The effect of axial velocity, static pressure, or total pressure measurement on control effectiveness was investigated. In addition, the influence of the actuator bandwidth on the performance of the controlled system was determined. The results of the study indicate that the potential for active control of rotating stall is greater than that achieved thus far with movable inlet guide vanes. Further, axial velocity sensing was most effective. Actuator bandwidth affected the performance of the controlled compressors significantly, but certain actuators were affected less severely than others. Author

A92-49109*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
SUBSONIC FLIGHT TEST EVALUATION OF A PERFORMANCE SEEKING CONTROL ALGORITHM ON AN F-15 AIRPLANE
GLENN B. GILYARD and JOHN S. ORME (NASA, Flight Research Center, Edwards, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 18 p. refs
(AIAA PAPER 92-3743) Copyright

The subsonic flight test evaluation phase of the NASA4 F-15 (powered by F100 engines) performance-seeking control program was completed for single-engine operation at part- and military-power settings. The subsonic performance-seeking control algorithm optimizes the quasi-steady-state performance of the propulsion system for three modes of operation: the minimum-fuel-flow mode, the minimum-temperature mode, and the maximum-thrust mode. Decreases in thrust-specific fuel consumption of 1 to 2 percent were measured in the minimum-fuel-flow mode; these fuel savings are significant especially for supersonic cruise aircraft. Decreases of up to approximately 100 R in fan turbine inlet temperature were measured in the minimum-temperature mode. Temperature reductions of this magnitude would more than double turbine life if inlet temperature was the only life factor. Measured thrust increases of up to approximately 15 percent in the maximum-thrust mode cause substantial increases in aircraft acceleration. The subsonic flight phase has validated the performance-seeking control technology which can significantly benefit the next generation of fighter and transport aircraft. Author

N92-28457*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
COMPARISON OF THREE CONTROLLERS APPLIED TO HELICOPTER VIBRATION
JANE A. LEYLAND May 1992 79 p
(Contract RTOP 505-61-51)
(NASA-TM-102192; A-89130; NAS 1.15:102192) Avail: CASI HC A05/MF A01

A comparison was made of the applicability and suitability of the deterministic controller, the cautious controller, and the dual controller for the reduction of helicopter vibration by using higher harmonic blade pitch control. A randomly generated linear plant model was assumed and the performance index was defined to be a quadratic output metric of this linear plant. A computer code, designed to check out and evaluate these controllers, was implemented and used to accomplish this comparison. The effects of random measurement noise, the initial estimate of the plant matrix, and the plant matrix propagation rate were determined for each of the controllers. With few exceptions, the deterministic controller yielded the greatest vibration reduction (as characterized by the quadratic output metric) and operated with the greatest reliability. Theoretical limitations of these controllers were defined and appropriate candidate alternative methods, including one method particularly suitable to the cockpit, were identified. Author

N92-28584*# Systems Technology, Inc., Hawthorne, CA.
EFFECTS OF COCKPIT LATERAL STICK CHARACTERISTICS ON HANDLING QUALITIES AND PILOT DYNAMICS
DAVID G. MITCHELL, BIMAL L. APONSO, and DAVID H. KLYDE Washington NASA Jun. 1992 208 p Prepared for PRC Kentron, Inc., Edwards, CA
(Contract NAS2-12722; ATD-90-STI-6401; RTOP 505-64-30)
(NASA-CR-4443; H-1769; NAS 1.26:4443) Avail: CASI HC A10/MF A03

This report presents the results of analysis of cockpit lateral control feel-system studies. Variations in feel-system natural frequency, damping, and command sensing reference (force and position) were investigated, in combination with variations in the aircraft response characteristics. The primary data for the report were obtained from a flight investigation conducted with a variable-stability airplane, with additional information taken from other flight experiments and ground-based simulations for both airplanes and helicopters . The study consisted of analysis of handling qualities ratings and extraction of open-loop, pilot-vehicle describing functions from sum-of-sines tracking data, including, for a limited subset of these data, the development of pilot models. The study confirms the findings of other investigators that the effects on pilot opinion of cockpit feel-system dynamics are not equivalent to a comparable level of added time delay, and until a more comprehensive set of criteria are developed, it is recommended that feel-system dynamics be considered a delay-inducing element in the aircraft response. The best correlation with time-delay requirements was found when the feel-system dynamics were included in the delay measurements, regardless of the command reference. This is a radical departure from past approaches. Author

N92-28652# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
SOME LONGITUDINAL HANDLING QUALITIES DESIGN GUIDELINES FOR ACTIVE CONTROL TECHNOLOGY TRANSPORT AIRCRAFT
W. P. DEBOER (Office National d'Etudes et de Recherches Aerospatiales, Paris (France).), H. T. HUYNH (Office National d'Etudes et de Recherches Aerospatiales, Paris, France), O. P. NICHOLAS (Royal Aerospace Establishment, Farnborough, England), D. SCHAFRANEK (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick, Germany, F.R.), and J. A. J. VANENGELEN 11 May 1990 21 p
(NLR-TP-90129-U; GARTEUR/TP-056; ETN-92-91435) Avail: CASI HC A03/MF A01

The main conclusions and recommendations from extensive work performed by the Flight Mechanics Action Group on handling qualities (FM/AG01) of the Group for Aeronautical Research and Technology in Europe (GARTEUR) are presented. The work of this AG, which involved cooperation between research institutes of France, Germany, the United Kingdom, and the Netherlands, was performed with the ultimate aim of establishing handling qualities guidelines for future transport aircraft with advanced flight control and display system. The work of the AG started with the consultation of aircraft industries within the participating countries concerning their opinion on anticipated manual control aspects for future transport aircraft. The underlying report may be regarded as the overall result of the work performed on the basis of this consultation, which resulted in a number of handling qualities guidelines. ESA

N92-28653# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
RESPONSE OF HELICOPTERS TO GUSTS
R. NOBACK 27 Apr. 1990 98 p
(Contract RNLAF-RB-KLU-1990/A.5)
(NLR-TP-90159-U; ETN-92-91436) Avail: CASI HC A05/MF A02

Equations to describe the response of helicopters to atmospheric gusts are derived. Results of calculations are compared to results as presented in the literature. The influence of various parameters is investigated, especially that of a mass parameter. Special attention is paid to the response to continuous sinusoidal turbulence. ESA

N92-28801# Naval Postgraduate School, Monterey, CA.
STABILITY AND CONTROL FLIGHT TESTING OF A HALF-SCALE PIONEER REMOTELY PILOTED VEHICLE M.S. Thesis
KENT ROBERT AITCHESON Sep. 1991 74 p
(AD-A245973) Avail: CASI HC A04/MF A01

Stability and control flight testing was conducted on a half-scale Pioneer remotely piloted vehicle. The aircraft was instrumented with sensors to measure flight control deflections, angle of attack, side slip angle, and airspeed. A developmental telemetry transmitter was installed to send the information to a ground based receiver where it was recorded for computer processing. Flight tests were conducted to characterize longitudinal static stability by varying the center of gravity to determine the neutral point. Directional static stability was characterized using steady heading side slip flight tests. The telemetry system's performance was acceptable and the directional stability data correlated favorably with data gathered from wind tunnel testing and computational methods. Longitudinal stability was more difficult to characterize due to limitations of elevator deflection resolution and the amount of data gathered. Additional flight testing will be conducted to tune the telemetry system with the data collection sensors, and to increase the Pioneer static stability data base. GRA

N92-29654*# Minnesota Univ., Minneapolis. Dept. of Aerospace Engineering and Mechanics.
FEEDBACK CONTROL LAWS FOR HIGHLY MANEUVERABLE AIRCRAFT Interim Report, Jan. - Jul. 1992
WILLIAM L. GARRARD and GARY J. BALAS Jul. 1992 41 p
(Contract NAG1-1380)
(NASA-CR-190535; NAS 1.26:190535) Avail: CASI HC A03/MF A01

The results of a study of the application of H infinity and mu synthesis techniques to the design of feedback control laws for the longitudinal dynamics of the High Angle of Attack Research Vehicle (HARV) are presented. The objective of this study is to develop methods for the design of feedback control laws which cause the closed loop longitudinal dynamics of the HARV to meet handling quality specifications over the entire flight envelope. Control law designs are based on models of the HARV linearized at various flight conditions. The control laws are evaluated by both linear and nonlinear simulations of typical maneuvers. The fixed gain control laws resulting from both the H infinity and mu synthesis techniques result in excellent performance even when the aircraft performs maneuvers in which the system states vary significantly from their equilibrium design values. Both the H infinity and mu synthesis control laws result in performance which compares favorably with an existing baseline longitudinal control law. Author

N92-30025*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HELICOPTER LOW-SPEED YAW CONTROL Patent Application
JOHN C. WILSON, inventor (to NASA), HENRY L. KELLEY, inventor (to NASA), and CYNTHIA A. CROWELL, inventor (to NASA) (Army Aerostructures Directorate, Hampton, VA.) 7 Nov. 1991 10 p
(NASA-CASE-LAR-14219-1; NAS 1.71:LAR-14219-1; US-PATENT-APPL-SN-788908) Avail: CASI HC A02/MF A01

A system for improving yaw control at low speeds consists of one strake placed on the upper portion of the fuselage facing the retreating rotor blade and another strake placed on the lower portion of the fuselage facing the advancing rotor blade. These strakes spoil the airflow on the helicopter tail boom during hover, low speed flight, and right or left sidewards flight so that less side thrust is required from the tail rotor. Author

09

RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

A92-44976
REAL-TIME CONTROL TOWER SIMULATION FOR EVALUATION OF AIRPORT SURFACE TRAFFIC AUTOMATION
STEVEN R. BUSSOLARI (MIT, Lexington, MA) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 1. Columbus, OH, Ohio State University, 1991, p. 502-507. Research sponsored by FAA. refs

High fidelity, real-time aircraft simulation has been a valuable tool for the human factors evaluation of flight deck automation, but no equivalent simulation has been available for the Air Traffic Control Tower (ATCT) environment. The capacity, flexibility, and data collection requirements placed on a research simulation preclude the use of existing tower training systems. Using a network of computer workstations, an ATCT real-time simulation has been developed that is capable of reproducing the traffic environment found at major airports. The simulation will be used for preliminary evaluation of the impact of automation upon tower controller workload and situational awareness. Author

A92-44981
OPERATIONAL EVALUATION OF A TOWER WORKSTATION FOR CLEARANCE DELIVERY
CHRIS MOODY (Mitre Corp., McLean, VA) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 1. Columbus, OH, Ohio State University, 1991, p. 538-543.

At towered airports a function known as clearance delivery exists to provide the initial instrument flight rules (IFR) clearance to departing flights via voice radio. At busy airports the radio frequencies used for this function can become saturated at peak periods. To alleviate this problem the FAA has determined that this clearance information (referred to here as Predeparture Clearance or PDC) will be a service offered via digital data link. The MITRE Corporation has developed an experimental tower workstation system which is used for issuing clearances in digital form. Three such workstations have been operationally evaluated at the Dallas/Ft. Worth, Chicago O'Hare and San Francisco Airports with the cooperation of several participating airlines. This paper describes the experimental system and reports on experiences gained from field operation including results of surveys distributed to pilots and tower controllers using the system. As a result of positive response from the users, implementation of a national system based on the experimental system is now under way by the FAA. Author

A92-45025
SIMULATION OF TRIPLE SIMULTANEOUS PARALLEL ILS APPROACHES
TERENCE FISCHER (CTA, Inc., McKee City, NJ) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 830-835. refs

A real-time simulation has been conducted in order to evaluate the efficacy of triple simultaneous parallel ILS approach operations at Dallas/Fort Worth (DFW) International Airport during instrument meteorological conditions. The subjects of the study were five ATC specialists and/or supervisors from DFW. Analysis of the Aircraft Proximity Index and Closest Point of Approach metrics indicated that the triple simultaneous ILS approaches led to miss distances that were statistically equivalent to those in the double simultaneous parallel ILS approaches at DFW. O.C.

A92-45026
TOWARD AN INTEGRATED MULTIMODAL APPROACH TO FLIGHT SIMULATION
GARY E. RICCIO (Illinois, University, Urbana) and LAWRENCE J. HETTINGER (Logicon Technical Services, Inc.; Wright State University, Dayton, OH) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 836-840. refs

A comprehensive view of flight simulation must acknowledge that motion cannot be controlled without producing variations in the magnitude and orientation of the velocity vector; this is a multimodal phenomenon with implications for posture control within the cockpit which cannot currently be accounted for in flight simulations. An approach to flight simulation is presented which incorporates velocity vector variations. Attention is given to 'vection', postural control, and simulator sickness. O.C.

A92-45027
THE DEVELOPMENT OF A REAL TIME VISUAL FLIGHT SIMULATOR FOR TACTICAL OPERATIONS RESEARCH AND MEASUREMENT
JEFF MARESH (Engineering Solutions, Inc., Columbus, OH) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 841-846.

An evaluation is conducted of several technical aspects of the simulation hardware and software employed by the Simulator for Tactical Operations Research and Measurement. Modularity in both hardware and software allowed upgrades to be straightforwardly implemented without wholesale replacement of existing resources. Because the visual scene can be developed on the basis of a CAD package, the volume of the program code that must be developed is significantly reduced. O.C.

A92-45028
CENTRE FOR FLIGHT SIMULATION BERLIN AIRBUS 340 SIMULATOR FOR RESEARCH AND TRAINING
GERHARD HUETTIG (Berlin, Technische Universitaet, Federal Republic of Germany) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 847-850.

The Center for Flight Simulation Berlin employs an IBM 6000 computer identical to that used in the A 340 airliner's training simulator for simulation system-related research, and will employ The Interactive Graphics Environment for Real Time Systems software package for graphics-display development efforts. Investigations will be conducted in the fields of crew ergonomics and human factors effects on crew performance, air-ground communications based on the Mode S data link, flight guidance and control, and crew-training concepts. O.C.

A92-45042
FULL MODEL SIMULATION OF THE NATIONAL AIRSPACE SYSTEM - RESEARCH AND TRAINING PLATFORM
GERALD D. GIBB (Embry-Riddle Aeronautical University, Daytona Beach, FL) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 935-938.

U.S. ATC system modernization has prompted the formulation of requirements for a highly integrated training system which, in addition to yielding ATC personnel proficiency, will furnish a research platform which emulates the flight environment with the requisite fidelity and a testbed for investigation of the effects of proposed ATC task changes before operational implementation. A simulation platform configuration prototype has been devised whose software is written in FORTRAN and 'C'; the control/display hardware is a Personal Iris 4-D workstation. O.C.

A92-45096
THE DAM VERTICAL SHOCK-TUBE [LE TUBE A CHOC VERTICAL DE LA DAM]
C. CAVAILLER, H. CROSO (CEA, Centre d'Etudes de Vaujours-Moronvilliers, Courtry, France), J. F. HAAS, and G. RODRIGUEZ (CEA, Centre d'Etudes de Limeil-Valenton, Villeneuve-Saint-Georges, France) CHOCS (ISSN 1157-741X), no. 2, June 1991, p. 70-88. In French. refs
Copyright

A vertical shock tube is described that can be used to study flow phenomena, and experimental results from the device are given and compared to theory. Following a brief theoretical discussion of flow phenomena in general treatment is given to the effects of initial defect geometries, flow speed, and diffuse vs membrane interfaces. The double-diaphragm shock tube is then described with illustrations of the separation between the high- and low-pressure chambers. The spatiotemporal operation of the device is discussed, and the experimental diagnostics include measurements of shock speed and flow visualization. The shock tube is shown to provide experimental results describing flow phenomena with zones of diffusion and with thin membranes. Results are compared with those derived from K-epsilon flow models, and good general agreement is noted. C.C.S.

A92-45265* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ON THE MEASUREMENT OF SUBSONIC FLOW AROUND AN APPENDED BODY OF REVOLUTION AT CRYOGENIC CONDITIONS IN THE NTF
DAVID W. CODER (U.S. Navy, David W. Taylor Research Center, Bethesda, MD), S. G. FLECHNER, and J. B. PETERSON, JR. (NASA, Langley Research Center, Hampton, VA) IN: High Reynolds number flows using liquid and gaseous helium. New York, Springer-Verlag, 1991, p. 105-124. Research sponsored by U.S. Navy and DARPA. refs
Copyright

Fluid mechanics scaling is briefly reviewed and testing ship models at high Reynolds numbers in the National Transonic Facility is discussed. Particular attention is given to the 1986 body of revolution experiment, the expanded model capabilities for a future body of revolution experiment, major features of a future flat plate experiment, the proposed liquid helium tunnel from the user's point of view, and a comparison of the NTF and the Conceptual Helium Tunnel. O.G.

A92-45266* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
WATER TUNNELS
LISA J. BJARKE (NASA, Flight Research Center, Edwards, CA) IN: High Reynolds number flows using liquid and gaseous helium. New York, Springer-Verlag, 1991, p. 125-130. refs
Copyright

Some of the uses of water tunnels are demonstrated through the description of the NASA Ames-Dryden Flow Visualization Facility. It is concluded that water tunnels are capable of providing a quick and inexpensive means of flow visualization and can aid in the understanding of complex fluid mechanics phenomena. O.G.

A92-45267
REMARKS ON HIGH-REYNOLDS-NUMBER TURBULENCE EXPERIMENTS AND FACILITIES
K. R. SREENIVASAN (Yale University, New Haven, CT) IN: High Reynolds number flows using liquid and gaseous helium. New York, Springer-Verlag, 1991, p. 181-184. refs
Copyright

Remarks made at the Seventh Oregon Conference on Low Temperature Physics on the need for research in high-Reynolds-number turbulence and the possibility of using a helium tunnel for the purpose are summarized. It is argued that, if the perspective of turbulence studies is ignored, it is clear that helium tunnels can extend the Reynolds number range accessible to most experimentalists. In particular, if they can be built without extraordinary expense so as to be accessible also to the university community, they acquire an added value. O.G.

A92-45275
POWER ECONOMY IN HIGH-SPEED WIND TUNNELS BY CHOICE OF WORKING FLUID AND TEMPERATURE
RONALD SMELT IN: High Reynolds number flows using liquid and gaseous helium. New York, Springer-Verlag, 1991, p. 265-284. refs
Copyright

Possible methods of making very high reductions in the power required for high-speed wind tunnels at fixed Mach number, Reynolds number, and pressure, which are based on new working substances or low temperatures, are discussed. It is found that, for operation at normal temperatures, best power economy can be obtained by using certain fluorine compounds of high molecular weight (SF_6, SeF_6, and TeF_6); the power required is only 1 to 2 percent of that of a similar tunnel using atmospheric air. O.G.

A92-45314
RECENT DEVELOPMENTS AT THE SHOEBURYNESS STOVL TEST FACILITY
L. H. K. REED (Rolls-Royce, PLC, Bristol, England) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. III.2.1-III.2.8. Research supported by Rolls-Royce, PLC and Ministry of Defence of England. Previously announced in STAR as N92-22096.
Copyright

The last two years have seen a number of test programs performed that are directly targeted at the technology acquisition need for the next generation of STOVL (Short Take Off Vertical Landing) fighter aircraft. The facilities used comprise a dynamic test gantry with airframe and two augmented powerplants allowing operation in ground effect to be simulated at full scale over a wide range of jet energies and configurations. The areas of concern in the ground environment of a STOVL vehicle are described, together with how the current test programs are acquiring the knowledge to give confidence that the design solution will be satisfactory. Author

A92-45323
GROUND SURFACE EROSION - BRITISH AEROSPACE TEST FACILITY AND EXPERIMENTAL STUDIES
ALISON J. WAKE, C. J. HILL (British Aerospace /Military Aircraft/, Ltd., Preston, England), and R. G. A. ANGEL (British Aerospace /Military Aircraft/, Ltd., Kingston-upon-Thames, England) IN: International Powered Lift Conference, London, England, Aug. 29-31, 1990, Proceedings. London, Royal Aeronautical Society, 1990, p. III.11.1-III.11.11. refs
Copyright

ASTOVL combat aircraft studies of the erosion of the landing surface during vertical lift operation are discussed. Attention is given to a facility commission at British Aerospace, with emphasis on the laboratory, vented via roof and wall louvres; the ground erosion rig, consisting of a combustion chamber, support tower and linear motor track; and the valve house, including the air and fuel systems. The facility is capable of producing jet pressure ratios from 1.1 to 10 with both quiescent, and from 450 to 1500 K, exhaust temperatures. Current studies are aimed at a precise definition of operational limitations of surfaces presently used by Harrier including the implications of rolling/creeping landing. Results of investigations of the implications of test techniques and assumptions used are presented. C.A.B.

A92-45380
ENHANCEMENT OF GROUND HANDLING THROUGH OPTIMUM SELECTION/USE OF GROUND SUPPORT EQUIPMENT (GSE)
PAUL D. TUCK IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 75-89. refs
(SAE PAPER 911973) Copyright

The USAF has undertaken a search for prototype GSE aircraft loader which can service a range of cargo aircraft defined by the C-130 at one extreme and the B747 at the other. It is presently shown that a family of cargo on/off-loaders which is capable of simultaneously servicing a transport aircraft's main and lower cabin lobes is both more operationally efficient and more cost-effective than a single, 'Cadillac-type' Super Loader. The loader in question must meet demanding air-transportability requirements. O.C.

A92-45388
THE LARGE SCALE TEST CONTROL SYSTEMS DESIGNED AND BUILT BY THE BOEING COMPANY TO SUPPORT THE 757 AND 767 MAJOR FATIGUE TESTS
STEVEN A. ONUSTACK (Boeing Co., Seattle, WA) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 179-190.
(SAE PAPER 911985) Copyright

This paper describes the hardware and software that were designed, developed, and built to support major fatigue testing of full-scale 757 and 767 airframes. These test control systems resulted in significant cost savings over previous programs. These systems are capable of applying pseudorandom loading of complex flight load spectrums with up to 72 channels of control and 110 channels of data acquisition. The major fatigue tests consisted of the application of two normal lifetimes of flights in a test environment that is performed on the ground with loads applied by closed loop servohydraulic load control systems. Author

A92-45422
FUNCTIONAL MOCK-UP TESTS FOR FLIGHT CONTROL SYSTEM OF THE NAL QSTOL RESEARCH AIRCRAFT 'ASKA'
AKIRA TADA, TADAO UCHIDA, TOSHIO OGAWA, NORIAKI OKADA (National Aerospace Laboratory, Chofu, Japan), ISOROKU UCIKAWA (Kawasaki Heavy Industries, Ltd., Gifu, Japan), HIDEYUKI YAMATO (Tokyo, University, Japan), and YASURO TAKEUCHI (Shinmeiwa Industries Co., Ltd., Hyogo, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 525-534. refs
(SAE PAPER 912036) Copyright

Control system functional mockup tests were conducted with ASKA, a quiet STOL (QSTOL) aircraft to examine the system's overall control functions using hardware-in-the-loop. Simulation was effectively simplified by omitting the control system right-half side and shortening the system's straight sections. All test measurements were precisely taken, and a 'filtering sampler', an antialiasing technique/device, was designed and employed for digital data acquisition. R.E.P.

A92-46780
CALIBRATION-RELATED PSEUDO-REYNOLDS NUMBER TRENDS IN TRANSONIC WIND TUNNELS
FELIX AULEHLA (MBB GmbH, Munich, Federal Republic of Germany) *Journal of Aircraft* (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 545-552. Previously cited in issue 21, p. 3354, Accession no. A87-49111. refs
Copyright

A92-47303
STRENGTH EVALUATION AND SAFETY OF MACHINE/STRUCTURE. III - CASE EXAMPLES ON STRENGTH AND SAFETY EVALUATION OF MACHINE/STRUCTURE 3.2 AIRCRAFT (AIRFRAME)
S. MIYAKE Japan Society of Materials Science, Journal (ISSN 0514-5163), vol. 41, no. 464, May 1992, p. 777-783. In Japanese. refs
Copyright

A92-47365
GAS TURBINE EXHAUST SYSTEM SILENCING DESIGN
R. B. TATGE and DINCER OZGUR (General Electric Co., Schenectady, NY) IN: NOISE-CON 91; Proceedings of the 11th National Conference on Noise Control Engineering, Tarrytown, NY, July 14-16, 1991. Poughkeepsie, NY, Noise Control Foundation, 1991, p. 223-230. refs
Copyright

The analysis and design of silencing systems are discussed for applications in the exhaust systems of gas turbines to reduce duct-exit and breakout noise. The calculation of transmission loss (TL) for a given silencer is explained, and the computation of duct-wall sound TL is mentioned. The analysis is based on the theories of Kurze (1969) and Sharp (1978) for determining sound TLs for the silencers and ductwork and therefore general sound levels. The analytical methods for TL are used for comparisons with measured values from a gas turbine configuration with silencers. Attention is given to the calculated and measured values for breakout noise at 3 ft from the duct, the sound level in the plane of the exhaust exit, and the sound level at 400 ft. The acoustical properties of the silencer and ductwork at elevated temperatures can be determined by scaling the flow resistance of materials as the gas viscosity. C.C.S.

A92-47522
REAL TIME PRESENTATION FOR RAFALE IN-FLIGHT TESTS
PHILLIPPE PATUREAU (Dassault Aviation, Vaucresson, France) and DOUGLAS ULLAH (Loral Instrumentation, San Diego, CA) IN: ITC/USA/'91; Proceedings of the International Telemetering Conference, Las Vegas, NV, Nov. 4-7, 1991. Research Triangle Park, NC, Instrument Society of America, 1991, p. 303-321.
Copyright

The new telemetry equipment installed at Dassault Aviation for monitoring RAFALE D C01 in-flight tests is described. The discussion covers a brief history of the development of the company's real time display resources and the principles underlying the selection and design of these resourses. In particular, attention is given to displays from a decommutator, computer generated displays, and System 500 instrumentation, software, and workstation. Finally, some planned improvement in the real-time telemetry system are discussed. V.L.

A92-47562
REMOTE TELEMETRY CONCEPTS
R. STIERS (Boeing Commercial Airplane Group, Seattle, WA) and T. LYDON (Veda, Inc., Arlington, VA) IN: ITC/USA/'91; Proceedings of the International Telemetering Conference, Las Vegas, NV, Nov. 4-7, 1991. Research Triangle Park, NC, Instrument Society of America, 1991, p. 717-724.
Copyright

A Remote Telemetry Station (RTS) was developed to support a flight-test telemetry range. As requirements to relocate the test range were investigated various approaches were evaluated. The RTS is capable of supporting many sites, tracking and receiving up to 1024 Kbits/sec of telemetry data, providing fully redundant two-way radio communication in the UHF and VHF bands, linking all the data, and appearing transparent to the users. The system meets all requirements in a highly integrated efficient flexible package. Author

A92-47567
GULF RANGE DRONE CONTROL UPGRADE SYSTEM MOBILE CONTROL SYSTEM
STEVEN M. WAGNER (USAF, Eglin AFB, FL) and JOHN H. GOODSON (General Electric Government Services, Inc., Range Projects Div., Eglin AFB, FL) IN: ITC/USA/'91; Proceedings of the International Telemetering Conference, Las Vegas, NV, Nov. 4-7, 1991. Research Triangle Park, NC, Instrument Society of America, 1991, p. 751-758. refs
Copyright

This paper describes the development and assembly of the Gulf Range Drone Control Upgrade System (GRDCUS) Mobile Control System (GMCS) van and focuses on the on-board computer systems, consoles, and data link technology. An overall system engineering approach was used during GMCS development and is highlighted through the use of rapid prototyping. This methodology and the lessons learned are presented in the paper. Author

A92-47584
DESIGN CONSIDERATIONS FOR A MODERN TELEMETRY PROCESSING AND DISPLAY SYSTEM
PAUL D. KNIGHT (U.S. Navy, Pacific Missile Test Center, Point Mugu, CA) IN: ITC/USA/'91; Proceedings of the International Telemetering Conference, Las Vegas, NV, Nov. 4-7, 1991. Research Triangle Park, NC, Instrument Society of America, 1991, p. 911-923.
Copyright

This paper delineates some design considerations that allow a system designer to adapt or modify a telemetry processing and design system as required in order to stay abreast of constantly changing telemetry requirements. A description of how these design considerations were used implementing a telemetry processing system is presented. Author

A92-48600
NEW HYPERSONIC TEST METHODS DEVELOPED AT ONERA - THE R5 AND F4 WIND TUNNELS [NOUVEAUX MOYENS D'ESSAIS HYPERSONIQUES DEVELOPPES A L'ONERA - LES SOUFFLERIES R5 ET F4]
B. CHANETZ, M.-C. COET, D. NICOUT, T. POT, P. BROUSSAUD, G. FRANCOIS, A. MASSON (ONERA, Chatillon, France), and D. VENNEMANN (ESA/CNES Joint Group, Toulouse, France) (NATO, AGARD, Symposium on Theoretical and Experimental Methods in Hypersonic Flows, Turin, Italy, May 4-8, 1992) ONERA, TP no. 1992-39, 1992, 13 p. In French. refs
(ONERA, TP NO. 1992-39)

The R5 wind tunnel allows the simulation of hypersonic flows at low Reynolds numbers, corresponding to intake conditions encountered at altitudes of about 60 km. The F4 wind tunnel is projected to study the effects of actual gas and especially effects associated with chemical kinetics during atmospheric reentry. Attention is given to the performance, installation details and description of the introduction of wind tunnel testing. R.E.P.

A92-48881#
EXPERIENCE IN THE OPERATION OF A HYPERSONIC NOZZLE STATIC THRUST STAND
KEVIN L. MIKKELSEN and JULIAN J. IDZOREK (FluiDyne Engineering Corp., Minneapolis, MN) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 26 p. refs
(AIAA PAPER 92-3292) Copyright

The testing of exhaust nozzles with high area ratios in a static thrust stand is described focusing on the results of testing for the NASP generic option nozzle. Improvements to the testing techniques and operational methodology are described with reference to improvements in the collected data. The static thrust stand for hypersonic nozzles is designed to measure flow and thrust coefficients, surface pressures, and heat flux in the nozzles while examining the effects of air liquefaction. The facility uses a single-component load cell to alleviate large moments without interfering with the force balance. Real-gas correction factors are incorporated into the testing to cover increased ranges of pressures and temperatures. The testing methodology is shown to provide data with a significant reduction in scatter with respect to nozzle thrust. C.C.S.

A92-48908*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INVESTIGATION OF THREE-DIMENSIONAL FLOW FIELD IN A TURBINE INCLUDING ROTOR/STATOR INTERACTION. I - DESIGN DEVELOPMENT AND PERFORMANCE OF THE RESEARCH FACILITY
B. LAKSHMINARAYANA, C. CAMCI (Pennsylvania State University, University Park), I. HALLIWELL (GE Aircraft Engines, Cincinnati, OH), and M. ZACCARIA (Pennsylvania State University, University Park) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 13 p. Research supported by Pennsylvania State University. refs
(Contract DAAL03-86-G-0013; NSG-3555)
(AIAA PAPER 92-3325) Copyright
A description of the Axial Flow Turbine Research Facility (AFTRF) installed at the Turbomachinery Laboratory of the Pennsylvania State University is presented in this paper. The facility diameter is 91.66 cm (3 feet) and the hub-to-tip ratio of the blading is 0.73. The flow path consists of turbulence generating grid, 23 nozzle vane and 29 rotor blades followed by outlet guide vanes. The blading design, carried out by General Electric Company personnel, embody modern HP turbine design philosophy, loading and flow coefficient, reaction, aspect ratio, and blade turning angles; all within the current aircraft engine design turbine practice. State-of-the-art quasi-3D blade design techniques were used to design the vane and the blade shapes. The vanes and blades are heavily instrumented with fast response pressure, shear stress, and velocity probes and have provision for flow visualization and laser Doppler anemometer measurement. Furthermore, provision has been made for detailed nozzle wake, rotor wake and boundary layer surveys. A 150 channel slip ring unit is used for transmitting the rotor data to a stationary instrumentation system. All the design objectives have been met. Author

N92-28248# Chemical Research and Development Center, Aberdeen Proving Ground, MD.
EXPERIMENTAL AERODYNAMIC FACILITIES OF THE AERODYNAMICS RESEARCH AND CONCEPTS ASSISTANCE BRANCH Final Report, Jan. - Feb. 1992
MILES C. MILLER Feb. 1992 28 p
(AD-A247489; CRDEC-TR-309) Avail: CASI HC A03/MF A01
This report is intended to acquaint researchers within the Department of Defense and approved U.S. Government contractors with the experimental aerodynamic facilities currently in use at the U.S. Army Chemical Research, Development and Engineering Center. GRA

N92-28388# Arizona Univ., Tucson. Coll. of Engineering and Mines.
EXPAND TURBULENCE LABORATORY FACILITIES TO MEET NEW DOD RESEARCH INTEREST Final Technical Report, 1 Oct. 1986 - 30 Sep. 1991
FRANK H. CHAMPAGNE 6 Mar. 1992 6 p
(Contract AF-AFOSR-0004-87)
(AD-A248581; AFOSR-92-0259TR) Avail: CASI HC A02/MF A01
The expansion of our turbulence laboratory facility funded by this DOD-URI award is complete. Two new test sections and a translator have been acquired for our wind tunnel. The new translator is specially designed to permit measurement of three-dimensional wakes with a minimum of blockage. Fortlier, our MASSCOMP 500 series laboratory computer, was PRP upgraded to a 32-bit machine. GRA

N92-28407# Naval Aerospace Medical Research Lab., Pensacola, FL.
USE OF A COMMERCIALLY AVAILABLE FLIGHT SIMULATOR DURING AIRCREW PERFORMANCE TESTING Final Report
SCOTT A. SHAPPELL and BRADY J. BARTOSH Nov. 1991 21 p
(AD-A245922; NAMRL-TM-91-2) Avail: CASI HC A03/MF A01
Investigations of aircrew sustained operations (SUSOPS) have been criticized for employing tasks with no apparent external validity. Because measures obtained directly from aviators flying high-performance aircraft are difficult to obtain, a laboratory compromise is needed. High-fidelity flight simulators used for aircrew training offer the most realistic simulation, but their availability is limited. Personal computer-based flight simulators may provide adequate simulation in the laboratory at a reasonable cost. This report describes a representative research protocol using a commercially available flight simulator during a simulated aircrew SUSOP. GRA

N92-28523# Federal Ministry for Defence, Bonn (Germany, F.R.). Armaments Technology Directorate.
OPPORTUNITIES FOR FLIGHT SIMULATION TO IMPROVE OPERATIONAL EFFECTIVENESS
J. HEYDEN *In* AGARD, Piloted Simulation Effectiveness 15 p Feb. 1992
Copyright Avail: CASI HC A03/MF A03
The keynote address gives an overview over the opportunities of piloted simulation for the development of aircraft and for the training of aircrews to operate the aircraft. Based on the military flight mission requirements some critical issues of peacetime military operations in Europe are discussed and the resulting opportunities for application of flight simulation in development and training are presented. The address concludes on recommendations for piloted simulation. Author

N92-28524# Wright Lab., Wright-Patterson AFB, OH. Flight Dynamics Directorate.
PILOTED SIMULATION EFFECTIVENESS DEVELOPMENT APPLICATIONS AND LIMITATIONS
RICHARD A. BOROWSKI *In* AGARD, Piloted Simulation Effectiveness 3 p Feb. 1992
Copyright Avail: CASI HC A01/MF A03
The author of this brief note begins by describing how flight simulators were first developed, and the reasons that brought about this research. The remainder of his paper is a survey of some simulation systems used in the U.S. with the recognition that similar and in some cases superior systems exist elsewhere. Concentration is placed on simulators run by the government, the military, and NASA. H.A.

N92-28525# Air Force Flight Test Center, Edwards AFB, CA.
UTILITY OF GROUND SIMULATION IN FLIGHT CONTROL PROBLEM IDENTIFICATION, SOLUTION DEVELOPMENT, AND VERIFICATION
K. L. KELLER, D. B. JANZEN, and A. A. ASAY *In* AGARD, Piloted Simulation Effectiveness 8 p Feb. 1992
Copyright Avail: CASI HC A02/MF A03
The Air Force Flight Test Center (AFFTC) Flying Qualities Simulator is consistently used prior to and in conjunction with flight test to identify aircraft flight control problems and also to develop, test, and validate solutions to these problems. The subject of this paper is an example of how ground simulation was vital in developing an effective software modification to eliminate a potentially dangerous aircraft flight control anomaly. Through simulation, an in flight uncommanded pitch oscillation incident was investigated and the source of the problem was identified. A potential solution was tested and validated by utilizing the simulator prior to flight test. Additional benefits were gained due to simulation studies. The project pilots were able to practice test maneuvers and emergency procedures essential to the flight test program. The preliminary work accomplished by ground simulation correctly predicted the effectiveness of the software modifications and

ensured the success of an efficient and valid flight test program. Author

N92-28526# *Aerospatiale, Toulouse (France).*
FLIGHT SIMULATION AND DIGITAL FLIGHT CONTROLS
D. CHATRENET *In* AGARD, Piloted Simulation Effectiveness 4 p Feb. 1992
Copyright Avail: CASI HC A01/MF A03

The A-320 is the first civil airliner to make extensive use of digital flight controls. Despite previous experience with this technology, developing this system quickly has proven a challenge. Flight simulation with a high degree of fidelity has played a key role in flight control development. Simulation has also complemented the flight testing of the A-320-200. Digital flight control has moved the critical areas from aerodynamic model accuracy to flight control system representation exactness. Simulator acceptance procedures had also to be adapted to address the case of closed loop controlled aircraft correctly. Author

N92-28527# McDonnell-Douglas Helicopter Co., Mesa, AZ. Flight Mechanics/Performance Dept.
THE APPLICATION OF FLIGHT SIMULATION MODELS IN SUPPORT OF ROTORCRAFT DESIGN AND DEVELOPMENT
P. SHANTHAKUMARAN *In* AGARD, Piloted Simulation Effectiveness 28 p Feb. 1992
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McDonnell Douglas Helicopter Company's overall approach to design development and flight evaluation through flight simulation models is presented. Flight simulation model description, validation against flight test data bases, and applications for rotorcraft design and development, are presented. Specific model refinements for each application are emphasized. Examples include power-off emergency landing, empennage design, maneuver envelope expansion, engine-airframe integration, and manned simulations. Author

N92-28528# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Helicopter Div.
EXPERIENCE WITH PILOTED SIMULATION IN THE DEVELOPMENT OF HELICOPTERS
M. OBERMAYER, K. KAMPA, W. DOEHNEL, and A. FAULKNER *In* AGARD, Piloted Simulation Effectiveness 11 p Feb. 1992
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Based on examples from several projects this paper reflects MBB's experience with applicability, limitations, acceptance, and effectiveness of helicopter simulation. Some of the key points are the objective and subjective validation of a simulator and various factors, which influence the acceptance by pilots. In this context it is very important to make a trade-off between simulator sophistication and required results. Other aspects of simulation effectiveness include evaluation and training of critical flight conditions prior to flight tests as well as involving the customer from early concept studies up to full mission simulations, which gives him more influence on the design and leads to better identification with the product. Author

N92-28532# National Aerospace Lab., Amsterdam (Netherlands).
AIRCRAFT SIMULATION AND PILOT PROFICIENCY: FROM SURROGATE FLYING TOWARDS EFFECTIVE TRAINING
P. G. A. M. JORNA (National Aerospace Lab., Amsterdam (Netherlands).), E. R. A. VANKLEEF (Royal Netherlands Air Force, The Hague.), and W. P. DEBOER *In* AGARD, Piloted Simulation Effectiveness 8 p Feb. 1992
Copyright Avail: CASI HC A02/MF A03

Simulators are currently built as simple system 'look-a-likes' and a structured or experimentally validated approach to their use and implementation as part of a comprehensive training system is lacking. This is one reason why their use in training was not always as successful as expected. This paper reviews some experiences with the application of simulators in military flight training and it reports research strategies like the development of objective performance measures in support of validation trials and future simulator development. It is proposed to prototype simulator concepts before implementing them and relevant research initiatives in this area are reviewed. Author

N92-28533# CAE Electronics Ltd., Montreal (Quebec). Tactical Systems Div.
THE USE OF A DEDICATED TESTBED TO EVALUATE SIMULATOR TRAINING EFFECTIVENESS
DAVID KURTS (CAE Electronics Ltd., Montreal (Quebec).) and CHARLES GAINER (Army Research Inst. Aviation Research and Development Activity, Fort Rucker, AL.) *In* AGARD, Piloted Simulation Effectiveness 9 p Feb. 1992
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The Simulator Complexity Test Bed (SCTB) is being produced for the U. S. Army Research Institute Aviation Research and Development Activity (ARIARDA) to specifically address the question of the level of simulation fidelity required to ensure adequate transfer of training in a tactical helicopter simulator environment. This paper presents the objectives of the SCTB, the hardware and software architecture designed to facilitate these goals, and presents examples of some typical research that will be conducted. The simulator is based on the Apache AH-64A attack helicopter using aircraft parts and simulated avionics to provide a realistic replica of the pilot and copilot gunner positions. Author

N92-28535# Air Force Flight Test Center, Edwards AFB, CA. Test and Evaluation Simulator.
USE OF SIMULATION IN THE USAF TEST PILOT SCHOOL CURRICULUM
DANIEL P. RINGENBACH (NSI Technology Services Corp., Greenbelt, MD.), STEVEN E. LOUTON (NSI Technology Services Corp., Research Triangle Park, NC.), and DANIEL GLEASON *In* AGARD, Piloted Simulation Effectiveness 7 p Feb. 1992
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The six degree-of-freedom, real time, Test Pilot School (TPS) simulator at the Test and Evaluation Mission Simulator (TEMS) of the Air Force Flight Test Center (AFFTC) is an invaluable and versatile tool used by the TPS. It is an effective learning tool providing positive reinforcement on basic aircraft dynamics taught in the classroom and an efficient evaluation tool for flight control systems designed by the students. Author

N92-28536# Alenia, Torino (Italy). Flight Simulation Center.
AM-X FLIGHT SIMULATOR FROM ENGINEERING TOOL TO TRAINING DEVICE
A. ARMANDO, P. CASTOLDI, and F. FASSI *In* AGARD, Piloted Simulation Effectiveness 12 p Feb. 1992
Copyright Avail: CASI HC A03/MF A03

Effectiveness of Flight Simulation with pilot-in-the-loop can be intended rather differently depending on the context in which the simulation activities are carried out, namely in the two traditional areas of Research & Development (R&D) and Training. In the latter case, effectiveness can be considered the amount of training a simulator is able to transfer per time unit, while in the case of R&D simulation its effectiveness is related to the amount of confidence engineers can gain in the prediction of an airborne system behavior before releasing it to the real flight. Pursuing the maximization of effectiveness in these two different contexts leads to different approaches in applying simulation methodologies. This paper will show to what extent a simulation facility created and continuously improved to support the development of a new attack aircraft, the AM-X, was finally capable of training operational pilots during the conversion to that aircraft. Author

N92-28537# *Sikorsky Aircraft, Stratford, CT.*
FULL MISSION SIMULATION: A VIEW INTO THE FUTURE
MICHAEL J. FERRANTI and STEPHEN H. SILDER, JR. *In* AGARD, Piloted Simulation Effectiveness 10 p Feb. 1992
Copyright Avail: CASI HC A02/MF A03

The use of engineering simulation as a design support tool is becoming more prevalent in assisting design engineers in prototyping new concepts in advanced integrated helicopters. The primary goal in using full mission simulation as a risk reduction tool is that it can provide significant insight into critical design areas. In this capacity, it allows the research engineer the means to review critical design issues and assess areas of high risk associated with air vehicle design. The use of the Engineering Development Full Mission Flight Simulator (EDFMFS) will allow the design engineers the opportunity to view the future performance of the design air vehicle. This includes areas of both aerodynamic and operational suitability. The use of representative flight simulators will allow major design issues to be resolved with a significant reduction in the cost normally associated with developmental flight testing. The performance of flight control laws and cockpit design can be evaluated in the safe and secure environment of the simulator before actual flight test. In this regard, the capabilities of EDFMFS's have shown themselves to be an outstanding tool in evaluating advanced design aircraft during the initial design phase. Today's use of statistical and multivarient analysis techniques provides the designers with a real time quantitative capability to collect and analyze data, thus, reducing the risk associated with new product development. The methodologies used that provide the designer and pilots with the unique opportunity to evaluate different aircraft configurations in the Full Mission Flight Simulator before the design is concluded are identified. Author

N92-28539# CAE Electronics Ltd., Saint Laurent (Quebec).
THE EVALUATION OF SIMULATOR EFFECTIVENESS FOR THE TRAINING OF HIGH SPEED, LOW LEVEL, TACTICAL FLIGHT OPERATIONS
ANDREW MORRIS (CAE Electronics Ltd., Montreal (Quebec).) and PAUL E. VANHEMEL (CAE-Link Corp., Alexandria, VA.) *In* AGARD, Piloted Simulation Effectiveness 11 p Feb. 1992
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The German Government has initiated a three phase program to evaluate the use of an improved simulator for the Tornado aircraft. In the first phase of this program computer aided engineering (CAE) has built a prototype simulator, referred to as the Evaluation Unit (EU). The improvements in the EU consist of visual system upgrades to provide a CAE Fiber-Optic Helmet Mounted Display (FOHMD) for the pilot and weapon system officer (WSO), with imagery from an Evans & Sutherland ESIG-1000 image generator, as well as a six-degree of freedom (DOF) motion system. The EU was installed at CAE Electronics GmbH in Stolberg, Germany. Military and industrial representatives are conducting an evaluation of the upgraded simulator to assess its capability to provide high speed, low level, tactical flight operations training capability. A factorial analysis of variance (ANOVA) design is being used to objectively assess recorded performance data and subjective impressions data collected during simulator flights by military crews from the German Air Force and Navy. Author

N92-28540# Ministry of Defence, London (England).
HARRIER GR MK 5/7 MISSION SIMULATORS FOR THE ROYAL AIR FORCE
B. R. CLIFFORD (Ministry of Defence, London (England).) and P. JACKSON (Link-Miles, Lancing, England) *In* AGARD, Piloted Simulation Effectiveness 6 p Feb. 1992
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IN 1985, in anticipation of the phased replacement of the Harrier GR MK 3 by the Harrier GR MK 5, the UK version of the AV8B, the UK Air Staff issued a requirement for two mission simulators capable of fulfilling a comprehensive pilot training and evaluation task. It identified the need for simulators which would provide a wide range of psycho-physical cues with accurate flight and systems simulation, integrated with a high resolution, wide field-of-view visual system compatible with the Harrier's operational roles and inherent speed and agility. It became apparent that this would require the utilization of new technology, particularly in the area of head and eye-slaved visual displays; studies within the MoD confirm this and conclude that although innovative, the application of such technology was feasible. Some of the background and selection process are reviewed, and the mission simulators selected to meet the Royal Air Force's training needs are briefly described. Author

N92-28543# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
USE OF A RESEARCH SIMULATOR FOR THE DEVELOPMENT OF NEW CONCEPTS OF FLIGHT CONTROL [UTILISATION D'UN SIMULATEUR DE RECHERCHE POUR LE DEVELOPPEMENT DE NOUVEAUX CONCEPTS DE COMMANDES DE VOL]
PH. GUICHETEAU *In* AGARD, Piloted Simulation Effectiveness 11 p Feb. 1992 In FRENCH; ENGLISH summary
Copyright Avail: CASI HC A03/MF A03

Several studies performed at ONERA have shown the usefulness of testing the behavior of the whole aircraft with the pilot in the loop by using a research flight simulator as soon as the preliminary design of new FCE for future aircraft is undertaken. The communication presents three conceptual studies related to mission oriented control systems which were performed at ONERA's research flight facility. The description of the conceptual phase of each of these studies and, for two of them, of their further validation on full flight simulators allows a conclusion about the complementary roles of research and full flight simulators. Author

N92-28544# Dassault-Breguet Aviation, Saint Cloud (France).
THE ROLE OF SIMULATION FOR THE STUDY OF APIS (PILOTING SUPPORT BY SYNTHETIC IMAGERY) [LE ROLE DE LA SIMULATION POUR L'ETUDE APIS (AIDE AU PILOTAGE PAR IMAGERIE SYNTHETIQUE)]
PIERRE LARROQUE, PIERRE PAGNIEZ, and ROLAND MIGINIAC *In* AGARD, Piloted Simulation Effectiveness 12 p Feb. 1992 In FRENCH
Copyright Avail: CASI HC A03/MF A03

This report presents different methods of simulation used at Dassault Aviation for the APIS (pilot support by synthetic imagery) study. The aim of this study was to define man-machine concepts for synthetic imagery derived from onboard information and updated in flight. The imagery system provides the pilot with a comprehension and decision tool that can be used for any flight conditions (low altitude, poor visibility...) and tactical conditions. This document describes: (1) the methods used to produce static images from needs analysis, enabling a preliminary selection of acceptable images; (2) the use of workstations to generate and pilot in real time the solutions retained and to improve the representations; (3) interfacing workstations with a real-time processor and a RAFALE type simulation cabin, permitting manual or automatic execution of a 3-D trajectory in a simple scenario and used after evaluation by 10 pilots; (4) scenarios retained and results obtained as a result of these evaluations; and (5) follow up future spinoffs for the engineering of Dassault fighter aircraft. Transl. by L.B.

N92-28545*# Systems Technology, Inc., Hawthorne, CA.
THE USE OF GROUND BASED SIMULATION FOR HANDLING QUALITIES RESEARCH: A NEW ASSESSMENT
DAVID G. MITCHELL (Systems Technology, Inc., Hawthorne, CA.), ROGER H. HOH (Hoh Aeronautics, Inc., Lomita, CA.), ADOLPH ATENCIO, JR. (Army Aviation Systems Command, Moffett Field, CA.), and DAVID L. KEY (Army Aviation Systems Command, Moffett Field, CA.) *In* AGARD, Piloted Simulation Effectiveness 14 p Feb. 1992
(Contract NAS2-13127)
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A study was conducted on the NASA Ames Research Center's Vertical Motion Simulator to determine the effects of simulator characteristics on perceived handling characteristics. Differences in pilot opinion were found as the visual and motion parameters were changed, reflecting a change in the pilots' perceptions of handling qualities, rather than changes in the aircraft model itself. The results indicate a need for tailoring the motion without dynamics to suit the task, with reduced washouts for precision maneuvering as compared to aggressive maneuvering. Visual delay data are inconclusive, but suggest that it may be better to allow some time delay in the visual path to minimize the mismatch between vision and motion, rather than eliminate the visual delay entirely through lead compensation. The simulation results are compared with ratings from a similar in-flight simulation experiment. Author

N92-28546# Defence Research Agency, Bedford (England). Flight Systems Dept.

INITIAL VALIDATION OF A R/D SIMULATOR WITH LARGE AMPLITUDE MOTION

A. D. WHITE, J. R. HALL, and B. N. TOMLINSON *In* AGARD, Piloted Simulation Effectiveness 24 p Feb. 1992

Copyright Avail: CASI HC A03/MF A03

The Advanced Flight Simulator (AFS) Complex at the Defense Research Agency (DRA) at Bedford was enhanced by the addition of a large displacement motion platform and a three channel Computer Generated Image (CGI) outside world visual system. The trial described here was the first in a series of trials aimed at validating the AFS in its present configuration and in particular at demonstrating its ability to address a wide variety of vehicle handling qualities with a high degree of fidelity and user confidence. It included a direct comparison between the ground based AFS and the Calspan Learjet in-flight simulator. The comparison between the AFS and Learjet involved three pilots flying the same offset approach landing tasks using the same aircraft model in both the AFS and in flight. The lateral handling qualities were varied by adjusting the time constant of a filter in the pilot's roll control loop. Pilot comments, handling quality, and PIO ratings indicate that the AFS reproduces the lateral handling qualities and roll PIO tendencies of the Learjet in-flight simulator with high fidelity. The degradation in handling qualities and increase in PIO tendencies with increasing filter time constant were clearly revealed in both the AFS and Learjet. The importance of good platform motion cueing and task design when evaluating handling qualities was also demonstrated. Author

N92-28547# Deutsche Airbus G.m.b.H., Hamburg (Germany, F.R.).

USE OF A VIRTUAL COCKPIT FOR THE DEVELOPMENT OF A FUTURE TRANSPORT AIRCRAFT

DIETER KRICKE and WILFRIED QUELLMANN *In* AGARD, Piloted Simulation Effectiveness 10 p Feb. 1992 Sponsored in part by BMFT and Council of the European Community

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A development tool called the 'visual cockpit' is discussed. A comparison of civil and military transport aircraft development shows a significant technology gap on the military tactical transport side during the last 30 years. Therefore, it seems very beneficial to consider a 'dual use' of well-proven 'civil technologies' for military applications. Specific military transport missions require aircraft capabilities, some of which are quite new and therefore challenging for transport aircraft (e.g. low level flight profiles in night and poor visibility conditions). The demonstration of the feasibility and an evaluation of technical solutions imply the need for suitable development tools. The Virtual Cockpit is explained in terms of its components (hardware/software), features, and capabilities. A major field of investigation in this context is the aircraft systems' central control and monitoring. Author

N92-28548# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Inst. fuer Flugmechanik.

THE ROLE OF SYSTEMS SIMULATION FOR THE DEVELOPMENT AND QUALIFICATION OF ATTAS

D. HANKE, H.-H. LANGE, and P. SAAGER *In* AGARD, Piloted Simulation Effectiveness 11 p Feb. 1992

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The Advanced Technologies Testing Aircraft System (ATTAS) is a flight test vehicle to be used as a flying simulator to demonstrate and validate new methods and technologies. In order to provide broad testing capabilities, ATTAS was heavily modified and equipped with a powerful digital fly-by-wire/light flight control system. Presented here is a technical description of the simulator structure and simulation capabilities. Also addressed is the specific role of system identification techniques for simulator validation. Several examples are given demonstrating system performance. Finally, conclusions concerning the merits of system simulation for the ATTAS development and operation are discussed. Author

N92-28549# Douglas Aircraft Co., Inc., Long Beach, CA.

THE USE AND EFFECTIVENESS OF PILOTED SIMULATION IN TRANSPORT AIRCRAFT RESEARCH AND DEVELOPMENT

J. HODGKINSON, K. F. ROSSITTO, and E. R. KENDALL *In* AGARD, Piloted Simulation Effectiveness 8 p Feb. 1992

Copyright Avail: CASI HC A02/MF A03

Simulation requirements for military and for commercial transport aircraft are contrasted. The special problems introduced by active control are discussed with reference to earlier fighter data. Transport simulator experiments to explore these problems are described. Author

N92-28550# Toronto Univ., Downsview (Ontario). Inst. for Aerospace Studies.

AN EVALUATION OF IFR APPROACH TECHNIQUES: GENERIC HELICOPTER SIMULATION COMPARED WITH ACTUAL FLIGHT

L. D. REID, S. ADVANI, and J. H. DELEEUW *In* AGARD, Piloted Simulation Effectiveness 18 p Feb. 1992

(Contract W2207-7-AF69/01-SS)

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Described here is a comparison process using a generic helicopter simulator and flight tests carried out in the National Aeronautical Establishment's Bell 205 research helicopter. The project was designed to establish some initial application boundaries for the newly commissioned helicopter simulator. Hence, the validation process took place in the reverse order, with the helicopter simulator runs performed after the flight tests. Author

N92-28551*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

APPLICATION OF PILOTED SIMULATION TO HIGH-ANGLE-OF-ATTACK FLIGHT-DYNAMICS RESEARCH FOR FIGHTER AIRCRAFT

MARILYN E. OGBURN (Vigyan Research Associates, Inc., Hampton, VA.), JOHN V. FOSTER, and KEITH D. HOFFLER (Vigyan Research Associates, Inc., Hampton, VA.) *In* AGARD, Piloted Simulation Effectiveness 16 p Feb. 1992

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The use of piloted simulation at Langley Research Center as part of the NASA High-Angle-of-Attack Technology Program (HATP), which was created to provide concepts and methods for the design of advanced fighter aircraft, is reviewed. A major research activity within this program is the development of the design processes required to take advantage of the benefits of advanced control concepts for high angle of attack agility. Fundamental methodologies associated with the effective use of piloted simulation for this research are described, particularly those relating to the test techniques, validation of the test results, and design guideline/criteria development. Author

N92-28552# British Aerospace Public Ltd. Co., Lancashire (England). Military Aircraft Div.

EFFECTIVE CUEING DURING APPROACH AND TOUCHDOWN: COMPARISON WITH FLIGHT

PETER BECKETT *In* AGARD, Piloted Simulation Effectiveness 11 p Feb. 1992

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The importance of the various cues provided by flight simulators is a topic for continual debate. Designers of simulators must wrestle with the issue in order to create a sufficient illusion of flight that allows the pilot to carry out his tasks. Hopefully, he becomes stimulated in a similar manner to the real world and behaves accordingly. For training purposes, we are then reinforcing behavior patterns. In research and development simulation, we become more confident that problems or deficiencies of pilot/aircraft interaction are identified early. Clearly, if the cueing is identical to the real world, we would expect identical behavior from the pilot. Simulators invariably fall short of this in many ways. What are considered to be essential cueing requirements are often intuitive, sometimes based on experience and sometimes completely open to individual opinion. A good test of cueing effectiveness is a comparison with flight. The cueing issues for landing approach and touchdown of fast jets are discussed here and simulation results are compared with flight. Author

N92-28579# Technische Univ., Delft (Netherlands). Faculty of Aerospace Engineering.
THE BASIC RESEARCH SIMULATOR PROGRAMME AND THE INDUSTRIAL AND AEROSPACE COMMUNITY: OPPORTUNITIES FOR COOPERATIVE RESEARCH
S. K. ADVANI Oct. 1991 69 p
(LR-662; ETN-92-91401) Avail: CASI HC A04/MF A01

The configuration of the basic research simulator and the proposed applications of the facility are outlined. The benefits to industry of the simulator are: the dynamic behavior and control of motion platforms; the performance of vehicle simulations in a ground based environment; and the human factors of vehicle operation. The dynamic behavior of a motion platform can be improved by minimizing the mass of the moving components and by placing the center of gravity in a low vertical location. In practice, metal fiber laminates (hybrid materials) will form the primary structure of the basic research simulator in order to minimize its weight. To lower the center of gravity, the cockpit floor will be attached beneath the primary load bearing frame of the moving platforms and below its gimbals. Further improvements to the dynamic properties will be achieved through the application of multivariable control techniques to drive the six degrees of freedom motion system. A motion system with favorable dynamic properties can serve as an ideal tool for conducting basic research in vehicle simulation and in human factors: motion signal noise and parasitic displacements on the nondriven directions can be virtually cancelled by proper design and control techniques. The provision for flexible cockpit and instrument arrangements supports research into instrument display formats. ESA

N92-28661# National Aerospace Lab., Amsterdam (Netherlands). Aerodynamics Div.
THE WINDTUNNEL AS A TOOL FOR LAMINAR FLOW RESEARCH
A. ELSENAAR 8 May 1990 17 p Presented at 17th ICAS Congress, Stockholm, Sweden, 9-14 Sep. 1990 Previously announced in IAA as A91-24324 Sponsored in part by Netherlands Agency for Aerospace Programs
(NLR-TP-90145-U; ETN-92-91536) Avail: CASI HC A03/MF A01

Testing laminar airfoils or wings in the wind tunnel entails some specific experimental problems. These problems are discussed using the (limited) experience of laminar flow tests made in a high speed wind tunnel. Special measurement techniques like infrared imaging for transition detection and fast continuous wake rake traverses, are required for detailed drag assessment. Premature transition due to contamination of the airfoil surface appears to be a problem. The transition location in flight is unlikely to be duplicated in the wind tunnel due to flow quality and Reynolds number differences. Therefore a methodology to extrapolate the wind tunnel test result to flight conditions is discussed. ESA

N92-28669# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
INSTRUMENTATION REQUIREMENTS FOR LAMINAR FLOW RESEARCH IN THE NLR HIGH SPEED WIND TUNNEL HST
A. ELSENAAR, P. B. ROHNE, D. ROZENDAL, and R. POESTKOKE 8 May 1989 14 p Presented at the 13th International Congress on Instrumentation in Aerospace Simulation Facilities, Goettingen, Fed. Republic of Germany, 18-21 Sep. 1989 Previously announced in IAA as A90-28283
(NLR-TP-89158-U; ETN-92-91520) Avail: CASI HC A03/MF A01

The testing of laminar flow airfoils and wings in wind tunnels imposes very stringent requirements on the wind tunnel and the measurement techniques. Starting from experience obtained in high speed tunnels, typical aspects like scale effects, flow quality and model contamination are discussed. Different techniques of transition detection are revised, and the infrared technique in combination with continuous wake rake traverses is concluded to provide the best opportunities for a detailed experimental analysis of a particular laminar flow design. ESA

N92-28673*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FLOW QUALITY STUDIES OF THE NASA LEWIS RESEARCH CENTER 8- BY 6-FOOT SUPERSONIC/9- BY 15-FOOT LOW SPEED WIND TUNNEL
E. ALLEN ARRINGTON and MARK T. PICKETT Jul. 1992 47 p Presented at the 17th Aerospace Ground Testing Conference, Nashville, TN, 6-8 Jul. 1992; sponsored in part by AIAA
(Contract NAS3-25266; RTOP 505-62-84)
(NASA-TM-105417; E-6827; NAS 1.15:105417; AIAA PAPER 92-3916) Avail: CASI HC A03/MF A01

A series of studies were conducted to determine the existing flow quality in the NASA Lewis 8 by 6 Foot Supersonic/9 by 15 Foot Low speed Wind Tunnel. The information gathered from these studies was used to determine the types and designs of flow manipulators which can be installed to improve overall tunnel flow quality and efficiency. Such manipulators include honeycomb flow straighteners, turbulence reduction screens, corner turning vanes, and acoustic treatments. The types of measurements, instrumentation, and results obtained from experiments conducted at several locations throughout the tunnel loop are described. Author

N92-28772# Wright Lab., Wright-Patterson AFB, OH.
A METHODOLOGY FOR THE EVALUATION OF RUNWAY ROUGHNESS FOR REPAIR
JOHN T. RIECHERS Sep. 1991 39 p
(AD-A250407; WL-TM-02-307-FIBE) Avail: CASI HC A03/MF A01

The Structural Integrity Branch has supported the evaluation of aircraft response to ground induced loadings through modeling since the 1970's. A methodology for the use of these modeling techniques to evaluate a runway for roughness, and to rate the prospective repairs by effectiveness is presented. This information can be used by local civil engineering to determine the extent of repairs required, and if these repairs can be accomplished under general maintenance funds allocations, or if a major construction request is necessary. GRA

N92-28829# National Aerospace Lab., Tokyo (Japan). Aeroengine Div.
AIR EJECTOR EXPERIMENTS USING THE TWO-DIMENSIONAL SUPERSONIC CASCADE TUNNEL: ZERO SECONDARY FLOW PERFORMANCE Report No. 1
SUSUMU TAKAMORI and HAJIME SAKAGUCHI Feb. 1991 19 p In JAPANESE
(ISSN 0452-2982)
(NAL-TM-632; JTN-92-80350) Avail: CASI HC A03/MF A01

The air ejector has almost limitless application possibilities in engineering practice due to its simplicity. To determine the feasibility of using an ejector as a suction pump for boundary layer air removal in the two dimensional supersonic cascade tunnel, especially when a portion of the tunnel's air supply is used for its primary flow, both subsonic and supersonic air ejector tests were conducted. The tested ejector was axially symmetrical and a center jet type, with its geometrical configuration being varied, i.e., the primary nozzle to mixing tube throat area ratio, and the straight mixing space (mixing tube) and diverging passage section (diffuser) lengths. These configuration changes enabled geometrical effects on ejector performance to be obtained. The following experimental results using a zero secondary flow air ejector are discussed: (1) the effects of the straight mixing and diverging passage section lengths on the relationship between secondary pressure (secondary

vacuum chamber pressure) and primary stagnation pressure (primary pressure characteristics) during a zero secondary flow condition; (2) the effect of throat area ratio of primary nozzle to mixing tube on primary pressure characteristics; (3) the relationship between the minimum secondary pressure and throat area ratio; (4) the optimal operating conditions for a zero secondary flow subsonic ejector; and (5) the effect of primary Mach numbers on a zero secondary flow supersonic ejector performance.
Author (NASDA)

N92-28833# National Aerospace Lab., Tokyo (Japan). Advanced Aircraft Research Group.
UPGRADING THE DATA PROCESSING SECTION OF THE NAL GUST WIND TUNNEL DATA PROCESSING SYSTEM
AKIHITO IWASAKI, TOSHIMI FUJITA, and HIROTOSHI FUJIEDA May 1991 22 p In JAPANESE
(ISSN 0452-2982)
(NAL-TM-635; JTN-92-80352) Avail: CASI HC A03/MF A01
The data processing system in NAL Gust Wind Tunnel is composed of data acquisition and data processing sections. The outline of the system used to upgrade the data processing section and secondary date processing for wind tunnel data are described. The new system includes an Eclipse MV/7800XP CPU, six megabytes of memory, and various peripheral devices. Performance enhancements were obtained using this upgrade.
Author (NASDA)

N92-28835# National Aerospace Lab., Tokyo (Japan). Aircraft Aerodynamics Div.
REPLACEMENT OF THE NAL HIGH PRESSURE AIR STORAGE SYSTEM
SHIGEO BABA, HISASHI SUENAGA, MASAMITU SUZUKI, and NOBUHIRO TODA Mar. 1991 31 p In JAPANESE
(ISSN 0452-2982)
(NAL-TM-634; JTN-92-80362) Avail: CASI HC A03/MF A01
The replacement process is described for the high pressure air storage vessel attached to the 2 m x 2 m Transonic Wind Tunnel of the NAL. The oldest two of three existing 10 m diameter vessel were dismantled and replaced by a new 13 m diameter vessel, thereby preserving the total capacity. Both the operational and maintenance histories of the old vessel are discussed, as well as the design construction features included in the new one, its initial test results, and the important issues related to future system operations. Author (NASDA)

N92-29204# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
NARSIM: A REAL-TIME SIMULATOR FOR AIR TRAFFIC CONTROL RESEARCH
W. DENBRAVEN and J. M. TENHAVE 25 May 1990 58 p Submitted for publication
(NLR-TP-90147-U; ETN-92-91537) Avail: CASI HC A04/MF A01
The lack of capacity and efficiency in the present day air transportation system is noted. Developments towards a future integrated Air Traffic Management (ATM) system were initiated in order to reduce these deficiencies. Real time Air Traffic Control (ATC) simulators, such as the NLR ATC Research Simulator (NARSIM), will play an essential role in the research on this future ATC, thus describing the area of interest for ATC research simulation. NARSIM is described. Its functions are characterized, followed by a description of the air traffic controller's work environment, the hardware configuration, and the controller workstations. An introduction to NARSIM's main research areas, which are integrated ATM and the man machine interface, is given. ESA

N92-29352*# North Carolina State Univ., Raleigh.
BUFFET TEST IN THE NATIONAL TRANSONIC FACILITY Final Report
CLARENCE P. YOUNG, JR., DENNIS W. HERGERT, THOMAS W. BUTLER, and FRED M. HERRING Jul. 1992 66 p Prepared in cooperation with Boeing Co., Seattle, WA Original contains color illustrations
(Contract NCC1-141; RTOP 505-59-85-01)
(NASA-CR-189595; NAS 1.26:189595) Avail: CASI HC A04/MF A01; 2 functional color pages
A buffet test of a commercial transport model was accomplished in the National Transonic Facility at the NASA Langley Research Center. This aeroelastic test was unprecedented for this wind tunnel and posed a high risk for the facility. Presented here are the test results from a structural dynamics and aeroelastic response point of view. The activities required for the safety analysis and risk assessment are described. The test was conducted in the same manner as a flutter test and employed on-board dynamic instrumentation, real time dynamic data monitoring, and automatic and manual tunnel interlock systems for protecting the model.
Author

N92-29505# General Electric Co., Gilbert, AZ. Government Services.
TRANSPORT DELAY MEASUREMENTS: METHODOLOGY AND ANALYSIS FOR THE F-16C COMBAT ENGAGEMENT TRAINER, THE DISPLAY FOR ADVANCED RESEARCH AND TRAINING, AND THE F-16A LIMITED FIELD OF VIEW Final Technical Paper, Mar. 1991 - Jan. 1992
ROGER W. LEINENWEVER and SUSANNE I. MORAN Mar. 1992 30 p
(Contract F33615-88-C-0014)
(AD-A248519; AL-TP-1992-0009) Avail: CASI HC A03/MF A01
Transport delays between the cockpit and visual/sensors in simulation systems can result in significant degradation of flight simulation training. At the Armstrong Laboratory, Aircrew Training Research Division, methodologies for testing visible delays were developed and measurements run on three systems. The tests showed significant transport delays; in some cases, higher than anticipated. Further analysis of the data revealed that the delays were caused by specific hardware and software configurations. Changes in configurations can eliminate the problem entirely, or can decrease transport delays to an acceptable range. GRA

N92-29655*# MCAT Inst., San Jose, CA.
STUDY OF OPTICAL TECHNIQUES FOR THE AMES UNITARY WIND TUNNELS. PART 3: ANGLE OF ATTACK Progress Report
GEORGE LEE Jun. 1992 27 p
(Contract NCC2-716)
(NASA-CR-190541; NAS 1.26:190541; MCAT-92-011-PT-3) Avail: CASI HC A03/MF A01
A review of optical sensors that are capable of accurate angle of attack measurements in wind tunnels was conducted. These include sensors being used or being developed at NASA Ames and Langley Research Centers, Boeing Airplane Company, McDonald Aircraft Company, Arnold Engineering Development Center, National Aerospace Laboratory of the Netherlands, National Research Council of Canada, and the Royal Aircraft Establishment of England. Some commercial sensors that may be applicable to accurate angle measurements were also reviewed. It was found that the optical sensor systems were based on interferometers, polarized light detector, linear or area photodiode cameras, position sensing photodetectors, and laser scanners. Several of the optical sensors can meet the requirements of the Ames Unitary Plan Wind Tunnel. Two of these, the Boeing interferometer and the Complere lateral effect photodiode sensors are being developed for the Ames Unitary Plan Wind Tunnel. Author

N92-29709# Anacapa Sciences, Inc., Fort Rucker, AL.
ASSESSMENT OF ARMY AVIATORS' ABILITY TO PERFORM INDIVIDUAL AND COLLECTIVE TASKS IN THE AVIATION NETWORKED SIMULATOR Interim Report, Sep. 1988 - Nov. 1990
BETH W. SMITH and KENNETH D. CROSS Apr. 1992 92 p
(Contract MDA903-87-C-0523; AF PROJ. 3405)
(AD-A250293; ARI-RN-92-32) Avail: CASI HC A05/MF A01
This research evaluates the training effectiveness of the Aviation Networked Simulator (hereafter referred to as AIRNET). The research was designed to (1) assess experienced

crewmembers' ability to perform selected individual and collective tasks in AIRNET, and (2) identify the specific design attributes that makes it difficult for crewmembers to perform tasks to standards in AIRNET. Because the research examined only in-simulator performance, inferences about the device's training effectiveness can be drawn only from data indicating that experienced crewmembers cannot perform a task effectively in AIRNET. Specifically, it is assumed that tasks cannot be trained effectively on a device if they cannot be performed adequately on that device. Transfer-of-training studies are required to assess the AIRNET's effectiveness for training tasks that can be performed adequately on the device. The report presents detailed data on the relative effectiveness of crewmembers performing the individual and collective tasks investigated. The report also presents detailed data on crewmember ratings of the adequacy of AIRNET for both performing and training specific tasks and conclusions and recommendations about the need to modify the design of AIRNET components. GRA

N92-30076# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Helicopter Div.
EXPERIENCE WITH PILOTED SIMULATION IN THE DEVELOPMENT OF HELICOPTERS
M. OBERMAYER, K. KAMPA, W. DOEHNEL, and A. FAULKNER 1991 12 p Presented at 79th AGARD Flight Mechanics Panel Symposium on Pilot Simulation Effectiveness, Brussels, Belgium, 14-17 Oct. 1991 Previously announced as N92-28528
(MBB-UD-0610-91-PUB; ETN-92-91697) Avail: CASI HC A03/MF A01

Applicability, limitations, acceptance, and effectiveness of helicopter simulation are considered. Some of the key points are the objective and subjective validation of a simulator and the various factors which influence the acceptance by pilots. In this context it is very important to make a tradeoff between simulator sophistication (i.e., cost) and required result (i.e., design input) in the actual phase of development. Other aspects of simulation effectiveness include evaluation and training of critical flight conditions prior to flight tests as well as involving the customer from early concept studies up to full mission simulations, which gives more influence in the design and leads to better identification with product. 'Do's' and 'don'ts' in piloted simulation to achieve maximum simulation effectiveness are presented. ESA

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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.

A92-45442* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
SPACE SHUTTLE ORBITER AUXILIARY POWER UNIT STATUS
M. RECK, G. LOKEN, J. HORTON, W. LUKENS (Sundstrand Aerospace, Rockford, IL), W. SCOTT (NASA, Johnson Space Center, Houston, TX), J. BAUGHMAN (Rockwell International Corp., Downey, CA), and T. BAUCH (STS Corp., Tokyo, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 731-747. refs
(SAE PAPER 912060) Copyright

An overview of the United States Space Shuttle Orbiter APU, which provides power to the Orbiter vehicle hydraulic system, is presented. Three complete APU systems, each with its own separate fuel system, supply power to three dedicated hydraulic systems. These in turn provide power to all Orbiter vehicle critical flight functions including launch, orbit, reentry, and landing. The basic APU logic diagram is presented. The APU includes a hydrazine-powered turbine that drives a hydraulic pump and various accessories through a high-speed gearbox. The APU also features a sophisticated thermal management system designed to ensure safe and reliable operation in the various launch, orbit, reentry, and landing environments. C.A.B.

A92-46428
PROPULSION SYSTEMS FROM TAKEOFF TO HIGH-SPEED FLIGHT
F. S. BILLIG (Johns Hopkins University, Laurel, MD) IN: High-speed flight propulsion systems. Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1991, p. 21-100. refs
Copyright

Potential applications for missiles and aircraft requiring highly efficient engines serve as the basis for discussing new propulsion concepts and novel combinations of existing cycles. Comparisons are made between rocket and airbreathing powered missiles for anti-ballistic and surface-to-air missions. The properties of cryogenic hydrogen are presented to explain the mechanics and limitations of liquid air cycles. Conceptual vehicle designs of a transatmospheric accelerator are introduced to permit examination of the factors that guide the choice of the optimal propulsion system. Author

A92-46726
CREW TRANSPORTATION FOR THE 1990S. I - COMMERCIALIZING MANNED FLIGHT WITH TODAY'S PROPULSION
ROBERT STAEHLE and J. R. FRENCH (World Space Foundation, South Pasadena, CA) Foundation Astronautics Notebook - 30, 1989.

Two commercial space transport concepts that have been developed employing reusable production engines are discussed. A winged space transport (WST) launched from a Boeing 747 was sized to carry six people to low orbit. With no margin for performance growth, it is not favored for development. A vertical launch/landing space transport was designed with capabilities and propulsion similar to the WST, but launched from the ground. A small launch mass penalty is offset by improved performance margins and by eliminating carrier aircraft costs. The two-pilot plus five-passenger vehicle is designed for short-duration trips to low earth orbit, or for docking up to 10 d at an orbiting station. Market applications include space station crew rotation, equipment delivery and product return, short-duration experiments, satellite servicing, reconnaissance, and tourism. Profitable per-mission prices are projected at $10-15 million, with development costs approaching $400 million. C.A.B.

A92-46766
THRUST/SPEED EFFECTS ON LONG-TERM DYNAMICS OF AEROSPACE PLANES
GOTTFRIED SACHS (Muenchen, Technische Universitaet, Munich, Federal Republic of Germany) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 4, July-Aug. 1992, p. 1050-1053. refs
Copyright

An effort is made to deepen perspectives concerning thrust/speed effects on long-term modes of motion, and results are presented for the hypersonic flight regime in view of analytical considerations which accentuate their generality. In the cases of both direct and indirect thrust/speed effects, there are significant reductions in the sensitivities of the phugoid and height mode throughout the hypersonic Mach number range. O.C.

A92-48712#
ABLATIVE CONTROL MECHANISM IN NOZZLE THERMO-PROTECTION
HONGQING HE and XU ZHOU (Northwestern Polytechnical University, Xian, People's Republic of China) AIAA, SAE, ASME,

and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 5 p. refs
(AIAA PAPER 92-3054) Copyright

Expressions for mass consumption rates of oxygen-bearing components in gas flow and of thermoprotective lining materials are deduced, then mass calculated equations of ablation are derived. These deductions are in accordance with aerodynamic-thermochemical reaction under conditions of three types of ablative control mechanisms. The transient equivalent thermocapacity heat-conduction equation for multilayer nozzle construction under ablative moving boundaries is solved with an implicit scheme. R.E.P.

A92-48780*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AN EXPERIMENTAL INVESTIGATION OF HIGH-ASPECT-RATIO COOLING PASSAGES
JULIE A. CARLILE (NASA, Lewis Research Center, Cleveland, OH) and RICHARD J. QUENTMEYER (Sverdrup Technology, Inc., Brook Park; NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 12 p. Previously announced in STAR as N92-25958. refs
(AIAA PAPER 92-3154) Copyright

An experimental investigation was conducted to evaluate the effectiveness of using high-aspect-ratio cooling passages to improve the life and reduce the coolant pressure drop in high-pressure rocket thrust chambers. A plug-nozzle rocket-engine test apparatus was used to test two cylindrical chambers with low-aspect-ratio cooling passages and one with high-aspect-ratio cooling passages. The chambers were cyclically tested and data were taken over a wide range of coolant mass flows. The results showed that for the same coolant pressure drop, the hot-gas-side wall temperature of the high-aspect-ratio chamber was 30 percent lower than the baseline low-aspect-ratio chamber, resulting in no fatigue damage to the wall. The coolant pressure drop for the high-aspect-ratio chamber was reduced in increments to one-half that of the baseline chamber, by reducing the coolant mass flow, and still resulted in a reduction in the hot-gas-side wall temperature when compared to the low-aspect-ratio chambers. Author

A92-48849*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MIXING AND COMBUSTION EFFECTS IN A SLIDING-WEDGE RAM ACCELERATOR WITH HYDROGEN INJECTION
R. RAMAKRISHNAN and D. J. SINGH (Analytical Services and Materials, Inc., Hampton, VA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 18 p. refs
(Contract NAS1-19320)
(AIAA PAPER 92-3251)

The ram accelerator concept has been envisioned as the basis of a ground-based flight-test facility concept in which the test section follows the ram-accelerated projectile, and allows hydrogen mixing/combustion experiments to be conducted when hydrogen carried by the projectile is injected into the freestream. A numerical simulation is presently conducted for such mixing and combustion; the chemical reactions in question are modeled using a seven-step, seven-species model. A grid-adaptation procedure is used to resolve flow features in areas of high fluid and species gradients. O.C.

N92-29104*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PERFORMANCE OF UNCOATED AFRSI BLANKETS DURING MULTIPLE SPACE SHUTTLE FLIGHTS
PAUL M. SAWKO and HOWARD E. GOLDSTEIN Apr. 1992 36 p
(Contract RTOP 506-43-31)
(NASA-TM-103892; A-91237; NAS 1.15:103892) Avail: CASI HC A03/MF A01

Uncoated Advanced Flexible Reusable Surface Insulation (AFRSI) blankets were successfully flown on seven consecutive flights of the Space Shuttle Orbiter OV-099 (Challenger). In six of the eight locations monitored (forward windshield, forward canopy, mid-fuselage, upper wing, rudder/speed brake, and vertical tail) the AFRSI blankets performed well during the ascent and reentry exposure to the thermal and aeroacoustic environments. Several of the uncoated AFRSI blankets that sustained minor damage, such as fraying or broken threads, could be repaired by sewing or by patching with a surface coating called C-9. The chief reasons for replacing or completely coating a blanket were fabric embrittlement and fabric abrasion caused by wind erosion. This occurred in the orbiter maneuvering system (OMS) pod sidewall and the forward mid-fuselage locations. Author

N92-29343*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
APPLIED ANALYTICAL COMBUSTION/EMISSIONS RESEARCH AT THE NASA LEWIS RESEARCH CENTER Progress Report
J. M. DEUR (Sverdrup Technology, Inc., Brook Park, OH.), K. P. KUNDU, and H. L. NGUYEN Jul. 1992 14 p Presented at the 28th Joint Propulsion Conference and Exhibit, Nashville, TN, 6-8 Jul. 1992
(Contract RTOP 537-02-20)
(NASA-TM-105731; E-7135; AIAA PAPER 92-3338; NAS 1.15:105731) Avail: CASI HC A03/MF A01; 3 functional color pages

Emissions of pollutants from future commercial transports are a significant concern. As a result, the Lewis Research Center (LeRC) is investigating various low emission combustor technologies. As part of this effort, a combustor analysis code development program was pursued to guide the combustor design process, to identify concepts having the greatest promise, and to optimize them at the lowest cost in the minimum time. Author

N92-29629# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Hubschrauber und Flugzeuge.
SAENGER: THE REFERENCE CONCEPT AND ITS TECHNOLOGICAL REQUIREMENTS - AEROTHERMODYNAMICS
E. H. HIRSCHEL 26 Aug. 1991 16 p Presented at Review of the German Hypersonic and Technology Programme, Bonn, Fed. Republic of Germany, 16-17 Apr. 1991
(MBB-FE-202-S-PUB-0463-A; ETN-92-91496) Copyright Avail: CASI HC A03/MF A01

The objectives of the technology program 'aerothermodynamics and propulsion integration' are defined. An overview of the special aerothermodynamic phenomena which must be regarded in the design of the Saenger lower stage which presently stands in the center of the technology program is given. The design tools, which must be provided; the components like the inlet, the afterbody, etc., which must be designed and tested; and the special problems like forebody optimization, heat load determination, upper stage integration, etc., which must be treated, are discussed. The general work plan is presented, showing the major activities up to start of the development of the Saenger space transportation system. It includes the development and manufacturing of the experimental vehicle (HYTEXT) as a means for the validation of the design tools and methods which are achieved in the technology program, and for the creation of a freeflight data base. ESA

N92-29680# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Hubschrauber und Flugzeuge.
AERODYNAMIC CHALLENGES OF THE SAENGER SPACE-TRANSPORTATION SYSTEM
E. H. HIRSCHEL 2 Sep. 1991 13 p Presented at 1st European Symposium on Aerothermodynamics for Space Vehicles, Noordwijk, Netherlands, 28-30 May 1991
(MBB-FE-202-S-PUB-0462-A; ETN-92-91495) Copyright Avail: CASI HC A03/MF A01

The two-stage-to-orbit Saenger space transportation system is the reference concept of the German hypersonics technology program. The technology development concentrates first on the needs of the lower stage. Its requirements on aerothermodynamics and propulsion integration are sketched. The aerothermodynamic design challenge is discussed and the design tools and the design methodology are reviewed. The calibration of both the computational and the experimental methods, as well as the test of vehicle components like the inlet, control surfaces etc., make the Hypersonic Technology Experimental vehicle (HYTEX) mandatory. Contents and workplan of the technology program 'aerothermodynamics and propulsion integration' are laid out. Selected results from the current work are presented. ESA

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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.

A92-45234

ELEVATED TEMPERATURE CRACK GROWTH IN AIRCRAFT ENGINE MATERIALS

THEODORE NICHOLAS (USAF, Materials Laboratory, Wright-Patterson AFB, OH) and SHANKAR MALL (USAF, Institute of Technology, Wright-Patterson AFB, OH) IN: Advances in fatigue lifetime predictive techniques; Proceedings of the Symposium, San Francisco, CA, Apr. 24, 1990. Philadelphia, PA, American Society for Testing and Materials, 1992, p. 143-157. Research sponsored by USAF. refs

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Crack growth rate characteristics in Inconel 718 and a Ti3Al titanium aluminide alloy are compared at 650 C under conditions of cyclic loading and superimposed hold times at maximum load. Whereas a decrease in frequency increases the growth rate in both materials, addition of hold times has different effects in the two materials. Hold times increase the growth rate in Inconel 718, but cause anywhere from a slight increase to a very slight decrease in growth rate in Ti3Al, depending on the cyclic frequency. A simple empirical model is proposed which accounts for crack growth retardation due to creep blunting from old time effects and considers the environmental degradation of the material with exposure time. The model is seen to provide reasonable capability to reproduce most of the growth rate characteristics observed experimentally while using the stress intensity factor, K, as the correlating parameter. Author

A92-45236

CONTRIBUTION OF INDIVIDUAL LOAD CYCLES TO CRACK GROWTH UNDER AIRCRAFT SPECTRUM LOADING

R. SUNDER (National Aeronautical Laboratory, Bangalore, India) IN: Advances in fatigue lifetime predictive techniques; Proceedings of the Symposium, San Francisco, CA, Apr. 24, 1990. Philadelphia, PA, American Society for Testing and Materials, 1992, p. 176-190. Research supported by Aeronautical Development Agency. refs

Copyright

A simple crack closure based model is used to analyze fatigue crack growth in airframe materials under a variety of aircraft wing load spectra. The load spectrum and crack growth damage distribution are graphically described by an integrated range/damage-exceedance (RDE) diagram for nondimensionalized representation of load and associated crack growth damage exceedance. The RDA diagram can be used to study the effect of truncation, load omission, and variation in other spectrum variables. O.G.

A92-45451

AEROSPACE PLANE HYDROGEN SCRAMJET BOOSTING

A. S. RUDAKOV, V. V. KRIUCHENKO, and A. I. LANSHIN (Tsentral'nyi NII Aviatsionnogo Motorostroeniia, Moscow, Russia) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 825-833. refs

(SAE PAPER 912071) Copyright

Results are presented of computational investigations carried out to clarify the possibilities of hydrogen scramjet thrust uprating in hypersonic flight (M greater than 8) by adding to the fuel substances with higher density. Thrust, specific impulse, and density impulse are calculated while adding nitrogen, oxygen, water, or inert liquated gases. Fuel is injected tangetially to air flow into combustion chamber with high velocity through gas generator nozzles. For scramjet boosting in hypersonic flight it is suggested to add oxygen to stoichiometric part of hydrogen instead of excessive part of hydrogen. Author

A92-45600

MICROBIOLOGICAL SPOILAGE OF AVIATION TURBINE FUEL. II - EVALUATION OF A SUITABLE BIOCIDE

H. M. DAYAL, K. C. TEWARI, and G. P. TANDON (Defence Materials and Stores Research and Development Establishment, Kanpur, India) Defence Science Journal (ISSN 0011-748X), vol. 42, no. 1, Jan. 1992, p. 47-52. refs

Copyright

Addition of ethylene glycol monoethyl ether, an anti-icing fuel additive, supports microbial growth when added to aviation turbine fuel in low dosages. However, increase in its concentration to certain limits effectively prevents bioactivity in the fuel. The optimum dosage of this biocide for prevention of bioactivity in aviation turbine fuel has been studied by the specific qualitative performance tests after 18 months storage of the inhibited fuel under accelerated conditions of temperature and humidity. Author

A92-45629

THE RELATIONSHIP BETWEEN TENSILE AND FLEXURAL STRENGTH OF UNIDIRECTIONAL COMPOSITES

MICHAEL R. WISNOM (Bristol, University, England) Journal of Composite Materials (ISSN 0021-9983), vol. 26, no. 8, 1992, p. 1173-1180. Research supported by Westland Helicopters, Ltd. and SERC. refs

Copyright

Weibull theory predicts a higher strength in bending than in tension. However, it assumes that failure initiates from a critical defect, whereas many unidirectional composites fail gradually in bending. A model has been developed of the composite as a bundle, each element of which consists of a small bundle of fibers. The resin is assumed to stabilize the bundle against buckling under compression, while allowing the individual elements to split and behave independently in tension. This model also predicts higher strength in bending than in tension, with a ratio of similar order of magnitude to that predicted by Weibull theory. The new model provides an explanation for the different strengths in bending and tension which is consistent with the progressive, noncatastrophic failure process which is often observed in bending tests of unidirectional composites. Author

A92-45630

FABRICATION AND MECHANICAL PROPERTIES OF AN OPTICALLY TRANSPARENT GLASS FIBER/POLYMER MATRIX COMPOSITE

JAMES R. OLSON (Carborumdum Co., Whirlpool Technical Center, Niagara Falls, NY), DELBERT E. DAY, and JAMES O. STOFFER (Missouri-Rolla, University, Rolla) Journal of Composite Materials (ISSN 0021-9983), vol. 26, no. 8, 1992, p. 1181-1192. Research supported by McDonnell Aircraft Co. refs

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An optically transparent composite has been produced by reinforcing PMMA with unidirectional borosilicate glass fibers. Optical transparency is achieved by matching the refractive index of the glass fiber and polymer matrix to within + or - 0.002. The optical transmission of the composite decreases with increasing volume percentage of glass fibers. Composites containing 30 volume percent of unidirectional 12-micron diameter fibers have a 589.3 nm transmission of 20 percent measured through a 10 mm thickness. Composites containing 30 volume percent of 56-micron diameter fibers have an optical transmission of 45 percent. Typewritten text can be clearly read through the composite when the composite is laid directly on the printed page. A flexural strength of 600 MPa is measured for composites with 40 volume percent fiber. The flexural modulus for the same composite is 18 MPa (nine times greater than the 2 MPa measured for pure PMMA). The work of fracture is 110 kJ/m-sq (more than double that of pure PMMA). Suggestions for further improvements in the optical properties are made. S.A.V.

A92-46631

ENHANCING THE PERFORMANCE CHARACTERISTICS OF ENGINE FUELS BY MEANS OF SURFACTANT ADDITIVES [ULUCHSHENIE EKSPLUATATSIONNYKH KHARAKTERISTIK MOTORNYKH TOPLIV S POMOSHCH'IU POVERKHNOSTNO-AKTIVNYKH PRISADOK]

O. P. LYKOV (GANG, Russia) Khimiia i Tekhnologiia Topliv i Masel (ISSN 0023-1169), no. 1, 1992, p. 16-25. In Russian. refs

Copyright

The use of various types of surfactant additives, including detergents, dispersants, antiicing additives, stabilizers, preservatives, and antiwear additives, for enhancing the performance of aviation fuels is discussed. It is shown that small amounts of surfactants (0.003-0.2 percent by mass) are capable of producing a significant improvement in the fuel performance characteristics. By using the concepts of colloid chemistry, it is possible to predict the properties of additives and tailor them to specific applications. V.L.

A92-46838

AXIAL ALIGNMENT OF SHORT-FIBER TITANIUM ALUMINIDE COMPOSITES BY DIRECTIONAL SOLIDIFICATION

S. L. KAMPE, G. H. SWOPE, and L. CHRISTODOULOU (Martin Marietta Laboratories, Baltimore, MD) IN: Intermetallic matrix composites; Proceedings of the MRS Symposium, San Francisco, CA, Apr. 18-20, 1990. Pittsburgh, PA, Materials Research Society, 1990, p. 97-103. Research supported by DARPA. refs

(Contract MDA972-88-C-0047)

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The floating zone directional solidification technique has been applied to an XD short-fiber-reinforced titanium aluminide ingot in an effort to produce in situ alignment of the reinforcement. Microstructural evaluation reveals that a general alignment of the high aspect ratio (greater than 100:1) fibers occurs under specific imposed solidification conditions. These metallographic observations are supported by 800 C mechanical data, which indicate higher axial and reduced transverse strengths relative to the unprocessed base material which contains a dispersion of randomly oriented fibers. The increased strengths are observed to be a consequence of an increase in the matrix hardening due to accommodation of plastic strain around the fiber reinforcement. Author

A92-47338

LOW VOC PRIMER FOR STRUCTURAL BONDING

WILLIAM DUMARS (Boeing Commercial Airplane Group, Seattle, WA) IN: International SAMPE Environmental Conference, 1st, San Diego, CA, May 21-23, 1991, Proceedings. Vol. 1. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 119-124.

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A one-part water-based chromated primer is introduced that can be used for structural bonding on aircraft and that meets pollution-control regulations. The paper emphasizes the results of physical and mechanical testing including: wide-area lap-shear, metal-to-metal peel, honeycomb peel, flatwise tensile, and crack-extension investigations. The corrosion-inhibiting liquid primer is composed of materials similar to those for existing solvent-based primers and has 20 percent nonvolatile compounds, 10.5 percent quantitative inhibitor, and 160 g/l of organic solvent. The low-VOC primer is shown to have good physical and mechanical qualities and to come close to meeting future pollution-control regulations. C.C.S.

A92-47340

ANODIZE AND PRIME YOUR ALUMINUM WITHOUT ENVIRONMENTAL HEADACHES

ROBERT L. FLOYD, JR. and BLAIR C. MADDOCK (Lockheed Aeronautical Systems Co., Marietta, GA) IN: International SAMPE Environmental Conference, 1st, San Diego, CA, May 21-23, 1991, Proceedings. Vol. 1. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 335-346. refs

Copyright

Conventional procedures for surface finishing of aluminum are increasingly at odds with newer, more stringent regulations for VOC and chromate emissions. An alternative finishing method, resin-real anodizing, provides a means of imparting corrosion resistance to the metal while producing no chromate or volatile emissions. The process employs traditional sulfuric acid anodizing, but modifies the final hydration step by using a resin-containing bath instead of the steam, water, or water solutions typically used. The resin particles are sized to fill the pore structure of the anodic film. The resulting resin-sealed surface acts effectively as a primed surface, and can be used unpainted or topcoated. Not only is the process environmentally friendly, it offers both weight and cost savings to the finished product. Resin-seal anodizing has been successfully used on the C-5 cargo aircraft and has recently been approved for use in selected C-130 aircraft applications. Author

A92-47341

NON-CHROMATED ANODIZE PROCESS FOR CORROSION RESISTANCE AND ADHESIVE BONDING

JASON MNICH (Rohr Industries, Inc., Riverside, CA) IN: International SAMPE Environmental Conference, 1st, San Diego, CA, May 21-23, 1991, Proceedings. Vol. 1. Covina, CA, Society for the Advancement of Material and Process Engineering, 1991, p. 371-383.

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A nonchromated anodizing process called sulfuric/boric acid anodizing (SBAA) is presented with descriptions of its use in the production of corrosion resistant adhesively bonded Al skins. The process was developed to replace chromic acid anodizing (CAA) without necessitating emission control equipment and the cost of chromium disposal. Al test panels are treated with either SBAA or CAA and tested according to an FAA certified qualification program with lap shear, flatwise tension, salt-spray, and wet paint-adhesion tests. SBAA is found to be superior to the CAA process in a wet floating roller-peel test, and the treatments perform comparably in the other test categories. The results not only demonstrate the value of SBAA for corrosion resistance, adhesion, and reduced $Cr(6+)$ but also show that compliance with environmental regulations can be accomplished by process and materials substitution. C.C.S.

A92-47835# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

ANALYSIS OF THERMO-CHEMICAL NONEQUILIBRIUM MODELS FOR CARBON DIOXIDE FLOWS

STACEY G. ROCK, GRAHAM V. CANDLER (North Carolina State University, Raleigh), and HANS G. HORNUNG (California Institute of Technology, Pasadena) AIAA, Thermophysics Conference, 27th, Nashville, TN, July 6-8, 1992. 13 p. refs

(Contract NCC1-140; NAGW-1331)

(AIAA PAPER 92-2852) Copyright

The aerothermodynamics of thermochemical nonequilibrium carbon dioxide flows is studied. The chemical kinetics models of McKenzie and Park are implemented in separate three-dimensional computational fluid dynamics codes. The codes incorporate a five-species gas model characterized by a translational-rotational and a vibrational temperature. Solutions are obtained for flow over finite length elliptical and circular cylinders. The computed flowfields are then employed to calculate Mach-Zehnder interferograms for comparison with experimental data. The accuracy of the chemical kinetics models is determined through this comparison. Also, the methodology of the three-dimensional thermochemical nonequilibrium code is verified by the reproduction of the experiments. Author

A92-47958
INVESTIGATION OF THE STRUCTURAL INHOMOGENEITY OF A TITANIUM ALLOY [ISSLEDOVANIE STRUKTURNOI NEODNORODNOSTI TITANOGO SPLAVA]
D. V. IORDANOV, N. D. GIZDOVA, IU. M. SIMEONOVA (Bulgarian Academy of Sciences, Space Research Institute, Stara Zagora, Bulgaria), and A. V. SHOPOV (Institut Mikroelektroniki, Sofia, Bulgaria) B'lgarska Akademiia na Naukite, Dokladi (ISSN 0366-8681), vol. 44, no. 10, 1991, p. 23-25. In Russian. refs
Copyright

Inspection of an aircraft engine indicated small cracks of a peculiar type on the titanium ring of the compressor. These cracks were located in a relatively unloaded region; however, under the effect of vibration they could lead to the formation of a 'closed circuit' and to separation of part of the body with subsequent fracture of the compressor. Auger spectroscopy and secondary ion mass spectroscopy were used to analyze the region of ring fracture due to such small cracks. The crack formation was found to be associated with an unusual increase in carbon content in the depthwise direction in the fracture region. This increase may be due to the processing of the material at the metallurgical stage. L.M.

A92-48269
CALCULATION METHODS ON EQUIVALENCE RATIO OF MULTI-PROPELLANT FOR PROPULSION SYSTEM
SHAOQING WANG (31st Research Institute, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), no. 3, June 1992, p. 41-46, 40. In Chinese.

Two calculation techniques on the equivalence ratio of multipropellant for propulsion systems are presented. There is no limit to the number of oxidant and fuel species utilized simultaneously. A compound engine consisting of rocket-ramjet, turbojet and afterburner is used as an example. R.E.P.

A92-48578
ADVANCED SUPERALLOYS FOR TURBINE BLADE AND VANE APPLICATIONS
T. KHAN and P. CARON (ONERA, Chatillon, France) (Canadian Institute of Mining and Metallurgy, Symposium on Advances in Gas Turbine Engine Materials, Ottawa, Canada, Aug. 19, 20, 1991) ONERA, TP no. 1992-2, 1992, 19 p. refs
(ONERA, TP NO. 1992-2)

Recent developments in single crystal superalloys and their mechanical properties are reviewed. These alloys make it possible to attain turbine inlet temperatures of about 1600 C and a metal temperature in excess of 1100 C. New compositions and improved processing routes are being developed for large directionally solidified and single crystal blades and vanes for applications in industrial gas turbines. The SC 16 superalloy provides a temperature advantage of about 50 C over the IN 738 superalloy along with an excellent corrosion resistance. The MC2 alloy has a very high strength and a temperature capability of greater than 1100 C. AM1 is now being used in the M88 SNECMA engine for the RAFALE fighter plane. Attention is also given to micromechanical models which take into account active slip systems and further progress in NiAl-based intermetallics. O.G.

A92-48610
ALUMINIDES MODIFIED BY PALLADIUM - PROTECTION OF NEW PARTS BY LOCAL FINISHING [ALUMINIURES MODIFIES PAR LE PALLADIUM - DE LA PROTECTION DES PIECES NEUVES A LA RETOUCHE LOCALE]
P. JOSSO, S. ALPERINE (ONERA, Chatillon, France), and P. STEINMETZ (Nancy I, Universite, Vandoeuvre, France) (Surfair IX, Cannes, France, June 3-5, 1992) ONERA, TP no. 1992-49, 1992, 21 p. In French. refs
(ONERA, TP NO. 1992-49)

On hot section parts of aircraft turbines consisting of nickel-base superalloys, aluminides modified by platinum have shown high resistance to heat corrosion and high temperature oxidation. Nevertheless, economic considerations have encouraged research with palladium for a less costly replacement metal modifier. The simplicity of implementing an electrolytic coating of palladium-nickel has allowed the development of a 'buffer' coating technique. R.E.P.

A92-48713#
ABLATION PERFORMANCE CHARACTERIZATION OF THERMAL PROTECTION MATERIALS USING A MACH 4.4 SLED TEST
R. A. REYNOLDS, G. W. RUSSELL, and R. W. NOURSE (U.S. Army, Missile Command, Redstone Arsenal, AL) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 7 p. Research supported by U.S. Army. refs
(AIAA PAPER 92-3055)

Sled Tests are often used to evaluate ablation performance and to provide design parameters for predicting thermal protection requirements for missile structures. This paper presents a discussion of such a test, performed to determine values of heats of ablation versus ablation temperatures for six materials which are candidates for use in external thermal protection schemes. These relations can then be used to predict ablation performance of these materials when being subjected to aero-heating environments having heating regimes which are reasonably similar to those of the test. Author

A92-48714#
AEROTHERMAL ABLATION BEHAVIOR OF SELECTED CANDIDATE EXTERNAL INSULATION MATERIALS
R. A. REYNOLDS, R. W. NOURSE, and G. W. RUSSELL (U.S. Army, Missile Command, Redstone Arsenal, AL) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 9 p. Research supported by U.S. Army. refs
(AIAA PAPER 92-3056)

Effective heat-of-ablation techniques are used to empirically evaluate the relative ablation performance of several composite materials for use as external thermal protection layers for supersonic, low-altitude missile systems. The candidate materials were subjected to various aerodynamic heating environments using the T-Range Facility at the Naval Air Warfare Center, China Lake, CA. Values of effective heat-of-ablation and ablation temperature are determined for each of the materials; these provide a means of predicting ablation rates for the range of aeroheating environments considered. Predictions using these values are compared to supersonic sled track flight data generated at Holloman Air Force Base, NM. The effective heat-of-ablation techniques employed in this effort provide reasonable engineering accuracy when compared to the track flight data. Author

A92-48846#
LASER-INITIATED CONICAL DETONATION WAVE FOR SUPERSONIC COMBUSTION. III
G. F. CARRIER, F. E. FENDELL, and M.-S. CHOU (TRW Space and Technology Group, Redondo Beach, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 11 p. refs
(Contract F49620-90-C-0070)
(AIAA PAPER 92-3247) Copyright

Further theoretical and experimental studies are undertaken of the feasibility of an air-breathing supersonic combustor based on a stabilized, conically configured (oblique) detonation wave. The conical wave is the resultant of the interaction of a train of spherical detonation waves, each directly initiated by a brief, localized deposition of energy from a very-rapidly-repeated pulsed laser. The laser is tightly focused on a fixed site (in the combustor) where there is a steady uniform supersonic stream of combustible gas. Simple analysis and laboratory experiments on the (nonintrusive) direct initiation of an individual spherical detonation wave by a single laser pulse are reported, with emphasis on the pulse-energy and pulse-duration parameters. Then, an estimate is given of the entropy production associated with the interaction of spherical detonations created in a supersonic reactive stream by a train of laser pulses. The entropy production, which arises from reflected shocks in already-detonated mixture, is reduced either by increasing the repetition rate of the laser or by increasing the flow speed of the cold-gas mixture. Author

A92-48848#

NUMERICAL SIMULATIONS OF THE TRANSDETONATIVE RAM ACCELERATOR COMBUSTING FLOW FIELD ON A PARALLEL COMPUTER

MOELJO SOETRISNO, SCOTT T. IMLAY, and DONALD W. ROBERTS (Amtec Engineering, Inc., Bellevue, WA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 20 p. refs

(Contract DAAH01-90-C-0373)

(AIAA PAPER 92-3249) Copyright

The present finite-rate combusting flow results for a 38-mm ram accelerator projectile cover a total of ten cases in the thermally-choked and the transdetonative operation modes and were obtained by means of both sequential and MIMD parallel computation. Attention is given to the modified diagonal implicit algorithm's parallel speed-up, efficiency, convergence, and robustness for several axisymmetric combusting flows. Results from these laminar calculations demonstrate the critical effects of boundary-layer combustion in the transdetonative operation mode. O.C.

A92-48919*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

A SIMPLIFIED REACTION MECHANISM FOR PREDICTION OF NO(X) EMISSIONS IN THE COMBUSTION OF HYDROCARBONS

K. P. KUNDU (NASA, Lewis Research Center, Cleveland, OH) and J. M. DEUR (Sverdrup Technology, Inc., Brookpark, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 10 p. refs

(AIAA PAPER 92-3340) Copyright

A simplified reaction mechanism is developed for the prediction of NO(x) in hydrocarbon combustion. The mechanism uses fewer reacting species and reaction steps than the detailed mechanisms available in the literature and therefore takes less computer time when used in CFD calculations. The mechanism has been used to calculate NO(x) emissions in the combustion of propane. With slight modifications, the same mechanism can be used to calculate NO(x) in the combustion of other hydrocarbons. Results obtained with the simplified reaction are compared with experimental results and results obtained with a detailed kinetic mechanism. V.L.

A92-48927#

MEASUREMENT OF SCALAR FLOWFIELD AT EXIT OF COMBUSTOR SECTOR USING RAMAN DIAGNOSTICS

ANIL GULATI (GE Corporate Research and Development Center, Schenectady, NY) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 11 p. refs

(AIAA PAPER 92-3350) Copyright

The technique of spontaneous Raman diagnostics is applied to the exit plane of an aircraft engine combustor sector to successfully demonstrate extension of the technique to practical hardware fueled with both natural gas and liquid fuel (kerosene). To handle flame-generated incandescene and laser-induced fluorescence expected in such an application, the technique is first applied to a laminar, sooty CH_4/CO flame to generate the calibration coefficients needed to correct for this interference. Raman profiles of temperature and major species are obtained at the sector exit with both natural gas and kerosene as fuel. The mean temperature data is shown to agree fairly well with thermocouple measurements at identical operating conditions. The rms temperature profiles show up to 12 percent and 16 percent rms fluctuations at the centerline of the burner with natural gas and kerosene, respectively. The mean profiles of major species show the expected trens. Up to 6 and 8 percent unburnt O_2 are measured at the centerline for natural gas and kerosene, respectively. Unburnt hydrocarbons, CO and H_2, at the centerline, indicate incomplete burning at that plane. The data are interpreted in terms of implications in evaluating combustor performance. Finally, the Raman system is applied to a room temperature cell at elevated pressures to help extend the system to this regime. Author

A92-48986#

EXPERIMENTAL INVESTIGATION OF LIQUID CARBONHYDROGEN FUEL COMBUSTION IN CHANNEL AT SUPERSONIC VELOCITIES

V. VINOGRADOV, S. KOBYZHSKII, and M. PETROV (Tsentral'nyi NII Aviatsionnogo Motorostroeniia, Moscow, Russia) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 9 p. refs

(AIAA PAPER 92-3429) Copyright

An experimental investigation of liquid hydrocarbon fuel ignition and combustion stabilization at supersonic velocities in the 2D channel was conducted to study the working process in a scramjet. The model was tested in CIAM's facility at freestream Mach number M of 6.0 and 1500 K temperature. Some variants of combustors with different kerosene injectors and flameholders were studied. Hydrogen was used for ignition and stabilization of kerosene burning. The conditions were found under what the kerosene combustion was successful in a combustor with constant area and expanding sections after the hygrogen stopped being injected. Distributions of aerothermodynamic parameters along the duct, data on stabilization, and joint inlet-combustor work are discussed. Author

A92-49105#

COMBUSTION OF SOLID FUELED RAMJET. I

I. NAKAGAWA and T. KUWAHARA (Nissan Motor Co., Ltd., Tokyo, Japan) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 8 p. refs

(AIAA PAPER 92-3727) Copyright

A ducted solid-fueled ramjet is proposed consisting of a primary combustor to produce reactive gases and a secondary combustor to produce final combustion gases. The solid fuels for this ramjet consist of AP as an oxidizer, and carboxyl-terminated polybutadiene mixed with boron particles as a fuel. The combustion characteristics of this fuel were evaluated for various air-flow conditions, using a specially designed direct connect flow facility. I.S.

A92-49106#

COMBUSTION OF SOLID FUELED RAMJET. II

A. IIDA (Asahi Chemical Industry Co., Ltd., Ohita, Japan) and I. KOMAI (Nippon Oil and Fats Co., Ltd., Aichi, Japan) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 7 p. refs

(AIAA PAPER 92-3728) Copyright

In order to improve the combustion performance of solid fueled ramjets, a solid fueled ramjet (DSFR) is introduced in this study. DSFR consists of a primary combustor and a secondary combustor. However, no choked flow exists between both combustors. The gas generator in the primary combustor burns at the stagnation pressure of the secondary combustor which is generated by the induced air from the atmosphere. The results of the flight-performance analysis conducted in this study indicate that the flight distance extends drastically with increasing the flight altitude even though the net impulse is independent of the altitude. In order to operate DSFR effectively, the pressure exponent of burning rate of the fuel-rich propellants is required to be 1. Author

A92-49134*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

IGNITION DELAYS, HEATS OF COMBUSTION, AND REACTION RATES OF ALUMINUM ALKYL DERIVATIVES USED AS IGNITION AND COMBUSTION ENHANCERS FOR SUPERSONIC COMBUSTORS

T. W. RYAN, III, W. W. HARLOWE, and S. SCHWAB (Southwest Research Institute, San Antonio, TX) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville,

TN, July 6-8, 1992. 12 p. Research supported by NASA. refs
(AIAA PAPER 92-3841) Copyright

The work was based on adapting an apparatus and procedure developed at Southwest Research Institute for rating the ignition quality of fuels for diesel engines. Aluminum alkyls and various Lewis-base adducts of these materials, both neat and mixed 50/50 with pure JP-10 hydrocarbon, were injected into the combustion bomb using a high-pressure injection system. The bomb was pre-charged with air that was set at various initial temperatures and pressures for constant oxygen density. The ignition delay times were determined for the test materials at these different initial conditions. The data are presented in absolute terms as well as comparisons with the parent alkyls. The relative heats of reaction of the various test materials were estimated based on a computation of the heat release, using the pressure data recorded during combustion in the bomb. In addition, the global reaction rates for each material were compared at a selected tmperature and pressure. Author

A92-49136#
A STUDY OF THE FLAMMABILITY LIMIT OF THE BACKWARD FACING STEP FLOW COMBUSTION
TAE-HO LEE (Agency for Defense Development, Propulsion Dept., Taejon, Republic of Korea) and DAVID W. NETZER (U.S. Naval Postgraduate School, Monterey, CA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 8 p. refs
(AIAA PAPER 92-3846) Copyright

An experimental investigation was conducted in order to determine the flammability limit of the solid-fuel ramjet using the backward-facing step-flow combustion of the plexiglass grain. In order to get the different step-height ratio, the grain was drilled straightforward or stepwise. The PHOENICS computer code was adopted in order to compare the flow patterns of some sample tests using a nonreacting cold turbulent flow model. The stepwise grain give some loading advantage, specially thin and long shape grain design. Author

N92-28374*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AN ANALYSIS OF COMBUSTION STUDIES IN SHOCK EXPANSION TUNNELS AND REFLECTED SHOCK TUNNELS
CASIMIR J. JACHIMOWSKI Jul. 1992 12 p
(Contract RTOP 505-62-40-04)
(NASA-TP-3224; L-17025; NAS 1.60:3224) Avail: CASI HC A03/MF A01

The effect of initial nonequilibrium dissociated air constituents on the combustion of hydrogen in high-speed flows for a simulated Mach 17 flight condition was investigated by analyzing the results of comparative combustion experiments performed in a reflected shock tunnel test gas and in a shock expansion tunnel test gas. The results were analyzed and interpreted with a one-dimensional quasi-three-stream combustor code that includes finite rate combustion chemistry. The results of this study indicate that the combustion process is kinetically controlled in the experiments in both tunnels and the presence of the nonequilibrium partially dissociated oxygen in the reflected shock tunnel enhances the combustion. Methods of compensating for the effect of dissociated oxygen are discussed. Author

N92-28398# Dayton Univ., OH.
LUBRICANT EVALUATION AND PERFORMANCE 2 Interim Report, Jul. 1988 - Dec. 1990
COSTANDY S. SABA, M. A. KELLER, H. A. SMITH, R. E. KAUFFMAN, and D. K. TOTH Jan. 1992 576 p
(Contract F33615-88-C-2817)
(AD-A247464; UDR-TR-91-53; WL-TR-91-2111) Avail: CASI HC A25/MF A04

The development of improved methods is described for defining, measuring, and assessing high temperature (500-750 F) lubricants for use in advanced aircraft turbine engines and the development of improved techniques for lubricant monitoring and lubricant condition monitoring for advanced lubricating fluids. Arrhenius plots were developed for describing the effective life of candidate 4 cSt lubricants, polyphenyl ethers, and other experimental fluids as a function of time and temperature for selected limiting values of changes in physical and chemical properties. Significant improvement in AE spectrometer sensitivity for analyzing wear metal was made. An in-line magnetic wear monitor was evaluated for possible application as a condition monitoring device for oil systems. Fluorescence, UV, dielectric constant, voltammetric, and thermal analysis techniques were developed and evaluated as high temperature lubricant monitoring devices. The tribological behavior of high temperature candidate fluids were evaluated and compared in the boundary lubrication regime using sliding four-ball test and various steel and ceramic specimens. GRA

N92-28426# Reinhart and Associates, Inc., Austin, TX.
SURFACE RESIDUAL STRESS ANALYSIS OF METALS AND ALLOYS Final Report, 4 Apr. 1991 - 4 Feb. 1992
TEODORO LEON-SALAMANCA and EUGENE R. REINHART 4 Feb. 1992 31 p
(Contract N00019-91-C-0062)
(AD-A248372) Avail: CASI HC A03/MF A01

The critically refracted longitudinal wave (CRLW) technique was used to establish how feasible it is to measure stress changes at the surface and interior of a material, in particular naval airframe metals such as Ti-6Al-4V, 6061-T651 aluminum, and 4340 steel. The CRLW propagation characteristics were found to be potentially practical if use of the 2P wave is implementable to have it as a reference wave. The CRLW technique was effective in detecting stress gradients in bent plates by measuring the acoustoelastic effect on the longitudinal wave velocity. The CRLW technique was applied in the range of 1.0 to 10 MHz and the expected longitudinal wave velocity changes followed the expected trends in the Al6061-T651 and 4340 steel plates (0.50 inch thick). The longitudinal wave velocity changes measured in the Ti-6Al-4V plate did not follow the expected trends probably due to its thickness (0.25 inch). GRA

N92-28912# Naval Civil Engineering Lab., Port Hueneme, CA.
PAINT REMOVAL USING CRYOGENIC PROCESSES Final Report, Oct. 1989 - Jun. 1991
RICHARD E. KIRTS and PHILIP L. STONE Jan. 1992 44 p
(AD-A247668; NCEL-TN-1839) Avail: CASI HC A03/MF A01

The use of a high-pressure jet of cryogenic fluid (e.g., liquid nitrogen at -320 F) to remove paint and other protective coatings from Navy aircraft and ships was studied. The objective of the work was to explore the feasibility of developing a paint removal method that is less harmful to the environment than the chemical paint stripping methods presently in use. It was learned that only thick (t greater than 0.020 inch) films of paint can be effectively removed by the mechanism of thermal shock. Aircraft paint is too thin and flexible to be removed by cryogenic methods. Cryogenic methods are not recommended for use on ships because of the danger of steel embrittlement by low temperatures. It was demonstrated that a jet of liquid nitrogen can effectively remove certain paints (regardless of thickness) by the mechanism of differential thermal contraction. The process may have application where control of paint waste is essential, for example, removal of thick films of lead base paint. GRA

N92-28921# Naval Air Development Center, Warminster, PA. Air Vehicle and Crew Systems Technology Dept.
TENSILE AND INTERLAMINAR PROPERTIES OF GLARE (TRADE NAME) LAMINATES Final Report, 1 Oct. 1990 - 1 Jul. 1991
JEFFREY COOK and MARY E. DONNELLAN 1 Sep. 1991 24 p
(AD-A250188; NADC-91087-60) Avail: CASI HC A03/MF A01

The mechanical properties of several GLARE laminates were investigated as part of an AKZO-coordinated round robin evaluation program. Tensile, floating roller peel, and three-point bend tests were performed on GLARE to determine its tensile properties, peel strength, and interlaminar shear strength, respectively.

Strength, elongation to failure, and elastic modulus of the GLARE configurations tested in tension compared favorably to ARALL-4 and monolithic 2024-T3. Peel strength of ARALL-4 was found to be very low in the longitudinal fiber direction due to uninhibited crack front propagation along the fiber/adhesive layer interface. The peel strength of GLARE was found to be ten times higher than for ARALL in the longitudinal direction. Three point bend tests revealed an interlaminar shear strength of over 70 MPa.
GRA

N92-29408# Pratt and Whitney Aircraft, West Palm Beach, FL. Government Engines and Space Propulsion.
FATIGUE IN SINGLE CRYSTAL NICKEL SUPERALLOYS Technical Progress Report, 16 Feb. - 15 Mar. 1992
DANIEL P. DELUCA and CHARLES ANNIS 15 Mar. 1992 10 p
(Contract N00014-91-C-0124)
(AD-A248190; PW/GESP-FR2198-05) 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

N92-29580# California Inst. of Tech., Pasadena.
SHOCK ENHANCEMENT AND CONTROL OF HYPERSONIC COMBUSTION Annual Technical Report, 1 Apr. 1990 - 30 Mar. 1991
FRANK E. MARBLE 26 Nov. 1991 17 p
(Contract AF-AFOSR-0188-90; AF PROJ. 2308)
(AD-A248558; AFOSR-92-0238TR) Avail: CASI HC A03/MF A01

Shock tube studies of shock enhanced mixing of helium into air were reported utilizing the Rayleigh scattering technique. Because of their greater sensitivity in the low concentration range, these measurements were believed to be more accurate than those obtained with laser induced fluorescence. The result indicated that mixing was more rapid and more complete than reported previously. Preliminary work on the consequence of multiple shocks has been promising. Work began on the interaction of shock induced mixing with shear layers in the GALCIT $M = 2.5$ supersonic wind tunnel. Experiments concerning the details of combustion in large vortices in the Caltech Unsteady Combustion Facility progressed very well using simultaneous measurements of pressure, shadowgraphy, and chemiluminescence. These results reveal a very different ignition mechanism and combustion pattern than had been anticipated.
GRA

12

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.

A92-44967
PERSPECTIVE VERSUS PLAN VIEW AIR TRAFFIC CONTROL (ATC) DISPLAYS - SURVEY AND EMPIRICAL RESULTS
MERIDYTH S. BURNETT and WOODROW BARFIELD (Washington, University, Seattle) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 1. Columbus, OH, Ohio State University, 1991, p. 448-453. refs

Results are presented of two preliminary display designs (plan view and perspective) employed for the purpose of extracting and analyzing specific user requirements from which specifications could be applied to design a 3D, color-coded, dynamic, perspective ATC display. These results provide evidence that critical trade-offs exist in the design of ATC systems in terms of human interface design, 3d symbology, information presentation and form, color-coded design, human-machine design, and user performance. Examining the performance benefits of utilizing 3D computer graphics, modeling and simulation tools, and color-coded symbology for designing radar displays is necessary to providing complete ATC systems that enable controllers to accomplish ATC tasks efficiently, expeditiously and safely.
R.E.P.

A92-45130
SIMULTANEOUS IMAGING AND INTERFEROMETRIC TURBULE VISUALIZATION IN A HIGH-VELOCITY MIXING/SHEAR LAYER
D. A. KALIN, D. A. SAYLOR (Teledyne Brown Engineering, Huntsville, AL), and T. STREET (U.S. Army, Strategic Defense Command, Huntsville, AL) IN: International Congress on High-Speed Photography and Photonics, 19th, Cambridge, England, Sept. 16-21, 1990, Proceedings. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1991, p. 780-787. refs
(Contract DASG60-87-C-0042)
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A single-jet supersonic mixing/shear layer simulator in which two high speed video data acquisition systems simultaneously sample the flow region has been used to characterize the structure of turbulence in a high-speed mixing/shear layer and its degradation effect on an optical test beam. The experiment imaged a point source through the flow field. Correlations are shown to exist between the turbulent structure of the flow field and specific aerooptic distortions, offering the foundations for real time error correction of optical degradations associated with hypersonic flight.
O.C.

A92-45202
SWIRL NUMBER EFFECTS ON CONFINED FLOWS IN A MODEL OF A DUMP COMBUSTOR
A. S. NEJAD, S. A. AHMED, and R. S. BORAY (USAF, Aero Propulsion and Power Laboratory, Wright-Patterson AFB, OH) IN: ICALEO '89 - Optical methods in flow and particle diagnostics; Proceedings of the Meeting, Orlando, FL, Oct. 15-20, 1989. Orlando, FL/Bellingham, WA, Laser Institute of America/Society of Photo-Optical Instrumentation Engineers, 1989, p. 1-17. Research supported by USAF. refs
Copyright

The results of an experimental investigation of isothermal swirling flows in a model of a coaxial dump combustor are presented. A set of three constant angle swirlers were designed and fabricated for this aspect of the study. A two component LDV system was used to obtain the velocity measurements of the flowfield. The detailed data base is provided for the development of turbulent closure models and the CFD code validation for the ramjet or turbojet applications. The results show the effects of the swirl strength on the flow characteristics, enhanced turbulent mixing and the resulting shortened corner recirculation zone.
Author

A92-45226
ADVANCES IN FATIGUE LIFETIME PREDICTIVE TECHNIQUES; PROCEEDINGS OF THE SYMPOSIUM, SAN FRANCISCO, CA, APR. 24, 1990
M. R. MITCHELL, ED. (Rockwell International Corp., Thousand Oaks, CA) and R. W. LANDGRAF, ED. (Virginia Polytechnic Institute and State University, Blacksburg) Research sponsored by ASTM. Philadelphia, PA, American Society for Testing and Materials, 1992, 494 p. For individual items see A92-45227 to A92-45244.
(ASTM STP-1122; ISBN 0-8031-1423-0) Copyright

Recent progress in the development of methods to predict fatigue performance of materials and structures is reviewed. Attention is given to general approaches to fatigue mechanics, elevated temperature phenomena, spectrum loading, the multiaxial behavior, and applications. Particular attention is given to a fracture-mechanics-based model for cumulative damage assessment, thermo-mechanical fatigue life prediction methods, a probabilistic fracture mechanics approach for structural reliability assessment of space flight systems, a multiaxial fatigue life estimation technique, plasticity and fatigue damage modeling of severely loaded tubing, damage evaluation in composite materials using thermographic stress analysis, and fatigue lifetime monitoring in power plants. O.G.

A92-45242
RELIABILITY CENTERED MAINTENANCE FOR METALLIC AIRFRAMES BASED ON A STOCHASTIC CRACK GROWTH APPROACH
S. D. MANNING (General Dynamics Corp., Fort Worth Div., TX), J. N. YANG (California, University, Irvine), F. L. PRETZER, and J. E. MARLER (General Dynamics Corp., Fort Worth Div., TX) IN: Advances in fatigue lifetime predictive techniques; Proceedings of the Symposium, San Francisco, CA, Apr. 24, 1990. Philadelphia, PA, American Society for Testing and Materials, 1992, p. 422-434. refs
Copyright
A reliability centered maintenance analysis (RCMA) method is proposed for metallic airframes. The method is aimed at evaluating preventive maintenance inspection requirements, options, and tradeoffs, in terms of risk, for protecting metallic aircraft structure against the consequences of fatigue cracking. The RCMA method takes into account crack growth life dispersion, statistical crack growth in multiple structural details, the conditional probability of a Class A mishap, allowable risk rates, and crack size detection limits. O.G.

A92-45260
STUDY OF GRINDING PROCESS AND STRENGTH FOR CERAMIC HEAT INSULATED ENGINE
HIDEO KAWAMURA (Isuzu Ceramics Research Institute Co., Ltd., Fujisawa, Japan) Society of Manufacturing Engineers, Superabrasives'91 Conference, Chicago, IL, June 11-13, 1991. 19 p. refs
(SME PAPER MR91-177) Copyright
Steps are described for the successful development of a ceramic thermally insulated turbine engine. The strength of the ceramic engine parts can be effectively increased depending on the grinding methods used. Because many microcracks have been observed after the grinding of engine parts with low strength, grinding processes are, therefore, studied. Since wear resistance, abrasion resistance, and low friction are the principal factors required of reciprocating engines, machining precision of these engines' sliding parts largely affects their abrasion and friction properties. Structural analysis means are discussed to estimate the mechanical and thermal stresses acting on all the ceramic components. Experimental results are discussed with regard to the workability of two types of Si3N4. It is shown that as machining efficiency improves, the affected layer increases for baking both at atmospheric pressure and at high pressure. Comparisons of strength properties are made for the Si3N4 materials under both baking conditions. S.A.V.

A92-45261
HIGH REYNOLDS NUMBER FLOWS USING LIQUID AND GASEOUS HELIUM
RUSSELL J. DONNELLY, ED. (Oregon, University, Eugene) Research supported by U.S. Navy. New York, Springer-Verlag, 1991, 280 p. For individual items see A92-45262 to A92-45275.
(ISBN 0-387-97475-X) Copyright
Consideration is given to liquid and gaseous helium as test fluids, high Reynolds number test requirements in low speed aerodynamics, the measurement of subsonic flow around an appended body of revolution at cryogenic conditions in the NTF, water tunnels, flow visualization, the six component magnetic suspension system for wind tunnel testing, and recent aerodynamic measurements with magnetic suspension systems. Attention is also given to application of a flow visualization technique to a superflow experiment, experimental investigations of He II flows at high Reynolds numbers, a study of homogeneous turbulence in superfluid helium, and thermal convection in liquid helium. O.G.

A92-45403
PRELIMINARY STUDY OF ALGORITHM FOR REAL-TIME FLUTTER MONITORING
KATSUHIKO SHIBATA and KATSUYA MATSUZAKI (Mitsubishi Heavy Industries, Ltd., Nagoya Aerospace Systems Works, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 325-330. refs
(SAE PAPER 912001) Copyright
This paper describes an algorithm for real-time flutter monitoring. An autoregressive (AR) model with time-varying coefficients is used for continuous monitoring of the nonstationary flutter parameters. AR coefficient change rates as well as AR coefficients can be obtained recursively by Kalman filter implementation. Using these AR coefficients and change rates, the natural frequencies and damping values of vibration modes can be estimated and predicted a few seconds ahead. This algorithm was tested on simulated data and wind tunnel test data and showed a good estimation performance. Author

A92-45416
DEMONSTRATION OF GAS LIQUID SEPARATION UNDER THE MICROGRAVITY BY AIRCRAFT KC-135
OSAMU MURAGISHI and SEIJI NISHIO (Kawasaki Heavy Industries, Ltd., Gifu Technical Institute, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 461-470.
(SAE PAPER 912024) Copyright
Verification of liquid-gas separation function of the functional tank under high-gravity by pull-up and under microgravity by parabolic flight was conducted aboard a KC-135. Video recording of liquid behavior under microgravity in the tanks that have partial structures of surface tension tank inside was performed. Experimental results with photo data, acceleration data, etc. are presented. R.E.P.

A92-45440
INTEGRATED WIRING SYSTEM
V. E. SAUCEDO (Lockheed Advanced Development Co., Burbank, CA) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 709-715.
(SAE PAPER 912058) Copyright
The Lockheed Integrated Wiring System (IWS) is presented. This computer-based system features a single-source data base that is used for all design, documentation, fabrication, and testing of aircraft wiring. This single-source data base ensures that items are manufactured to match all engineering specifications. This application of concurrent engineering minimizes the transmittal or errors, reduces the time required for design, planning and mockup, ensures a coordinated effort among the affected divisions, and provides high-quality documentation. C.A.B.

A92-45606
EFFECT OF FLOW RATE ON LOSS MECHANISMS IN A BACKSWEPT CENTRIFUGAL IMPELLER
TALIB Z. FARGE and MARK W. JOHNSON (Liverpool, University, England) International Journal of Heat and Fluid Flow (ISSN 0142-727X), vol. 13, no. 2, June 1992, p. 189-196. refs
Copyright
Detailed measurements of the three velocity components, total, and static pressures on five measurement planes without a low speed shrouded backswept centrifugal impeller are presented. A comparison is made between the design flowfield and the flowfields for both below and above design flow rates. The flow is dominated

by a passage vortex that rotates in the opposite direction to the impeller. This vortex develops in the inducer, is strongest in the axial to radial bend, and then decays toward the outlet. The vortex is also most prominent at the lowest flow rate and is responsible for stabilizing the shroud boundary layer and hence reducing the large losses associated with the separation of this boundary layer in radial impellers. At the outlet, the wake is located on the shroud at all flow rates, but tends to be spread more evenly across the shroud than is the case in a radial machine. The impeller efficiency is also generally found to be spread more evenly across the shroud than is the case in a radial machine. The impeller efficiency is also generally found to be higher at lower flow rates in contrast to observations for radial impellers. Author

A92-45774
ISODOPPLER AND MOCOMP CORRECTIONS IMPROVE MTI RADAR
ALLAN NIRENBERG (Horizons Technology Corp., Melbourne, FL) and JOSEPH EDIE (Grumman Corp., Melbourne, FL) Microwaves & RF (ISSN 0745-2993), vol. 31, no. 6, June 1992, p. 117, 118, 120. Research supported by USAF.
Copyright

A moving-target-indicating (MTI) radar which uses Doppler signal to distinguish moving targets from stationary background clutter is described. In airborne MTI radar where the radar platform is also moving, both motion-compensation (mocomp) and isoDoppler corrections must be made on returned radar signals using phased-array antennas to ensure that only the true target Doppler information is extracted by the signal processing functions. O.G.

A92-45826
EIGENFUNCTION ANALYSIS OF TURBULENT MIXING PHENOMENA
M. WINTER, T. J. BARBER (United Technologies Research Center, East Hartford, CT), R. M. EVERSON, and L. SIROVICH (Brown University, Providence, RI) AIAA Journal (ISSN 0001-1452), vol. 30, no. 7, July 1992, p. 1681-1688. Research supported by DARPA. Previously cited in issue 07, p. 1038, Accession no. A91-21519. refs
(Contract N00014-86-K-0754)
Copyright

A92-45833
EFFECT OF A BULGE ON THE SUBHARMONIC INSTABILITY OF SUBSONIC BOUNDARY LAYERS
J. A. MASAD and A. H. NAYFEH (Virginia Polytechnic Institute and State University, Blacksburg) AIAA Journal (ISSN 0001-1452), vol. 30, no. 7, July 1992, p. 1731-1737. refs
(Contract N00014-85-K-0011)
Copyright

The effect of a two-dimensional hump on the three-dimensional subharmonic instability of subsonic flow over a flat plate was investigated. The mean flow was calculated by using interacting boundary layers, thereby accounting for viscid/inviscid interactions and capturing separation bubbles. The results show that increasing the hump height produces an increase in the amplification factors of both the primary and subharmonic waves. When the hump causes separation, the growth rates of both the primary and subharmonic waves are considerably larger than those in the case of no separation. The effect of compressibility on reducing the amplification factors of the primary and subharmonic waves decreases as the hump height increases. Author

A92-45883* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THE EFFECT OF MOLECULAR RELAXATION PROCESSES IN AIR ON THE RISE TIME OF SONIC BOOMS
JONGMIN KANG and ALLAN D. PIERCE (Pennsylvania State University, University Park) IN: International Congress on Recent Developments in Air- and Structure-Borne Sound and Vibration, Auburn, AL, Mar. 6-8, 1990, Proceedings. Vol. 1. Auburn, AL, Auburn University, 1990, p. 97-104. Research supported by NASA. refs
Copyright

A theory is developed to explain the effect of molecular relaxation processes on the rise time of sonic booms. To determine the rise time of sonic booms, both O2 and N2 relaxation processes must be included. The N2 relaxation process delays the shock pressure reaching the maximum pressure, and the O2 relaxation process causes a shock profile to have a gentle slope. The N2 relaxation controls the lower part of overpressure; the O2 relaxation controls the higher part. The constant rise time curves show that the rise times increase as the overpressures and humidity decrease. The present approach gives longer rise times than those acquired by Bass et al. for given shock overpressures. Author

A92-45885
RITZ VECTORS SYNTHESIS VERSUS MODAL SYNTHESIS FOR FLUID-STRUCTURE INTERACTION MODELING
J. P. COYETTE (Dynamic Engineering, Saint Louis, MO) IN: International Congress on Recent Developments in Air- and Structure-Borne Sound and Vibration, Auburn, AL, Mar. 6-8, 1990, Proceedings. Vol. 1. Auburn, AL, Auburn University, 1990, p. 115-126. refs
Copyright

The problem of forced response in the frequency domain of fluid-structure interaction is addressed. It is shown that the conventional two-field formulation and a special Ritz vectors procedure can be used to solve the interaction problem efficiently and accurately. Symmetry is preserved using accelerations instead of displacements to describe the structural behavior. C.D.

A92-46252
THREE-DIMENSIONAL-MODE RESONANCE IN FAR WAKES
T. C. CORKE, J. D. KRULL, and M. GHASSEMI (Illinois Institute of Technology, Chicago) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 239, June 1992, p. 99-132. refs
(Contract N00014-90-J-1420)
Copyright

This work is aimed at understanding mechanisms which govern the growth of secondary 3D modes of a particular type which feed from a resonant energy exchange with the primary Karman instability in 2D wakes. The approach was to introduce controlled time-periodic 3D (oblique) wave pairs of equal but opposite sign, simultaneously with a 2D wave. The waves were introduced by an array of v-component-producing elements on the top and the bottom surfaces of the body. These were formed by metallized electrodes which were vapor deposited onto a piezoelectrically active polymer wrapped around the surface. The amplitudes, streamwise and spanwise wavenumbers, and initial phase difference are all individually controllable. The initial work focused on a fundamental/subharmonic interaction, and the dependence on spanwise wavenumber. The results include mode eigenfunction modulus and phase distributions in space, and stream functions for the phase-reconstructed flowfield. Analysis of these shows that such a resonance mechanism exists and its features can account for characteristic changes associated with the growth of 3D structures in the wake of 2D bodies. Author

A92-46498
MAGNETIC PARTICLE TESTING OF TURBINE BLADES MOUNTED ON THE TURBINE ROTOR SHAFT
CLEMENT IMBERT (University of West Indies, St. Augustine, Trinidad and Tobago) and KRISHNA RAMPERSAD (Trinidad and Tobago Electricity Commission, Port-of-Spain) Journal of Testing and Evaluation (ISSN 0090-3973), vol. 20, no. 4, July 1992, p. 296-300. refs
Copyright

An outline is presented of the general technique of magnetic particle inspection (MPI) of turbine blades mounted on the turbine rotor shaft with specific reference to the placement of the magnetizing coils. In particular, this study reports on the use of MPI in the examination of martensitic stainless steel turbine blades in power plants in Trinidad and Tobago in order to establish procedures for the detection of discontinuities. The techniques described are applicable to ferromagnetic turbine blades in general. The two practical techniques mentioned are the method of placing a preformed coil over a number of blades in one row and the method of wrapping the coil around the rotor shaft across an entire row of blades. Of the two methods, the former is preferred to the latter one, because there is greater uniformity of magnetic flux induced and lower current required to induce adequate flux density with the preformed coil. However, both methods provide satisfactory magnetic flux, and either can be used. S.A.V.

A92-46801

APPROACH FOR ANALYSIS AND DESIGN OF COMPOSITE ROTOR BLADES

GERALDO A. MACEDO MAURA (Centro Tecnico Aerospacial, Sao Jose dos Campos, Brazil) and RAMESH KOLAR (U.S. Naval Postgraduate School, Monterey, CA) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 693-697. Previously cited in issue 11, p. 1694, Accession no. A90-29276. refs

A92-46825

THE APPLICATION OF PARTICLE IMAGE VELOCIMETRY (PIV) IN A SHORT-DURATION TRANSONIC ANNULAR TURBINE CASCADE

P. J. BRYANSTON-CROSS, C. E. TOWERS, T. R. JUDGE, D. P. TOWERS (Warwick, University, Coventry, England), S. P. HARASGAMA, and S. T. HOPWOOD (Royal Aerospace Establishment, Propulsion Dept., Farnborough, England) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 114, no. 3, July 1992, p. 504-509. Previously announced in STAR as N91-28504. refs

(ASME PAPER 91-GT-221) Copyright

A series of experiments was performed to demonstrate the application of Particle Image Velocimetry to turbomachinery flows. The tests were performed at transonic speeds on a fully annular engine size turbine nozzle guide vane. The vane cascade was installed in a short duration Isentropic Light Piston Cascade (ILPC) test facility operating with high inlet turbulence levels. The technique was shown to map the whole flow field with a resolution of 0.5 mm. The quality of the results obtained are not greatly affected by local turbulence rates. The accuracy of the measurements is put at around 4 pct. of absolute velocity and is limited by the quality of the image on the film plane. The velocities derived from the PIV images were compared with predictions from a 3-D viscous numerical calculation. It is shown that the experimental and predicted results are in good agreement. It is considered that this technique has considerable potential in application to turbomachinery flow field diagnostics. Author

A92-46916

TAYLOR SERIES APPROXIMATION OF GEOMETRIC SHAPE VARIATION FOR THE EULER EQUATIONS

ARTHUR C. TAYLOR, III, VAMSHI M. KORIVI, and GENE W. HOU (Old Dominion University, Norfolk, VA) AIAA Journal (ISSN 0001-1452), vol. 30, no. 8, Aug. 1992, p. 2163-2165. refs

(Contract NSF DMC-86-57917)

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A linear approximate analysis scheme for the Euler equations which focuses on the treatment of geometric-shape variations is presently implemented and tested, with a view to CFD applications in design software. The effectiveness of the use of slopes to accurately predict changes occurring in the field variables of a flow problem in response to small changes in geometric shape is confirmed. A brief comparative study of CPU times indicates the potential for substantial computational reductions in design-oriented CFD. O.C.

A92-46936

LINEAR ANALYSIS OF NATURALLY CURVED AND TWISTED ANISOTROPIC BEAM

MARCO BORRI, GIAN L. GHIRINGHELLI, and TEODORO MERLINI (Milano, Politecnico, Milan, Italy) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 42-1 to 42-15. Research supported by U.S. Army. refs

The determination of the governing equations of a naturally curved and twisted anisotropic beam is presently addressed by a model which takes into account all elastic couplings due to the material and the curved geometry, under the assumption of uniformity in cross-section, curvature and twist. While requiring only a 2D approximation, a degree of detail is achieved which would be unrealistic in a 3D approach. The FEM of the beam cross section furnishes a useful mathematical tool for the tailoring of practical helicopter rotor blade designs. O.C.

A92-46940

BUCKLING, POSTBUCKLING AND CRIPPLING OF THIN WALLED COMPOSITE AIRFRAME STRUCTURES UNDER COMPRESSION

LEVEND PARNAS, ERIAN A. ARMANIOS, and P. SRIRAM (Georgia Institute of Technology, Atlanta) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 46-1 to 46-8. refs

This paper presents an analytical and experimental study conducted for thin-walled stiffeners. The stiffener configuration is an I-beam section composed of plate element subjected to remote compression. A quantitative model is developed to determine the postbuckling and crippling strength. The method leads to a criterion for a mode of failrue in thin-walled composite stiffeners. This mode is local material failure which initiates in corners or junctures between contiguous elements and extends across webs. The criterion yields a linear relationship between buckling and crippling loads. Experimental crippling results show good agreement with predictions based upon the new criterion. Author

A92-46946

DYNAMIC ANALYSIS OF ROTOR FLEX-STRUCTURE BASED ON NONLINEAR ANISOTROPIC SHELL MODELS

OLIVIER A. BAUCHAU and WUYING CHIANG (Rensselaer Polytechnic Institute, Troy, NY) IN: AHS International Specialists' Meeting on Rotorcraft Basic Research, Atlanta, GA, Mar. 25-27, 1991, Proceedings. Alexandria, VA, American Helicopter Society, 1991, p. 21-1 to 21-11. Research supported by Chung Shan Institute of Science and Technology. refs

In this paper an anisotropic shallow shell model is developed that accommodates transverse shearing deformations and arbitrarily large displacements and rotations, but strains are assumed to remain small. Two kinematic models are developed, the first using two DOF to locate the direction of the normal to the shell's midplane, the second using three. The latter model allows for an automatic compatibility of the shell model with beam models. The shell model is validated by comparing its predictions with several benchmark problems. In actual helicopter rotor blade problems, the shell model of the flex structure is shown to give very different results shown compared to beam models. The lead-lag and torsion modes in particular are strongly affected, whereas flapping modes seem to be less affected. Author

A92-46996#

LASER VELOCIMETRY MEASUREMENTS IN AN MHD AERODYNAMIC DUCT

A. GEORGE, W. W. WILSON, and ROBERT L. COOK (Mississippi State University, Mississippi State) AIAA, Plasmadynamics and Lasers Conference, 23rd, Nashville, TN, July 6-8, 1992. 7 p. refs

(AIAA PAPER 92-2986) Copyright

Fluid flow profile measurements made by a laser Doppler velocimeter just downsteam of the combustor nozzle at the DOE Coal-Fired Flow Facility at the University of Tennessee Space Institute are described. Attention is given to a proof-of-concept test program consisting of long-duration coal-fired tests of equipment that is envisioned for use in an MHD power system. A combination of high velocities, intense background radiation, small particle sizes, and a small-diameter collection aperture resulted in low amplitude signal bursts. A forward scatter detection configuration would significantly improve signal quality for these measurement conditions. C.A.B.

A92-47071

EFFECT OF THE GRID SYSTEM ON HEAT TRANSFER COMPUTATIONS FOR HIGH SPEED FLOWS

KLAUS A. HOFFMANN (Wichita State University, KS), M. S. SIDDIQUI (Texas, University, Austin), and WALTER H. RUTLEDGE (Sandia National Laboratories, Albuquerque, NM) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 569-578. Previously announced in STAR as N91-25375. refs

(Contract DE-AC04-76DP-00789)

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Difficulties in the accurate heat transfer computation of high speed, blunt body flows have been encountered by numerous researchers. The primary reason for these difficulties has been shown to be the grid dependency of the wall flux quantities. Obviously, the accuracy of the computed heat fluxes will, to a certain extent, depend on the particular numerical scheme employed. The flux vector splitting technique is studied. An attempt was made to develop procedures which will provide guidelines for selecting appropriate grid systems and, in particular, the grid line distribution near the surface for accurate heat transfer computations. The results have clearly shown the dependency of the heat flux quantities on the grid system. In addition, it is shown that changes in flow Mach number and/or Reynolds number may require further refinement of the grid system. Author

A92-47128* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

SENSITIVITY OF TIRE RESPONSE TO VARIATIONS IN MATERIAL AND GEOMETRIC PARAMETERS

AHMED K. NOOR, JOHN A. TANNER, and JEANNE M. PETERS (Virginia, University; NASA, Langley Research Center, Hampton) Finite Elements in Analysis and Design (ISSN 0168-874X), vol. 11, no. 1, May 1992, p. 77-86. refs

(Contract NAG1-1180)

Copyright

A computational procedure is presented for evaluating the analytic sensitivity derivatives of the tire response with respect to material and geometric parameters of the tire. The tire is modeled by using a two-dimensional laminated anisotropic shell theory with the effects of variation in material and geometric parameters included. The computational procedure is applied to the case of uniform inflation pressure on the Space Shuttle nose-gear tire when subjected to uniform inflation pressure. Numerical results are presented showing the sensitivity of the different response quantities to variations in the material characteristics of both the cord and the rubber. Author

A92-47176

PERFORMANCE OF HYBRID BALL BEARINGS IN OIL AND JET FUEL

STEPHEN M. SCHRADER and EUGENE E. PFAFFENBERGER (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) (STLE, Annual Meeting, 45th, Denver, CO, May 7-10, 1990) STLE Tribology Transactions (ISSN 0569-8197), vol. 35, no. 3, July 1992, p. 389-396. refs

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A 308-size hybrid ball bearing, with ceramic balls and steel rings, was tested using a diester oil and gas turbine fuel as lubricants at several speeds and loads. Heat generation data from this test work was then correlated with the heat generation model from a widely used computer code. The ability of this hybrid split inner ring bearing design to endure thrust reversals, which are expected in many turbine applications, was demonstrated. Finally, the bearing was successfully endurance tested in JP-10 fuel for 25 hours at 7560 N axial load and 36,000 rpm. This work has successfully demonstrated the technology necessary to use fuel-lubricated hybrid bearings in limited-life gas turbine engine applications such as missiles, drones, and other unmanned air vehicles (UAVs). In addition, it has provided guidance for use in designing such bearing systems. As a result, the benefits of removing the conventional oil lubricant system, i.e., design simplification and reduced maintenance, can be realized. Author

A92-47188

MAGNETIC BEARING DESIGN AND CONTROL OPTIMIZATION FOR A FOUR-STAGE CENTRIFUGAL COMPRESSOR

FRANK D. PINCKNEY and JOHN M. KEESEE (Magnetic Bearings, Inc., Radford, VA) (STLE and ASME, Tribology Conference, Saint Louis, MO, Oct. 14-16, 1991) STLE Tribology Transactions (ISSN 0569-8197), vol. 35, no. 3, July 1992, p. 561-565. refs

Copyright

A four-stage centrifugal pipeline compressor with a flexible rotor was equipped with magnetic bearings. Magnetic bearing sizing, shaft rotor dynamics, and controller/bearing design are discussed. Controller changes during shop and field tuning and the resulting rotor dynamic effects are also presented. Results of the field operation of this compressor indicate no vibration-related problems, despite the shaft second and third undamped modes being within the operating speed range. During the first 14 months after field commissioning, 9900 operating hours had been accumulated, indicating a 97 percent unit availability. Author

A92-47267

SEGMENTAL HEAT TRANSFER IN A PIN FIN CHANNEL WITH EJECTION HOLES

S. C. LAU, R. D. MCMILLIN, and R. T. KUKREJA (Texas A & M University, College Station) International Journal of Heat and Mass Transfer (ISSN 0017-9310), vol. 35, no. 6, June 1992, p. 1407-1417. refs

(Contract NSF CBT-87-13833)

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An experimental investigation has been conducted to study, for turbulent air flow through a pin fin channel with ejection holes, the effects of varying the ejection hole configuration on the distribution of the regionally-averaged heat transfer and the overall pressure drop. The channel models the internal cooling passages near the trailing edges of rotor or stator blades in modern gas turbune engines. When air exits through ejection holes, the segmental heat transfer decreases much faster with increasing distance from the channel entrance and the overall channel pressure drop is lower than in the straight-flow-only case. Increasing the number of ejection holes and increasing the size of the ejection holes lower the distribution of the segmental heat transfer and the overall pressure drop. Author

A92-47412

TOOLING FOR C-17 COMPOSITE PARTS

NANCY M. HAM (Ciba-Geigy Formulated Systems Group, Lansing, MI) IN: Composites in manufacturing - Case studies. Dearborn, MI, Society of Manufacturing Engineers, 1991, p. 149-164. refs

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The fabrication of tooling for manufacturing composite components for the C-17 cargo transport is discussed. The discussion covers an analysis of the most common methods of fabricating tooling, the use of different tool-making techniques for different parts of the C-17, selection of tooling materials and appropriate tests, and C-17 composite tooling sequences. It is shown that the use of CAD/CAM techniques makes it possible to reduce the number of steps in typical composite tooling sequences. V.L.

A92-47528

24-BIT FLIGHT TEST DATA RECORDING FORMAT

H. L. MILLS and K. D. TURVER (Boeing Commercial Airplane Group, Seattle, WA) IN: ITC/USA/'91; Proceedings of the International Telemetering Conference, Las Vegas, NV, Nov. 4-7, 1991. Research Triangle Park, NC, Instrument Society of America, 1991, p. 385-389.

Copyright

Boeing Commercial Airplane Group's Flight Test Engineering organization is developing a new test data recording format to be used on the new model 777 airplane. ARINC 429, ARINC 629 and IRIG PCM data will be formatted for recording test data. The need to support a variety of data recorders, and three types of data, mandate the development of a new recording format. The format Flight Test chosen is a variation of IRIG Standard 106-86, Chapter 8. The data from each channel is treated as a data packet, including time and channel ID, and then multiplexed into 24 bits. This allows a time accuracy of 10 microseconds and a minimum latency caused by multiplexing. Author

A92-47656
A METHOD OF FAILURE ANALYSIS OF COMPLICATED STRUCTURES
JIAN-QIU WEI Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 13, no. 3, March 1992, p. A128-A132. In Chinese. refs

A method of failure analysis of complex structures is developed. It is shown that, in order to solve unsymmetrical failure problems for complex structures by the semimodel, it must be assumed that the original rigidity of the structure remains constant and that the equivalent additional force is a substitute for the rigidity effect of the failure elements. The failure analysis method is simple and economical and can be applied to analyze designs, improvements, and failures of a variety of structures. I.S.

A92-47663
A STUDY ON CRACK INITIATION METHOD FOR DURABILITY ANALYSIS
WEN-TING LIU and JUN-JIANG XIONG (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 13, no. 3, March 1992, p. A182-A186. In Chinese. refs

A crack initiation method for durability analysis is developed. In this method, the reliability of safe life under load is related to the crack exceedance probability, on the basis of P-S-N curves for structure member initiation. The condition is that the crack length reaches economic repairment limit. A simple example is presented. I.S.

A92-47671
APPROXIMATE ANALYSIS FOR FAILURE PROBABILITY OF STRUCTURAL SYSTEMS
YIN-LIN CAI and JIAN-SHENG ZHOU (Harbin Shipbuilding Engineering Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 13, no. 3, March 1992, p. A219-A222. In Chinese. refs

An approximate formula for calculating failure probability of structural systems is presented, which uses the lower and upper bounds of the first simple bounds to estimate the failure probability. In this formula, the correlation between each of the two failure modes of a structure is considered, but only the first failure probability of the failure modes is contained. Computations using the approximate formula are quite simple and accurate, with maximum error being within 5 percent. I.S.

A92-47853#
EXAMINATION OF ULTRAVIOLET RADIATION THEORY FOR BOW SHOCK ROCKET EXPERIMENTS
DEBORAH A. LEVIN (Institute for Defense Analyses, Alexandria, VA), GRAHAM V. CANDLER (North Carolina State University, Raleigh), ROBERT J. COLLINS (Minnesota, University, Minneapolis), PETER W. ERDMAN, EDWARD C. ZIPF (Pittsburgh, University, PA), and CARL L. HOWLETT (Utah State University, Logan) AIAA, Thermophysics Conference, 27th, Nashville, TN, July 6-8, 1992. 13 p. refs
(AIAA PAPER 92-2871) Copyright

Comparison is made between the results from a modified state-of-the-art radiation code and bow shock radiation data from recent flight experiments. Initial predictions of the radiation did not yield satisfactory comparison with the first flight experiment, flown at 3.5 km/sec between altitudes of 40 and 70 km, despite improvements to the original flow model. It is found that characterizing the NO excited state population with the translational temperature, rather than the vibrational temperature, yields better comparison to the flight data. Comparison of bow shock data from the second flight, flown at 5.1 km/sec at altitudes of 70 to 90 km, shows that modifications in either flow or radiation modeling are still needed, particularly at high altitudes. The quasi-steady-state distribution of electronic states of NO is found to be valid for these flows. Author

A92-47913#
HEAT TRANSFER TO A CYLINDER SUBMERGED IN A RECTANGULAR CAVITY IN SUPERSONIC FLOW
RANDAL W. LYCANS (United Technologies Corp., Huntsville, AL) and C. I. STUCKEY (Remtech, Inc., Huntsville, AL) AIAA, Thermophysics Conference, 27th, Nashville, TN, July 6-8, 1992. 9 p. refs
(AIAA PAPER 92-2949) Copyright

A study is described which is aimed at determining the convective heat transfer to a cylinder submerged in an open cavity in supersonic flow. The test apparatus was designed to simulate electrical cables routed through the external tank attach ring of the Space Shuttle's solid rocket booster. Three different tube diameters were tested at one location, forward of the recommpression face of the cavity. Peak heat fluxes on the models are found to be in the range from 60 to 80 percent of the approaching flat plate heat flux, depending on the tube diameter. The controlling parameter appears to be the distance from the recompression face of the cavity, which determines the position in the vortex present at this location. O.G.

A92-48026* National Aeronautics and Space Administration, Washington, DC.
FIBER OPTIC AND LASER SENSORS VIII; PROCEEDINGS OF THE MEETING, SAN JOSE, CA, SEPT. 17-19, 1990
RAMON P. DEPAULA, ED. (NASA, Washington, DC) and ERIC UDD, ED. (McDonnell Douglas Electronic Systems Co., Huntington Beach, CA) Meeting sponsored by SPIE. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers (SPIE Proceedings. Vol. 1367), 1991, 395 p. For individual items see A92-48027 to A92-48058.
(SPIE-1367; ISBN 0-8194-0428-4) Copyright

This issue presents topics on the advances in fiber-optic sensor technology, fiber-optic gyroscope, fiber-optic position and pressure sensors, fiber-optic magnetic and temperature sensors, and generic fiber-optic sensors. Papers included are on a novel analog phase tracker for interferometric fiber-optic sensor applications, recent development status of fiber-optic sensors in China, the magnetic-field sensitivity of depolarized fiber-optic gyros, a depolarized fiber-optic gyro for future tactical applications, fiber-optic position transducers for aircraft controls, and a metal embedded optical-fiber pressure sensor. Attention is also given to a fiber-optic magnetic field sensor using spectral modulation encoding, a bare-fiber temperature sensor, an interferometric fiber-optic accelerometer, improvement of specular reflection pyrometer, a theoretical analysis of two-mode elliptical-core optical fiber sensors, and a fiber probe for ring pattern. I.S.

A92-48201
ACTIVE MAGNETIC BEARINGS GIVE SYSTEMS A LIFT
LEO O'CONNOR Mechanical Engineering (ISSN 0025-6501), vol. 114, no. 7, July 1992, p. 52-57.
Copyright

While the active magnetic bearings currently being used in such specialized applications as centrifugal compressors for natural gas pumps are more expensive than conventional bearings, they furnish improved machine service life, controlled damping of high-speed rotors to eliminate critical-speed vibrations, and the obviation of lubrication systems. Attention is presently given to magnetic bearings used by the electric power industry, homopolar magnetic radial and thrust bearings, weapon-system and gas turbine engine applications of magnetic bearings, and the benefits of magnetic bearings for energy-storage flywheels. O.C.

A92-48353
THE OPTIMIZATION OF VARIABLE CROSS-SECTION SPINES WITH TEMPERATURE DEPENDENT THERMAL PARAMETERS

J. REARDON and A. RAZANI (New Mexico, University, Albuquerque) International Communications in Heat and Mass Transfer (ISSN 0735-1933), vol. 19, no. 4, July-Aug. 1992, p. 549-557. refs

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An optimization method based on a temperature correlated profile is expanded upon for the optimization of pin fins with variable cross-sections including the temperature dependence of thermal parameters. The application of this method to optimization of fin arrays is discussed. The validity of the optimization method for a single fin is demonstrated by comparison to analytical results of a special case. An example demonstrates the importance of considering temperature dependence of thermal parameters when optimizing a heat sink. Author

A92-48354

THE EFFECT OF TIP CONVECTION ON THE PERFORMANCE AND OPTIMUM DIMENSIONS OF COOLING FINS

K. LAOR and H. KALMAN (Negev, University, Beersheba, Israel) International Communications in Heat and Mass Transfer (ISSN 0735-1933), vol. 19, no. 4, July-Aug. 1992, p. 569-584. refs

Copyright

A general heat balance differential equation for straight and annular fins with rectangular, triangular, and parabolic shapes has been solved numerically. It is found that the effect of tip convection significantly affects the fin efficiency and has almost no effect on the tip heat dissipation compared to the total heat dissipation.
O.G.

A92-48446

RTOK ELIMINATION WITH TSMM

PAUL W. SWART (Unisys Corp., Eagan, MN) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 214-220.

Copyright

One of the major problems in current technology in the military environment is the identification of failures that occur in airborne electronics while on a mission that cannot be reproduced on the ground-in other words, return tested OK (RTOK). A module that monitors environmental conditions, real time, called the Time Stress Measurement Module (TSMM) is described. TSMM monitors environmental conditions affecting electronics modules and within electronic systems for test, maintenance, and AVIP purposes. The current TSMM provides for monitoring of temperatures, vibration, shock, voltage variations, and transients. The sensor data can be accessed across the PI-Bus at any time before, during, or after a mission while the module is installed, allowing an expert system to take extreme environmental conditions and predict failures or correlate that data against failures that have already occurred. The sensor data can be retained after loss of power. I.E.

A92-48448

LIQUID FLOW-THROUGH COOLING FOR AVIONICS APPLICATIONS

M. BARWICK, M. MIDKIFF, and D. SEALS (AT&T Bell Laboratories, Whippany, NJ) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 227-230.

An avionics cooling system has been developed that circulates fluid through the structural frame of its SEM-E modules. The liquid flow-through (LFT) module frame is only 100 mils thick, yet is capable of maintaining low junction and surface temperatures for modules dissipating in excess of 200 W. The module form/factor is compatible with existing SEM-E circuit board formats and connectors and features toolless, dripless, quick-disconnect removal and insertion. A prototype avionics cooling system has been developed consisting of 52 LFT modules and a parallel feed rack/manifold. Both the module and the system have demonstrated outstanding cooling efficiency, and good reliability under preliminary shock and vibration testing. Cooling tests show a significant improvement over edge-conduction cooling. Thermal comparison tests indicate a 20 C improvement in frame surface temperature over an edge-conduction-cooled 50-W module. I.E.

A92-48460

FERROELECTRIC MEMORY EVALUATION AND DEVELOPMENT SYSTEM

DAVID W. BONDURANT (Ramtron International Corp., Colorado Springs, CO) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 308, 309.

Copyright

Attention is given to the Ramtron FEDS-1, an IBM PC/AT compatible single-board 16-b microcomputer with 8-kbyte program/data memory implemented with nonvolatile ferroelectric dynamic RAM. This is the first demonstration of a new type of solid state nonvolatile read/write memory, the ferroelectric RAM (FRAM). It is suggested that this memory technology will have a significant impact on avionics system performance and reliability.
I.E.

A92-48465

VHDL DESIGN AND SIMULATION FOR AIRBORNE GRAPHICS GENERATION REQUIREMENTS

JERRY A. MYERS (USAF, Crew Systems Development Div., Wright-Patterson AFB, OH) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 342-348. refs

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The author presents current and future plans of the Cockpit Integration Directorate and the Electronics Technology Directorate to develop an airborne graphics generator for future cockpits. The discussion includes plans of the Cockpit Integration Directorate to generate through current and future Air Force contracts, in cooperation with in-house research at the Cockpit Integration Directorate, a system-level VHSIC Hardware Description Language (VHDL) simulation of the airborne graphics generator. It is noted that VHDL provides an excellent platform for system-level simulations. Flight testing will be restricted to final adjustments and final concept demonstration. I.E.

A92-48592

NUMERICAL ANALYSIS OF AN ENGINE TURBINE DISK LOADED WITH A LARGE NUMBER OF THERMOMECHANICAL CYCLES

S. KRUCH (ONERA, Chatillon, France) (Complas III - International Conference on Computational Plasticity Fundamentals and Applications, 3rd, Barcelona, Spain, Apr. 6-10, 1992) ONERA, TP no. 1992-31, 1992, 13 p. refs

(ONERA, TP NO. 1992-31)

A new numerical methodology, named 'cycle jump technique' for the analysis of complex behavior of structures subjected to large thermomechanical loads is developed and applied to analyze a SNECMA aircraft engine turbine disk loaded with a large number of thermomechanical cycles. The cycle jump technique, implemented in the EVPCYCL computer code, is able to avoid cycle-by-cycle computations when the variation of the local governing parameters, such as viscoplastic strain and damage, do not change significantly between cycles. The cycle jump technique calculation required over 500 cycles before reaching the stabilized cycle and being in position to analyze the state of the stresses in the critical areas of the structure, demonstrating the importance and effectiveness of the technique. I.S.

A92-48607

INDIRECT MEASUREMENTS OF CONVECTIVE FLOW BY IR THERMOGRAPHY [MESURES INDIRECTES DE FLUX CONVECTIFS PAR THERMOGRAPHIE INFRAROUGE]

A. RISTORI, J. GUERNIGOU, and J. PERUCCHINI (ONERA, Chatillon, France) (Societe Francaise des Thermiciens, Journee d'Etude sur les Problemes Radiatifs dans les Domaines

Aeronautiques et Spatiaux, Paris, France, Apr. 1, 1992) ONERA, TP no. 1992-46, 1992, 12 p. In French. Research supported by DRET. refs
(ONERA, TP NO. 1992-46)

ONERA has conducted an experimental study of the effect of buffers on heat transfer by internal convection. This study is performed with the DELPHES test facility. The heat transfer coefficients are determined by identification of thermocouple measurements and transient IR thermography measurements with theoretical results calculated from a finite-element thermal code. These experiments are also used to evaluate heat flux measurement techniques and to validate codes for fluid-mechanical calculation. R.E.P.

A92-48722#
THE FLOW PATTERN AND EXTERNAL HEAT TRANSFER INVESTIGATION FOR GAS TURBINE VANES END SURFACES
V. A. GORELOV, V. A. MALKOV, and A. A. KHALATOV (Lyulka Engine Design Bureau, Moscow, Russia) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 4 p.
(AIAA PAPER 92-3071) Copyright

Experimental investigation results of the flow pattern and heat transfer on the end surface of an curvilinear converging channel are presented in this paper. Geometry of the models used for this investigation, was characteristic of the turbine first stage vanes. Velocity profiles measurements of main and cross flowing streams with and without air blowing-out for end-surfaces film cooling have been made. The investigation of local heat transfer on the end surface different areas have been carried out. Some investigation results of the vanes-end-surface film cooling effectiveness in air supplying through annular slot, located upstream of the vanes leading edges, are presented. Author

A92-48734*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
MIXING IN THE DOME REGION OF A STAGED GAS TURBINE COMBUSTOR
W. A. SOWA, R. A. BRADY, and G. S. SAMUELSEN (California, University, Irvine) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 10 p. refs
(Contract NAG3-1124)
(AIAA PAPER 92-3089) Copyright

To lower NO(x) emissions from gas-turbine engines the effect of dome design and operational changes on the mixing quality in the fuel-rich region is studied. A statistical analysis is employed to establish the parametric sensitivity in this complex flow. A mixing-effectiveness index is defined and used to optimize the gas-species uniformity and the extent of reaction at the exit plane of the dome. Mixing effectiveness is tied to the fuel and air injection locations, the macroscale structure of the dome aerodynamics, and the level of turbulence. Increases in nozzle/air to fuel ratio, reference velocities, and the dome expansion angle increased the level of turbulence. The optimum configuration featured counter-swirling fuel and air streams and produced a strong torroidal recirculation zone, an effective spray angle of 45 degrees, and azimuthal velocities that decayed to zero inside of two duct diameters. The results underscore the system specific nature of mixing optimization. Author

A92-48735*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
EXPERIMENTAL STUDY OF CROSS-STREAM MIXING IN A RECTANGULAR DUCT
D. S. LISCINSKY, B. TRUE (United Technologies Research Center, East Hartford, CT), A. VRANOS (AB Research Associates, South Windsor, CT), and J. D. HOLDEMAN (NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 13 p. Previously announced in STAR as N92-27652. refs
(Contract NAS3-25952)
(AIAA PAPER 92-3090) Copyright

An experimental investigation of non-reacting cross-stream jet injection and mixing in a rectangular duct was conducted for application in a low emissions combustor. Planar digital imaging was used to measure concentration distributions in planes perpendicular to the duct axis. Mixing rate was measured for 45 deg slanted slot and round orifice injectors. Five areas of inquiry are discussed: (1) mixing improves continuously with increasing momentum-flux ratio; (2) given a momentum-flux ratio, there is an optimum, orifice spacing; (3) mixing is more dependent on injector geometry than mass flow ratio; (4) mixing is influenced by relative slot orientation; and (5) jet structure is different for round holes and slanted slots injectors. The utility of acquiring multipoint fluctuating properties of the flow field is also demonstrated. Author

A92-48792#
DEVELOPMENT AND APPLICATION OF A ZONAL K-EPSILON TURBULENCE MODEL FOR COMPLEX 3-D FLOWFIELDS
J. A. LADD (McDonnell Aircraft Co., Saint Louis, MO) and L. D. KRAL (McDonnell Douglas Research Laboratories, Saint Louis, MO) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 21 p. Research supported by McDonnell Douglas Corp. refs
(AIAA PAPER 92-3176) Copyright

A compressible, low Reynolds number two-equation turbulence model is applied to complex engineering problems. An upwind, implicit, factored algorithm with an optional TVD operator is used to solve both the mean-flow equations and the k-epsilon equations for three-dimensional turbulenct flow. A zonal approach is used for solution of both the mean flow variables and the turbulence variables. The zonal method allows complex geometries to be broken down into smaller blocks which are then computed sequentially. Several low Reynolds number k-epsilon models are implemented and validated for a subsonic and supersonic flat plate boundary layer. Calculations using the k-epsilon turbulence model are also presented for an axisymmetric jet plume, a supersonic combusting shear layer, a multislot ejector nozzle, and an F/A-18 forebody at high angle of attack. Comparison of the two-equation turbulence model results is made with results using algebraic turbulence models as well as experimental measurements. The two-equation turbulence model predicts better many of the flowfield characteristics for these complex geometries when compared with the algebraic solutions. Author

A92-48803#
SIMPLE EFFECTIVE THICKNESS MODEL FOR CIRCULAR BRUSH SEALS
CONSTANCE A. DOWLER (USAF, Wright Laboratory, Wright-Patterson AFB, OH), RAYMOND E. CHUPP, and GLENN F. HOLLE AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 9 p. refs
(AIAA PAPER 92-3192)

Brush seals are being investigated as replacements for some of the labyrinth seals in gas turbine engines. A relatively simple flow model approach has been presented to generalize brush seal leakage throughout the range of test and application environments. The model uses a single parameter, effective brush thickness, to correlate flow through the seal. A revision to the flow model is presented in this paper to account for seal curvature, which is especially important for smaller diameter brush seals. The revised model has been applied to leakage flow data from five sources. The results demonstrate the utility of the flow model approach in correlating the performance of brush seals having different design geometries. The revised model is shown to effectively account for the effect of seal curvature. Author

A92-48844*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HIGH SPATIAL RESOLUTION MEASUREMENTS OF RAM ACCELERATOR GAS DYNAMIC PHENOMENA
J. B. HINKEY, E. A. BURNHAM, and A. P. BRUCKNER (Washington, University, Seattle) AIAA, SAE, ASME, and ASEE,

Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 27 p. refs
(Contract F08635-89-C-0196; NAG1-1288)
(AIAA PAPER 92-3244) Copyright

High spatial resolution experimental tube wall pressure measurements of ram accelerator gas dynamic phenomena are presented. The projectile resembles the centerbody of a ramjet and travels supersonically through a tube filled with a combustible gaseous mixture, with the tube acting as the outer cowling. Pressure data are recorded as the projectile passes by sensors mounted in the tube wall at various locations along the tube. Data obtained by using a special highly instrumented section of tube has allowed the recording of gas dynamic phenomena with a spatial resolution on the order of one tenth the projectile length. High spatial resolution tube wall pressure data from the three regimes of propulsion studied to date (subdetonative, transdetonative, and superdetonative) are presented and reveal the 3D character of the flowfield induced by projectile fins and the canting of the projectile body relative to the tube wall. Also presented for comparison to the experimental data are calculations made with an inviscid, 3D CFD code. Author

A92-48845#
EXPANSION TUBE EXPERIMENTS FOR THE INVESTIGATION OF RAM-ACCELERATOR-RELATED COMBUSTION AND GASDYNAMIC PROBLEMS
J. SRULIJES, G. SMEETS, and F. SEILER (Saint-Louis, French-German Research Institute, France) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 10 p. refs
(AIAA PAPER 92-3246) Copyright

By means of a specially devised expansion tube, it has proven possible to accelerate an explosive gas mixture to a superdetonative, ram-accelerator-type velocity without autoignition. By reducing the driver length, a gas flow of decreasing velocity was generated; this allowed detailed observations of the sub-, trans-, and superdetonative regimes to be conducted in a simple experiment. In addition to aiding ram accelerator-related research, this method will help optimize the operating parameters of 30 mm and 90 mm ram accelerator test facilities that are currently under construction. O.C.

A92-48847#
PROGRESS TOWARDS THE DEVELOPMENT OF TRANSIENT RAM ACCELERATOR SIMULATION AS PART OF THE U.S. AIR FORCE ARMAMENT DIRECTORATE RESEARCH PROGRAM
N. SINHA, B. J. YORK, S. M. DASH (Science Applications International Corp., Propulsion Fluid Dynamics Div., Fort Washington, PA), R. DRABCZUK (USAF, Wright Laboratory, Eglin AFB, FL), and G. E. ROLADER (Science Applications International Corp., Shalimar, FL) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 15 p. refs
(AIAA PAPER 92-3248) Copyright

This paper describes the development of an advanced CFD simulation capability in support of the U.S. Air Force Armament Directorate's ram accelerator research initiative. The state-of-the-art CRAFT computer code has been specialized for high fidelity, transient ram accelerator simulations via inclusion of generalized dynamic gridding, solution adaptive grid clustering, high pressure thermochemistry, etc. Selected ram accelerator simulations are presented which serve to exhibit the CRAFT code's capabilities and identify some of the principal research/design issues. Author

A92-48872#
ROTOR SUPPORT FOR THE STME OXYGEN TURBOPUMP
DAVID HALUCK, ROGER BURSEY, JR., and FRANK FERLITA (Pratt & Whitney Group, West Palm Beach, FL) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 7 p.
(AIAA PAPER 92-3282) Copyright

The rotor support for the NLS Space Transportation Main Engine (STME) oxygen turbopump is discussed. The rotor is supported by two large angular contact split inner ring ball bearings which are cooled with liquid oxygen. Lubrication is provided by the sacrificial wear of Salox-M self-lubricating composite cage material and the subsequent transfer from the rolling element to the raceway surfaces. The bearings are designed to carry both radial and axial loads. The two-ball-bearing rotor support allows startup and shutdown related transient axial loads to be handled in either direction. The paper presents diagrams of the STME oxygen turbopump, showing ball bearings, and results of ball bearing tests. I.S.

A92-48876*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A COMPARATIVE STUDY OF SCRAMJET INJECTION STRATEGIES FOR HIGH MACH NUMBERS FLOWS
D. W. RIGGINS (Missouri-Rolla, University, Rolla), C. R. MCCLINTON, R. C. ROGERS (NASA, Langley Research Center, Hampton, VA), and R. D. BITTNER (Analytical Services and Materials, Inc., Hampton, VA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 23 p. refs
(AIAA PAPER 92-3287) Copyright

A simple method for predicting the axial distribution of supersonic combustor thrust potential is described. A complementary technique for illustrating the spatial evolution and distribution of thrust potential and loss mechanisms in reacting flows is developed. Wall jet cases and swept ramp injector cases for Mach 17 and Mach 13.5 flight enthalpy inflow conditions are numerically modeled and analyzed using these techniques. The visualization of thrust potential in the combustor for the various cases examined provides a unique tool for increasing understanding of supersonic combustor performance potential. Author

A92-48896#
NUMERICAL SIMULATION OF TURBINE 'HOT SPOT' ALLEVIATION USING FILM COOLING
DANIEL J. DORNEY and ROGER L. DAVIS (United Technologies Research Center, East Hartford, CT) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 12 p. Research supported by United Technologies Corp. refs
(Contract N00014-88-C-0677)
(AIAA PAPER 92-3309) Copyright

Experimental data has shown that combustor hot streaks can lead to pressure side 'hot spots' on first stage turbine rotor blades. In previous numerical studies, it has been shown that unsteady Navier-Stokes procedures can be used to predict the rotor pressure surface temperature increase associated with these combustor hot streaks. In the current investigation, similar two- and three-dimensional unsteady Navier-Stokes simulations have been performed to demonstrate the use of numerical tools in the optimization of film cooling configurations. In this study, the addition of prudently placed film cooling holes along the rotor pressure surface is shown to significantly diminish the adverse effects of the hot streak. Using a two-dimensional Navier-Stokes procedure, a parametric study was performed to determine the impact of the location of the film cooling holes, fluid injection velocity, and fluid injection angle on the time-averaged rotor surface temperature. The experience gained from these two-dimensional simulations was then applied to a series of three-dimensional simulations, in which the effects of the film cooling hole distribution on the rotor pressure surface temperature were studied. The results of these simulations indicate that computational procedures can be used to design feasible film cooling schemes which eliminate the adverse effects of combustor hot streaks. Author

A92-48907#
VANE-BLADE INTERACTION IN A TRANSONIC TURBINE. II - HEAT TRANSFER
K. V. RAO, R. A. DELANEY (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN), and M. G. DUNN (Calspan Advanced

Technology Center, Buffalo, NY) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 10 p. refs
(Contract F33615-90-C-2028)
(AIAA PAPER 92-3324)

Part II of this paper presents results of a combined computational/experimental investigation into the effects of stator-rotor interaction on the heat transfer distributions on the vane and blade of a transonic turbine stage. The predictions were obtained using a 2D unsteady Navier-Stokes code described in Part I of this paper and the measurements were acquired in a short-duration shock tunnel facility. Twenty miniature thin-film heat flux button gages were mounted at the mid-span of the vane and blade and contoured inserts containing many thin-film gages were used on the blade leading-edge to spatially resolve the heat transfer rates in that high gradient region. A grid refinement study was performed with steady noninteractive solutions to ascertain the minimum grid size needed to obtain grid undependent solutions. Predicted time averaged and phase-resolved heat transfer rates are compared with measurements on the vane and blade. Author

A92-48923*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
KRF LASER-INDUCED OH FLUORESCENCE IMAGING IN A SUPERSONIC COMBUSTION TUNNEL
T. M. QUAGLIAROLI, G. LAUFER, S. D. HOLLO, R. H. KRAUSS, R. B. WHITEHURST, III, and J. C. MCDANIEL, JR. (Virginia, University, Charlottesville) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 8 p. refs
(Contract NAG1-795)
(AIAA PAPER 92-3346) Copyright

Planar fluorescence images of OH in a continuous-flow, electrical-resistively heated, high enthalpy, hydrogen-air combustion tunnel, induced by a tunable KrF laser, were recorded. These images were compared to previously recorded fluorescence images induced by a doubled-dye laser under similar conditions. Images induced by the doubled-dye laser system demonstrated a severe distortion caused by absorption and fluorescence trapping. By contrast, images of the fluorescence induced by the tunable KrF laser retained the symmetry properties of the flow. Based on signal-to-noise ratio measurements the yield of the fluorescence induced by the doubled-dye laser is larger than the fluorescence yield induced by the KrF laser. The measurements in the present facility of OH fluorescence induced by the KrF laser were limited by the photon-statistical noise. Based 2 on this result, doubled-dye laser systems are recommended for OH imaging in small and OH lean (less than 10 exp 15/cu cm) facilities. KrF lasers should be selected otherwise. Author

A92-48936*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ADVANCED ROTORCRAFT TRANSMISSION PROGRAM SUMMARY
ROBERT B. BOSSLER, JR. (Lucas Western, Inc., Applied Technology Div., City of Industry, CA) and GREGORY F. HEATH (McDonnell Douglas Helicopter Co., Mesa, AZ) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 12 p. Research supported by U.S. Army. refs
(Contract NAS3-25454)
(AIAA PAPER 92-3363) Copyright

The current status of the Advanced Rotorcraft Transmission (ART) program is reviewed. The discussion includes a general configuration and face gear description, weight analysis, stress analysis, reliability analysis, acoustic analysis, face gear testing, and planned torque split testing. Design descriptions include the face gear webs sized for equal stiffness, a positive engagement clutch, the lubrication system, and a high contact ratio planetary. Test results for five gear materials and three housing materials are presented. V.L.

A92-48937*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
BOEING HELICOPTERS ADVANCED ROTORCRAFT TRANSMISSION (ART) PROGRAM SUMMARY OF COMPONENT TESTS
JOSEPH W. LENSKI, JR. (Boeing Defense and Space Group, Helicopters Div., Philadelphia, PA) and MARK J. VALCO (U.S. Army, Propulsion Directorate; NASA, Lewis Research Center, Cleveland, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 28 p. Research supported by U.S. Army.
(Contract NAS3-25421)
(AIAA PAPER 92-3364) Copyright

The principal objectives of the ART program are briefly reviewed, and the results of advanced technology component tests are summarized. The tests discussed include noise reduction by active cancellation, hybrid bidirectional tapered roller bearings, improved bearing life theory and friction tests, transmission lube study with hybrid bearings, and precision near-net-shape forged spur gears. Attention is also given to the study of high profile contact ratio noninvolute tooth form spur gears, parallel axis gear noise study, and surface modified titanium accessory spur gears. V.L.

A92-48938# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ADVANCED ROTORCRAFT TRANSMISSION (ART) PROGRAM SUMMARY
T. L. KRANTZ (U.S. Army, Propulsion Directorate; NASA, Lewis Research Center, Cleveland, OH) and J. G. KISH (Sikorsky Aircraft, Stratford, CT) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 13 p. Previously announced in STAR as N92-24984. refs
(Contract RTOP 505-63-36)
(AIAA PAPER 92-3365) Copyright

The Advanced Rotorcraft Transmission (ART) Program was initiated to advance the state of the art for rotorcraft transmissions. The goal of the ART Program was to develop and demonstrate the technologies needed to reduce transmission weight by 25 pct and reduce noise by 10 dB while obtaining a 5000 hr 'mean time between failure'. The research done under the ART Program is summarized. A split path design was selected as best able to meet the program goals. Key part technologies needed for this design were identified, studied, and developed. Two of these technologies are discussed in detail: the load sharing of split path designs including the use of a compliant elastomeric torque splitter and the application of a high ratio, low pitch line velocity gear mesh. Development of an angular contact spherical roller bearing, transmission error analysis, and fretting fatigue testing are discussed. The technologies for a light weight, quiet, and reliable rotorcraft transmission were demonstrated. Author

A92-48939*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
ADVANCED ROTORCRAFT TRANSMISSION (ART) - COMPONENT TEST RESULTS
Z. S. HENRY (Bell Helicopter Textron, Inc., Fort Worth, TX) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 13 p. Research supported by U.S. Army.
(Contract NAS3-25455)
(AIAA PAPER 92-3366) Copyright

The preliminary design of the ART and some of the component test results are presented. The goals for the future rotorcraft transmissions include a 25-percent weight reduction in comparison with current state-of-the-art transmissions, a 10-dB reduction in the transmitted noise level, and a system reliability of 5,000 hr mean-time-between-removal for the transmission. The ART tests completed to date support the attainment of the three major goals of the program. V.L.

A92-49015#
A NUMERICAL STUDY OF TWO-PHASE FLOW IN GAS TURBINE COMBUSTORS

A. K. TOLPADI (GE Research and Development Center, Schenectady, NY) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 10 p. refs
(AIAA PAPER 92-3468) Copyright

A method is presented for computing steady two-phase turbulent combusting flow in a gas turbine combustor. The gas phase equations are solved in an Eulerian frame of reference. The two-phase calculations are performed by using a liquid droplet spray combustion model and treating the motion of the evaporating fuel droplets in a Lagrangian frame of reference. The numerical algorithm employs nonorthogonal curvilinear coordinates, a multigrid iterative solution procedure, the standard k-epsilon turbulence model, and a combustion model made up of an assumed shape probability density function and the conserved scalar formulation. The trajectory computation of the fuel provides the source terms for all the gas phase equations. Results of the application of the two-phase model to a modern GE/SNECMA single annular CFM56 turbofan engine combustor are reported. Author

A92-49016#
PREDICTION OF GAS TURBINE COMBUSTOR FLOW BY A FINITE ELEMENT CODE
D. LENTINI, C. FELIZIANI, P. IONTA, and F. RISPOLI (Roma I, Universita, Rome, Italy) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 12 p. Research supported by ASI. refs
(AIAA PAPER 92-3469) Copyright

A finite element computer code for gas turbine combustor flows, currently under development, is presented which aims at an improved grid flexibility, a reduced numerical diffusion by using the SUPG (Streamline Upwind/Petrov-Galerkin) formulation, and at a detailed representation of the chemistry-turbulence interaction. Both an equilibrium model and a finite-rate model have been developed. The models make it possible to reduce the computer time by a factor of about ten. An application to a 2D flow in a gas turbine combustor, with equilibrium chemistry, is reported to show the workability of the proposed code. Author

A92-49018#
RESTART OF THEORY OF AIR-BREATHING ENGINES
AUSTIN RESTER AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 12 p. refs
(AIAA PAPER 92-3472) Copyright

Expansion and compression ratios are treated as independent variables in the derivation of new equations for thermal efficiencies. A conceptual process of isentropic compression of exhaust gases to ambient conditions simplifies the equations for piston engines. Expansion is shown to govern thermal efficiency. A variable-process piston engine is introduced in this paper. Relative to 1/2 load conditions, this new engine is 25 percent more efficient than an Otto engine. Relative to full load, the new engine is 35 percent more powerful than a naturally-aspirated Otto engine. New energy-efficient gas turbines and turbo-jets which utilize pulse-combustion to maximize expansion of combustion gases are also introduced. Author

A92-49028#
DESIGN CRITERIA AND ANALYSIS OF THE DYNAMIC BEHAVIOR OF HIGH SPEED, HEAVILY LOADED AND PRECISION EPICYCLIC GEARS FOR AIRCRAFT USE
K. BUYUKATAMAN (Pratt & Whitney Group, East Hartford, CT) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 12 p. refs
(AIAA PAPER 92-3491) Copyright

An account is given of the design and analysis efforts required for dynamic-properties characterization of single-stage epicyclic gears applicable to aircraft high bypass fans, which require low volume and weight properties. Attention is given to the elastodynamic system simulation conducted, as well as to the mathematical optimization methods applied to the design, taking into account the effects of design features on the resonating frequencies and their amplitudes. Variations induced by certain design features or manufacturing errors have an influence on dynamic loading, mode shapes, vibration frequencies and amplitudes, and the size of the final design. O.C.

A92-49031#
ANALYTICAL EVALUATION OF RESONANT RESPONSE OF SPIRAL BEVEL GEARS IN THE RAH-66 HELICOPTER FANTAIL TRANSMISSION
R. J. DRAGO and F. W. BROWN (Boeing Defense & Space Group, Philadelphia, PA) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 10 p. refs
(AIAA PAPER 92-3495) Copyright

Consideration is given to an analytical approach to the dual problems of defining the occurrence of a potentially damaging resonance and modifying the design of a gear to avoid the resonance. Resonant frequencies were determined for the RAH-66 Fantail gears. A dynamic response level was predicted on the basis of frequency response analyses. The method and criteria utilized indicate acceptable performance without incorporation of axillary damping provisions. O.G.

A92-49048#
MANUFACTURING TECHNOLOGY METHODOLOGY FOR PROPULSION SYSTEM PARTS
M. M. MCRAE (Howmet Corp., Whitehall, MI) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 10 p. refs
(AIAA PAPER 92-3525) Copyright

A development history and a current status evaluation are presented for lost-wax casting of such gas turbine engine components as turbine vanes and blades. The most advanced such systems employ computer-integrated manufacturing methods for high process repeatability, reprogramming versatility, and feedback monitoring. Stereolithography-based plastic model 3D prototyping has also been incorporated for the wax part of the investment casting; it may ultimately be possible to produce the 3D prototype in wax directly, or even to create a ceramic mold directly. Nonintrusive inspections are conducted by X-radiography and neutron radiography. O.C.

A92-49064# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EXPERIMENTS ON THE ENHANCEMENT OF COMPRESSIBLE MIXING VIA STREAMWISE VORTICITY. I - OPTICAL MEASUREMENTS
J. W. NAUGHTON and G. S. SETTLES (Pennsylvania State University, University Park) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 15 p. refs
(Contract NAG1-872; NGT-50400)
(AIAA PAPER 92-3549) Copyright

The present study was initiated in an attempt to increase the compressible mixing rate of a supersonic jet injected into a co-flowing supersonic stream by adding streamwise vorticity to the injected flow. This flowfield was imaged using the planar laser scattering technique, and mixing rates were derived entirely from captured images. The results of this image analysis indicate that increases in mixing rate of up to 60 percent are possible through the addition of streamwise vorticity. Furthermore, the degree of mixing enhancement appears to be dependent on the amount of swirl added. Analysis of the instantaneous turbulent structure suggests that this increase in mixing is due to a modification of the largest turbulent structures in the mixing layer. Author

A92-49085#
A NEW VANE SWIRLER AS APPLIED TO DUAL-INLET SIDE-DUMP COMBUSTOR
M. SITU, X. Y. QIU, Q. YU, X. L. CAO, and Q. M. LEE (31st Research Institute, Beijing, People's Republic of China) AIAA,

SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 9 p. refs
(AIAA PAPER 92-3654) Copyright

A new vane swirler with insert ring and exit expansion section has been experimentally investigated and applied to side-dump combustor. This swirler behaves a character of supercritical downstream, and produces an embedded recirculation zones in which a larger recirculation zone increases with increasing exit expansion angle. Those vanes are installed in the central extrances of axisymmetrical dump combustor and the side-dump combustor to form a central part swirling flows. Nonreacting velocity flowfields of the vane swirler and pressure drop in a laboratory of the vane swirler and pressure drop in a laboratory scale dual-inlet side-dump combustors have been measured. Results show that the recirculation region is produced and stabilized. Finally, a combustion experiment in a full-scale dual-inlet side-dump combustor has been carried out. The results of the combustion test indicate that the work is stable and the combustion efficiency is adequate.
Author

A92-49087#
NUMERICAL STUDY OF SECONDARY SEPARATION IN GLANCING SHOCK/TURBULENT BOUNDARY LAYER INTERACTIONS
ARGYRIS G. PANARAS and EGON STANEWSKY (DLR, Institut fuer Experimentelle Stroemungsmechanik, Goettingen, Federal Republic of Germany) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 11 p. refs
(AIAA PAPER 92-3666) Copyright

Experimentally it has been found that in moderate strength glancing shock/turbulent boundary layer interactions, as they occur, e.g., in supersonic and hypersonic intakes, a secondary separation line appears in the surface flow pattern. In the present paper, a flow of this type, studied at the Pennsylvania State University, is simulated numerically. It is shown that if the turbulence model of Baldwin and Lomax is applied according to the physics of the flow, the resulting solution agrees very well with the experimental evidence (wall pressure, skin friction, flow angle). Then, post-processing of the solution reveals that in this type of interaction the secondary separation phenomenon is similar to that observed in flows around bodies at high incidence. Furthermore, it has been found that the secondary separation adversely affects the conical nature of the flow. The dynamic characteristics of the conical vortex which are known to appear in these types of flow change in such a way that the various flow parameters exhibit a variation along conical rays in the region of the conical vortex, instead of remaining constant, a requirement for a purely conical flow.
Author

A92-49096#
DEVELOPMENT OF HIGH PERFORMANCE COMPRESSOR DISCHARGE SEAL
JOHN H. MUNSON (General Motors Corp., Allison Gas Turbine Div., Indianapolis, IN) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 10 p. Research supported by U.S. Navy. refs
(AIAA PAPER 92-3714) Copyright

A gas lubricated film riding seal (FRFS) that is being developed for use in an advanced subsonic demonstrator engine is investigated. Results obtained indicate that, for gas turbine application, hydrodynamic FRFSs appear to be preferred to hydrostatic designs. A spiral groove design was the overall best seal, followed by a Rayleigh pad seal. Particular attention is given to the problem of integrating the seals into an engine in such a manner that distortion of the sealing faces is minimized. It is found that this can be accomplished in a straightforward manner. O.G.

A92-49126*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A COMPUTATIONAL STUDY OF ADVANCED EXHAUST SYSTEM TRANSITION DUCTS WITH EXPERIMENTAL VALIDATION
C. WU, S. FAROKHI, and R. TAGHAVI (Kansas, University, Lawrence) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 12 p. Research supported by GE Aircraft Engines. refs
(Contract NAG3-841)
(AIAA PAPER 92-3794) Copyright

The current study is an application of CFD to a 'real' design and analysis environment. A subsonic, three-dimensional parabolized Navier-Stokes (PNS) code is used to construct stall margin design charts for optimum-length advanced exhaust systems' circular-to-rectangular transition ducts. Computer code validation has been conducted to examine the capability of wall static pressure predictions. The comparison of measured and computed wall static pressures indicates a reasonable accuracy of the PNS computer code results. Computations have also been conducted on 15 transition ducts, three area ratios, and five aspect ratios. The three area ratios investigated are constant area ratio of unity, moderate contracting area ratio of 0.8, and highly contracting area ratio of 0.5. The degree of mean flow acceleration is identified as a dominant parameter in establishing the minimum duct length requirement. The effect of increasing aspect ratio in the minimum length transition duct is to increase the length requirement, as well as to increase the mass-averaged total pressure losses. The design guidelines constructed from this investigation may aid in the design and manufacture of advanced exhaust systems for modern fighter aircraft. Author

N92-28253# Naval Training Systems Center, Orlando, FL.
AN ANALYSIS OF AIRCREW COMMUNICATION PATTERNS AND CONTENT Final Report, Aug. 1989 - Apr. 1990
RANDALL L. OSER, CAROLYN PRINCE, BEN B. MORGAN, JR., and STEVEN S. SIMPSON 3 Sep. 1991 80 p
(Contract NR PROJ. RM3-3-T-21)
(AD-A246618; NTSC-TR-90-09) Avail: CASI HC A05/MF A01

The findings reported here represent a detailed analysis of tactical rotary-wing aircrew communication patterns and content. This research is part of an extensive effort to investigate the nature of tactical aircrew coordination and to develop effective mission-oriented aircrew coordination training. The primary objectives of this research were to answer the following questions: (1) What specific communication patterns and content are demonstrated by different helicopter crewmembers (i.e., Helicopter Aircraft Commander - HAC and Helicopter 2nd Pilot - H2P)? (2) Do tactical aircrew communication patterns and content vary as a function of the performance demands and requirements of different flight conditions (i.e., routine and non-routine)? (3) Are the communication patterns and content of more effective aircrews different from those of less effective aircrews? (4) What similarities exist between the communication patterns and content of military rotary-wing aircrews and commercial fixed-wing aircrews? and (5) Can the results of the communication analyses have an impact on aircrew coordination training? GRA

N92-28361*# Old Dominion Univ., Norfolk, VA. Dept. of Mechanical Engineering and Mechanics.
VISCOUS EFFECTS ON A VORTEX WAKE IN GROUND EFFECT Final Report, period ending 31 May 1991
Z. ZHENG and ROBERT L. ASH Jun. 1992 48 p
(Contract NAG1-987)
(NASA-CR-190400; NAS 1.26:190400) Avail: CASI HC A03/MF A01

Wake vortex trajectories and strengths are altered radically by interactions with the ground plane. Prediction of vortex strength and location is especially important in the vicinity of airports. Simple potential flow methods have been found to yield reasonable estimates of vortex descent rates in an otherwise quiescent ambient background, but those techniques cannot be adjusted for more realistic ambient conditions and they fail to provide satisfactory estimates of ground-coupled behavior. The authors have been involved in a systematic study concerned with including viscous effects in a wake-vortex system which is near the ground plane. The study has employed numerical solutions to the Navier-Stokes equations, as well as perturbation techniques to study ground

coupling with a descending vortex pair. Results of a two-dimensional, unsteady numerical-theoretical study are presented in this paper. A time-based perturbation procedure has been developed which permits the use of analytical solutions to an inner and outer flow domain for the initial flow field. Predictions have been compared with previously reported laminar experimental results. In addition, the influence of stratification and turbulence on vortex behavior near the ground plane has been studied.
Author

N92-28425# Army Lab. Command, Watertown, MA. Material Technology Lab.
A SENSITIVITY ANALYSIS ON COMPONENT RELIABILITY FROM FATIGUE LIFE COMPUTATIONS Final Report
DONALD M. NEAL, WILLIAM T. MATTHEWS, MARK G. VANGEL, and TREVOR RUDALEVIGE Feb. 1992 23 p
(AD-A247430; MTL-TR-92-5) Avail: CASI HC A03/MF A01
Some uncertainties in determining high component reliability at a specified lifetime from a case study involving the fatigue life of a helicopter component are identified. Reliabilities are computed from results of a simulation process involving an assumed variability (standard deviation) of the load and strength in determining fatigue life. The uncertainties in the high reliability computation are then examined by introducing small changes in the variability for the given load and strength values in the study. Results showed that for a given component lifetime, a small increase in variability of load or strength produced large differences in the component reliability estimates. Among the factors involved in computing fatigue lifetimes, the component reliability estimates were found to be most sensitive to variability in loading. Component fatigue life probability density functions were obtained from the simulation process for various levels of variability. The range of life estimates were very large for relatively small variability in load and strength.
GRA

N92-28434*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
APPLICATION OF FACE-GEAR DRIVES IN HELICOPTER TRANSMISSIONS
F. L. LITVIN (Illinois Univ., Chicago.), J.-C. WANG (Illinois Univ., Chicago.), R. B. BOSSLER, JR. (Lucas Western, Inc., City of Industry, CA.), Y.-J. D. CHEN (McDonnell-Douglas Helicopter Co., Mesa, AZ.), G. HEATH (McDonnell-Douglas Helicopter Co., Mesa, AZ.), and D. G. LEWICKI 1992 10 p Proposed for presentation at the Sixth International Power Transmission and Gearing Conference, Scottsdale, AZ, 13-16 Sep. 1992; sponsored by ASME
(Contract RTOP 505-63-36; DA PROJ. 1L1-62211-A-47-A)
(NASA-TM-105655; E-7019; NAS 1.15:105655; AVSCOM-TR-91-C-036) Avail: CASI HC A02/MF A01
The use of face gears in helicopter transmissions was explored. A light-weight, split torque transmission design utilizing face gears was described. Face-gear design and geometry were investigated. Topics included tooth generation, limiting inner and outer radii, tooth contact analysis, contact ratio, gear eccentricity, and structural stiffness. Design charts were developed to determine minimum and maximum face-gear inner and outer radii. Analytical study of transmission error showed face-gear drives were relatively insensitive to gear misalignment, but tooth contact was affected by misalignment. A method of localizing bearing contact to compensate for misalignment was explored. The proper choice of shaft support stiffness enabled good load sharing in the split torque transmission design. Face-gear experimental studies were also included and the feasibility of face gears in high-speed, high-load applications such as helicopter transmissions was demonstrated.
Author

N92-28694# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
TURBULENCE MODELING: SURVEY OF ACTIVITIES IN BELGIUM AND THE NETHERLANDS, AND APPRAISAL OF THE STATUS AND A VIEW ON THE PROSPECTS
B. VANDERBERG 28 May 1990 12 p Presented at AGARD Fluid Dynamics Panel Technical Status Review on Appraisal of the Suitability of Turbulence Models in Flow Calculations, Friedrichshafen, Fed. Republic of Germany, 26 Apr. 1990
(NLR-TP-90184-U; ETN-92-91540) Avail: CASI HC A03/MF A01
Some experimental results obtained in turbulent boundary layers, as occur on airplane wings, are considered in relation to the usual turbulence mode assumptions. The status of turbulence modeling is found not to be satisfactory. To support the development of semiempirical models of acceptable accuracy, a more extensive base of reliable turbulence data is desirable.
ESA

N92-28712# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics/Informatics Div.
BOUNDARY CONDITIONS FOR EULER EQUATIONS AT INTERNAL BLOCK FACES OF MULTI-BLOCK DOMAINS USING LOCAL GRID REFINEMENT
A. KASSIES (Aeritalia S.p.A., Naples (Italy).) and R. TOGNACCINI (Aeritalia S.p.A., Naples, Italy) 10 Apr. 1990 19 p Presented at the AIAA 21st Fluid Dynamics, Plasma Dynamics and Lasers Conference, Seattle, WA, 18-20 Jun. 1990 Previously announced in IAA as A90-38725 Prepared in cooperation with Aeritalia S.p.A., Naples, Italy
(Contract NIVR-01604-N)
(NLR-TP-90134-U; ETN-92-91533) Avail: CASI HC A03/MF A01
A method for the numerical treatment of boundary conditions for Euler equations at internal block faces of arbitrary complex three dimensional patched multiblock domains is developed. The method should allow cell length and skewness discontinuities of the grid normal to the internal faces, and local grid refinement in each block individually. The method is developed for multiblock flow solvers based on an explicit cell centered finite volume scheme with adaptive numerical dissipation. The discontinuities of the grid at internal block faces are treated by a boundary condition using the gradient vector of each flow variable to determine the flow state at the internal face. In case of local grid refinement, where a coarse grid cell may be connected to any number of fine grid cells, a unique value of the gradient vector is used for all fine grid cells connected to a coarse grid cell. The resulting scheme is fully conservative and may be easily extended to other types of flow solvers. By implementing the described method in a three dimensional multiblock solver, a powerful aerodynamic analysis tool for solving the Euler equations in an arbitrary flow domain is obtained. The ability of the flow solver to handle grid discontinuities over internal faces allows much freedom in the grid generation process. The use of local grid refinement per block offers the desired flow simulation accuracy with grids of reasonable size.
ESA

N92-28788# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction de lAerodynamique.
CONSTRUCTION OF A NUMERICAL OPTIMIZATION METHOD FOR THE DEFINITION OF HYPERSUPPORTED PROFILES Final Summary Report [REALISATION DUNE METHODE DOPTIMISATION NUMERIQUE POUR LA DEFINITION DE PROFILES HYPERSUSTENTES. RAPPORT DE SYNTHESE FINAL]
F. MOENS Jun. 1991 66 p In FRENCH
(Contract DRET-89-34-001)
(ONERA-RSF-43/1736-AY-146A; ETN-92-91326) Avail: CASI HC A04/MF A01
The method for a two dimensional description of hyper-supported profiles by numerical optimization consists of a stress minimization program, named CONMIN, and the aerodynamic program, named VIS18. The viscous effects are taken into account by the strong coupling iterative method. The decision variables considered are the deflection values, slots and flap covers, and the incidence of the assembly. The aim of the study is to maximize the whole lift-slope coefficient, for given values of stresses of the overspeeds of different bodies. The importance of including the viscous effects was demonstrated for the optimization of the OALT25 laminar profile, with a two slit flap. The deflection values calculated are greater than those obtained by optimization in an

inviscid fluid, and a separation on the second flap is observed. Problems concerning relative minimal values and of multiple solutions were found for the optimization of the OAULM02 profile, with a single slot flap. These effects can be reduced by increasing the coupling interactions, although the calculation time increases. ESA

N92-28814# Oak Ridge National Lab., TN.

ASSESSMENT OF VALVE ACTUATOR MOTOR ROTOR DEGRADATION BY FOURIER ANALYSIS OF CURRENT WAVEFORM

J. D. KUECK (Carolina Power and Light Co., Raleigh, NC.), J. C. CRISCOE (Carolina Power and Light Co., Raleigh, NC.), and N. M. BURSTEIN 1992 15 p Presented at the 54th Annual American Power Conference, Chicago, IL, 13-15 Apr. 1992
(Contract DE-AC05-84OR-21400)
(DE92-013233; CONF-920432-11) Avail: CASI HC A03/MF A01

This paper presents a test report of a motor diagnostic system which uses Fourier Analysis of the motor current waveform to detect broken rotor bars in the motor or defects in the driven equipment. The test was conducted on a valve actuator motor driving a valve actuator which was in turn driving a dynamometer to measure the actuator torque output. The motor was gradually degraded by open circuiting rotor bars. The test confirmed the efficacy of the waveform analysis method for assessing motor rotor degradation and also provided data regarding the change in waveform characteristics as motor rotors are gradually degraded to failure. DOE

N92-28836# National Aerospace Lab., Tokyo (Japan). Space Technology Research Group.

QUATERNION AND EULER ANGLES IN KINEMATICS

ISAO YAMAGUCHI, TAKASHI KIDA, OSAMU OKAMOTO, and YOSHIAKI OOKAMI Jun. 1991 18 p In JAPANESE
(ISSN 0452-2982)
(NAL-TM-636; JTN-92-80363) Avail: CASI HC A03/MF A01

A summary of quaternion in the kinematics of rigid body dynamics is presented. Quaternion is a four parameter system for specifying the orientation of a rigid body. Four parameters of quaternion are updated by integrating linear differential equations whose coefficients are the angular velocity of the body. After describing the coordinate systems and vectors, quaternion is introduced. Then, using a comparison with the Euler angles, typical presentation of body orientation and the relationships between quaternion and angular velocity are discussed. Finally, a computer simulation algorithm is derived to solve rigid body dynamics using quaternion. Author (NASDA)

N92-28879# Pennsylvania State Univ., University Park. Turbomachinery Lab.

EXPLICIT NAVIER-STOKES COMPUTATION OF TURBOMACHINERY FLOWS Final Report, 1 Aug. 1986 - 31 Dec. 1991

ROBERT KUNZ and B. LAKSHMINARAYANA Jan. 1992 251 p
(Contract DAAL03-86-G-0044)
(AD-A249284; PSU-TURBO-R-9201) Avail: CASI HC A12/MF A03

A new three-dimensional explicit Navier-Stokes procedure has been developed for computation of turbomachinery flows. Several numerical strategies and modelling techniques have been developed and incorporated which enable convergent and accurate predictions of high Reynolds number flowfields across a wide range of Mach numbers. These include incorporation of a compressible low Reynolds number form of the turbulence transport model and other physical and solution parameters, eigenvalue and local velocity artificial dissipation scalings, a compact flux evaluation procedure, and a hybrid low Reynolds number ke/algebraic Reynolds stress model. Detailed stability and order of magnitude analyses are performed on the discrete system of seven governing equations. Conclusions are drawn concerning the influence of system rotation and turbulence transport source terms, implicit source term treatment and the coupling of the discrete mean flow equation system to the turbulence model equations and its effect on the stability of the numerical scheme. Three-dimensional validation is provided by the results of an incompressible curved duct flow computation. A high Reynolds number axial rotor flow, for which extensive experimental data is also available, was computed. A backswept transonic centrifugal compressor flow, for which L2F meridional passage velocity measurements are available, is computed. Full Navier-Stokes solutions are presented which are shown to capture detailed viscous dominated flow features. GRA

N92-29099* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

SUPERCONDUCTING BEARINGS WITH LEVITATION CONTROL CONFIGURATIONS Patent

YURY FLOM, inventor (to NASA) and JAMES D. ROYSTON, inventor (to NASA) 26 May 1992 13 p Filed 17 Apr. 1991 Supersedes N91-28578 (29 - 20, p 3354)
(NASA-CASE-GSC-13346-1; US-PATENT-5,117,139; US-PATENT-APPL-SN-691609; US-PATENT-CLASS-310-90.5; US-PATENT-CLASS-505-876; INT-PATENT-CLASS-H02K-1/14; INT-PATENT-CLASS-F16C-32/04) Avail: US Patent and Trademark Office

An improved superconducting bearing is presented. Rotor is confined within two superconducting circular bearing structures, each of which has a number of embedded heating elements, and will levitate rotor which has embedded magnets in its end. Heating elements are connected to a feedback control unit, as are rotor position sensors. The temperature profiles of each circular bearing structure is then adjusted according to the information on rotor position provided to control unit by position sensors. Novelty is believed to reside in providing a superconducting circular bearing structure allowing for a control of the levitating forces.
Official Gazette of the U.S. Patent and Trademark Office

N92-29105*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

A 4-SPOT TIME-OF-FLIGHT ANEMOMETER FOR SMALL CENTRIFUGAL COMPRESSOR VELOCITY MEASUREMENTS

MARK P. WERNET and GARY J. SKOCH Jul. 1992 8 p Presented at the Sixth International Symposium on the Application of Laser Techniques to Fluid Mechanics, Lisbon, Portugal, 20-23 Jul. 1992; sponsored by the Instituto Superio Techico
(Contract DA PROJ. 1L1-62211-A-47-A; RTOP 505-62-50)
(NASA-TM-105717; E-7112; NAS 1.15:105717; AVSCOM-TR-92-C-026) Avail: CASI HC A02/MF A01

The application of laser anemometry techniques in turbomachinery facilities is a challenging dilemma requiring an anemometer system with special qualities. Here, we describe the use of a novel laser anemometry technique applied to a small 4.5 kg/s, 4:1 pressure ratio centrifugal compressor. Sample velocity profiles across the blade pitch are presented for a single location along the rotor. The results of the intra-blade passage velocity measurements will ultimately be used to verify CFD 3-D viscous code predictions. Author

N92-29118# Oxford Univ. (England).

TURBULENT SPOT GENERATION AND GROWTH RATES IN A TRANSONIC BOUNDARY LAYER Final Report, 15 May 1989 - 14 Oct. 1991

J. P. CLARK, J. E. LEGRAFF, and T. V. JONES 18 Mar. 1992 24 p
(Contract AF-AFOSR-0427-89)
(AD-A250221; AFOSR-92-0365TR) Avail: CASI HC A03/MF A01

Wide-bandwidth surface heat transfer instrumentation has been used to track the generation, convection and growth of turbulent spots in a laminar boundary layer undergoing transition to turbulence. The model was a flat plate subjected to a range of free stream conditions in a piston-driven isentropic compression heated transient wind tunnel at Oxford University. Freestream Mach number (subsonic to 2.0), freestream turbulence and streamwise pressure gradient (favorable to adverse) were varied. Preliminary analysis of the time-resolved heat transfer data allowed estimates of spot convection rates, generation rates and spreading angles to be estimated. Convection rates were little affected by Mach number, whereas spreading angles were narrowed by favorable pressure gradients and expanded by adverse gradients. GRA

N92-29136*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
DYNAMICS OF A SPLIT TORQUE HELICOPTER TRANSMISSION
MAJID RASHIDI (Cleveland State Univ., OH.) and TIMOTHY KRANTZ (Army Aviation Systems Command, Cleveland, OH.) 1992 14 p *Prepared for presentation of the 6th International* Power Transmission and Gearing Conference, Scottsdale, AZ, 13-16 Sep. 1992; sponsored in part by ASME
(Contract DA PROJ. 1L1-62211-A-47-A; RTOP 505-63-36)
(NASA-TM-105681; E-7060; AVSCOM-TR-91-C-043; NAS 1.15:105681) Avail: CASI HC A03/MF A01

A high reduction ratio split torque gear train has been proposed as an alternative to a planetary configuration for the final stage of a helicopter transmission. A split torque design allows a high ratio of power-to-weight for the transmission. The design studied in this work includes a pivoting beam that acts to balance thrust loads produced by the helical gear meshes in each of two parallel power paths. When the thrust loads are balanced, the torque is split evenly. A mathematical model was developed to study the dynamics of the system. The effects of time varying gear mesh stiffness, static transmission errors, and flexible bearing supports are included in the model. The model was demonstrated with a test case. Results show that although the gearbox has a symmetric configuration, the simulated dynamic behavior of the first and second compound gears are not the same. Also, results show that shaft location and mesh stiffness tuning are significant design parameters that influence the motions of the system. Author

N92-29191# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
MODULAR SIMULATION OF HEI FRAGMENTS AND BLAST PRESSURE M.S. Thesis
GORDON L. GALLOWAY Mar. 1992 257 p
(AD-A248205; AFIT/GOR/ENS/92M-11) Avail: CASI HC A12/MF A03

The fragmentation and blast pressure of High Explosive Incendiary projectiles are major causes of aircraft fuel fires. Because Halon 1301 is being banned from DoD use as a fire suppressant, alternative fire suppressants must be developed and tested. These new suppressants must counteract the fire directly or eliminate one or more of the factors which cause the fire. To this end, this thesis takes a detailed look at the HEI processes that lead to a fire. A comprehensive review of the current knowledge and understanding of these processes is presented. In addition, hypothesized dependencies between the various processes are stated. These hypothesized dependencies can not be proved or disproved with data at this time. Therefore, tests and test set-ups are outlined to collect the necessary data. The evidence in support of these dependencies is also presented. To aid the testing of various fire suppressant system and the hypothesized HEI explosion dependencies a simulation of the HEI explosion was developed. This simulation allows the user to simulate any configuration of the aircraft dry bay, and any attack scenario for the projectile. Using this simulation one of the hypothesized dependencies was tested and shown to be possible. GRA

N92-29344# Naval Postgraduate School, Monterey, CA.
IMPROVING THE LAMP MK 3 SH-60B HF COMMUNICATION SYSTEM M.S. Thesis
FREDERICK C. ADAMS, JR. Sep. 1991 64 p
(AD-A245970) Avail: CASI HC A04/MF A01

This thesis examines the over-the-horizon (OTH) communications capability of the SH-60B Seahawk. The LAMPS Mk III communications system incorporated a high frequency (HF) radio in its design to provide reliable two-way voice communications at extended ranges for use during operations that require the helicopter to be below the ship's radio horizons. In addition, the HF radio system is necessary to provide communications with non-LAMPS equipped naval forces and commercial shipping and to provide long-range, sea-air rescue capabilities. Topics addressed with respect to the OTH communications capability of the SH-60B Seahawk are the basis of HF propagation theory, a chronology of events concerning the SH-60B's current HF communication system and an analysis of issues. Author (GRA)

N92-29603# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
SHORT CRACKS AND DURABILITY ANALYSIS OF THE FOKKER 100 WING/FUSELAGE STRUCTURE
R. J. H. WANHILL and L. SCHRA 2 Oct. 1990 24 p Presented at the International Conference on Short Cracks, Sheffield, England, Dec. 1990
(NLR-TP-90336-U; ETN-92-91449) Avail: CASI HC A03/MF A01

Short and long fatigue crack growth in the industry standard damage tolerant aluminum alloy 2024-T3 were compared using flight simulation loading representative for the Fokker 100 wing/fuselage structure. The results and a straightforward durability analysis showed that the behavior of short cracks is not significant for the current wing/fuselage structure. The data provide a reference for evaluating new candidate materials for durable wing/fuselage structures in transport aircraft. ESA

N92-29683# Manchester Univ. (England). Aeroanutical Engineering Group.
AERONAUTICAL ENGINEERING GROUP PUBLICATIONS, 1950 - PRESENT
1989 19 p
(AERO-REPT-8907; ETN-92-91342) Avail: CASI HC A03/MF A01

A list of 232 publications of the aeronautical engineering group is presented. For each entry the author(s), source and date of publication, and article title, are presented. ESA

N92-29830*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AERODYNAMIC DESIGN OPTIMIZATION USING SENSITIVITY ANALYSIS AND COMPUTATIONAL FLUID DYNAMICS Patent Application
OKTAY BAYSAL, inventor (to NASA) (Old Dominion Univ., Norfolk, VA.) and MOHAMAD E. ELESHAKY, inventor (to NASA) (Old Dominion Univ., Norfolk, VA.) 3 Jan. 1992 24 p
(Contract NAG1-1188)
(NASA-CASE-LAR-14815-1-CU; NAS 1.71:LAR-14815-1-CU; US-PATENT-APPL-SN-820432) Avail: CASI HC A03/MF A01

An efficient aerodynamic shape optimization method based on a computational fluid dynamics/sensitivity analysis algorithm has been developed which determines automatically the geometrical definition of an optimal surface starting from any initial arbitrary geometry. This method is not limited to any number of design variables or to any class of surfaces for shape definition. NASA

N92-29873# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Helicopter Component Test.
COMPUTED TOMOGRAPHY (CT) AS A NONDESTRUCTIVE TEST METHOD USED FOR COMPOSITE HELICOPTER COMPONENTS
REINHOLD OSTER 1991 9 p Presented at the 17th European Rotorcraft Forum, Berlin, Fed. Republic of Germany, 24-27 Sep. 1991
(MBB-UD-0603-91-PUB; ETN-92-91695) Avail: CASI HC A02/MF A01

The first components of primary helicopter structures to be made of glass fiber reinforced plastics were the main and tail rotor blades of the Bo105 and BK117 helicopters. These blades are now successfully produced in series. New developments in rotor components, e.g. the rotor blade technology of the Bo108 and PAH2 programs, make use of very complex fiber reinforced structures to achieve simplicity and strength. Computer tomography was found to be an outstanding nondestructive test method for examining the internal structure of components. A CT scanner generates x-ray attenuation measurements which are used to produce computer reconstructed images of any desired part of an object. The system images a range of flaws in composites in a number of views and planes. Several CT investigations and their results are reported taking composite helicopter components as an example. ESA

N92-29877# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (Germany, F.R.). Abt. Hochfrequenzphysik.
GLOBAL AND HIGH RESOLUTION RADAR CROSS SECTION MEASUREMENTS AND TWO-DIMENSIONAL MICROWAVE IMAGES OF A SCALED AIRCRAFT MODEL FROM THE TYPE AIRBUS A 310 [GLOBALE UND HOCHAUFGELOESTE RADARRUECKSTRAHLQUERSCHNITTS-MESSUNGEN UND ZWEIDIMENSIONALE MIKROWELLENABBILDUNGEN VON EINEM SKALIERTEN UND FLUGZEUGMODELL VOM TYP AIRBUSS A 310]
KARL-HEINZ BETHKE Jun. 1991 54 p In GEORGIAN
(ISSN 0939-298X)
(DLR-MITT-91-10; ETN-92-91731) Avail: CASI HC A04/MF A01; DLR, Wissenschaftlisches Berichtswesen, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC

The results from radar cross section high resolution measurements of a metallized scaled model of a usual airliner of the Airbus A310 type are presented. The measurements were performed for line polarization states by using a coherent short pulse radar at a frequency of 12.5 GHz. Two dimensional microwave images were generated for varied aspect angles by using inverse synthetic aperture principles to obtain an exact identification of each scattering center of the model. Polarization dependent back diffusions are particularly visible at the wing edges in the respective reflection images. The fins of airfoils are visible by vertical polarization for aspect angles from side views. ESA

N92-29933# Pennsylvania State Univ., University Park. Turbomachinery Lab.
EXPLICIT NAVIER-STOKES COMPUTATION OF TURBOMACHINERY FLOWS Final Report, 1 Aug. 1986 - 31 Dec. 1991
ROBERT F. KUNZ and BUDUGUR LAKSHMINARAYANA Jan. 1992 23 p
(Contract DAAL03-86-G-0044)
(AD-A248458; PSU-TURBO-9201) Avail: CASI HC A03/MF A01

A new three-dimensional explicit Navier-Stokes procedure was developed for computation of turbulent turbomachinery flows. Several numerical strategies and modelling techniques were developed and incorporated which enable convergent and accurate predictions of high Reynolds number flow fields across a wide range of Mach numbers. These include incorporation of a compressible low Reynolds number form of the k-e turbulence model in a fully explicit fashion, appropriate stability bound treatment of the transport turbulence model and other physical and solution parameters, eigenvalue and local velocity artificial dissipation scalings, a compact flux evaluation procedure and a hybrid low Reynolds number kappa-sigma/algebraic Reynolds stress model. This report provides a summary of this research. In what follows, primary research findings are summarized (details provided in cited references by the present authors), and several sample turbomachinery application results are provided. Specifically, two-dimensional results are provided for a supersonic compressor cascade operating at unique incidence condition. Three-dimensional validation is provided by a high Reynolds number axial rotor flow, for which extensive experimental data is available. This large scale computation is shown to capture rotational inviscid, blade and endwall boundary layer and wake flow physics, including spanwise mixing effects, with good accuracy. Finally, a backswept transonic centrifugal compressor flow, for which L2F meridional passage velocity measurements are available, are computed. GRA

N92-29954*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ACTIVE THERMAL ISOLATION FOR TEMPERATURE RESPONSIVE SENSORS Patent Application
SCOTT D. MARTINSON, inventor (to NASA), DAVID L. GRAY, inventor (to NASA), DEBRA L. CARRAWAY, inventor (to NASA), and DANIEL C. REDA, inventor (to NASA) 2 Jan. 1992 16 p
(NASA-CASE-LAR-14612-1; NAS 1.71:LAR-14612-1; US-PATENT-APPL-SN-820431) Avail: CASI HC A03/MF A01

The detection of flow transition between laminar and turbulent flow and of shear stress or skin friction of airfoils is important in basic research for validation of airfoil theory and design. These values are conventionally measured using hot film nickel sensors deposited on a polyimide substrate. The substrate electrically insulates the sensor and underlying airfoil but is prevented from thermally isolating the sensor by thickness constraints necessary to avoid flow contamination. Proposed heating of the model surface is difficult to control, requires significant energy expenditures, and may alter the basic flow state of the airfoil. A temperature responsive sensor is located in the airflow over the specified surface of a body and is maintained at a constant temperature. An active thermal isolator is located between this temperature responsive sensor and the specific surface of the body. The total thickness of the isolator and sensor avoid any contamination of the flow. The temperature of this isolator is controlled to reduce conductive heat flow from the temperature responsive sensor to the body. This temperature control includes (1) operating the isolator at the same temperature as the constant temperature of the sensor; and (2) establishing a fixed boundary temperature which is either (a) less than or equal to or (b) slightly greater than the sensor constant temperature. The present invention accordingly thermally isolates a temperature responsive sensor in an energy efficient, controllable manner while avoiding any contamination of the flow. NASA

N92-30028*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMBINED LOAD TEST APPARATUS FOR FLAT PANELS Patent Application
ROBERT R. MCWITHEY, inventor (to NASA) (AS&M, Inc., Hampton, VA.), CARL J. MARTIN, JR., inventor (to NASA) (Lockheed Engineering and Sciences Co., Hampton, VA.), and JEFFREY A. CERRO, inventor (to NASA) (Lockheed Engineering and Sciences Co., Hampton, VA.) 7 Apr. 1992 16 p
(NASA-CASE-LAR-14698-1; NAS 1.71:LAR-14698-1; US-PATENT-APPL-SN-866769) Avail: CASI HC A03/MF A01

Future hypersonic aircraft such as the National Aero-Space Plane and a high speed civil transport will require the design and use of efficient, highly-loaded, flat structural panels to achieve mission requirements. These panels will be subjected to severe combinations of in-plane mechanical distributed loads (i.e., normal loads in two perpendicular directions plus a shear load), in addition to pressure and thermal loads. A testing apparatus is provided for applying uniform combined in-plane stresses to a flat panel containing an interior test area. Actuators cause two sets of load rods to apply loads to the edge of the flat panel. The first set applies loads which are perpendicular to and independent of the loads applied by the second set. The loads are applied according to a cosine load distribution to obtain a uniform stress field within the test area. The flat panel may be rotated with respect to the applied loads to obtain a wide range of combined stresses in the test area. Movement outside the plane of the flat panel may be selectively prevented by connecting the flat panel to a restraining disk by support rods. The support rods then define the test area. A thermal load may be applied to one side of the flat panel and a pressure load may be applied to the other side. The novelty of this method is found in providing a testing apparatus which allows mechanical, thermal and pressure loads to be applied simultaneously to a flat panel for testing purposes. NASA

N92-30042*# Stanford Univ., CA. Center for Turbulence Research.
A PRELIMINARY EXPERIMENTAL INVESTIGATION OF LOCAL ISOTROPY IN HIGH-REYNOLDS-NUMBER TURBULENCE
SRINIVAS V. VEERAVALLI and SEYED G. SADDOUGHI *In its* Annual Research Briefs, 1991 p 3-20 Dec. 1991
Avail: CASI HC A03/MF A04

Detailed measurements of the velocity field were made in the wall boundary layer of the 80 by 120 foot facility at NASA Ames. The Reynolds Number R(sub lambda), based on the Taylor microscale lambda at the measurement location, was approximately 1450, one of the largest attained in laboratory flows. The data indicate that to within measurement accuracy, the w-spectrum follows, but the v-spectrum deviates from, the isotropic relation in the inertial subrange. No definite statement can be made regarding local isotropy for the dissipating scales because the spectral measurements were contaminated by high-frequency electrical noise, but it appears that the inertial-subrange anisotropy persists in the dissipation region. Author

N92-30044*# Stanford Univ., CA. Center for Turbulence Research.
NON-LINEAR INTERACTIONS IN HOMOGENEOUS TURBULENCE WITH AND WITHOUT BACKGROUND ROTATION
FABIAN WALEFFE *In its* Annual Research Briefs, 1991 p 31-43 Dec. 1991
Avail: CASI HC A03/MF A04

Domaradzki et al. concluded (1988, 1990 a,b) that turbulent transfers are dominated by non-local interactions with local energy transfer. This is only partly consistent with the common wisdom that local interactions with local energy transfer dominate the inertial cascade. Brasseur et al. (1991 a,b,c) then called on this predominance of non-local interactions to refute the Kolmogorov assumption of local isotropy at the small scales. The inertial wave decomposition showed features observed in the simulations. A deeper analysis was undertaken in search of a better understanding of triad interactions and of the significance of the numerical results. The helical (or inertial wave) decomposition of the velocity field clearly identified two types of triadic transfers depending on whether the small scale helical modes have helicities of the same or the opposite sign. Only one type of interaction shows local transfer when the triads are non-local. In those cases, the local cascade to higher wavenumber must always be accompanied by a feedback on the large scale. An instability principle, suggested by the stability characteristics of triad interactions, has been introduced and predicts the direction of the energy transfers. These predictions agree with DNS and the Test Field Model. Author

N92-30064*# Stanford Univ., CA. Center for Turbulence Research.
METHODS FOR DIRECT SIMULATION OF TRANSITION IN HYPERSONIC BOUNDARY LAYERS 2
J. J. W. VANDERVEGT *In its* Annual Research Briefs, 1991 p 299-307 Dec. 1991
Avail: CASI HC A02/MF A04

The prediction of transition to turbulence in compressible boundary layers currently receives significant attention due to its importance in the design of high speed transport vehicles. Drag, lift, and heat transfer strongly depend on whether the boundary layer is laminar or turbulent. The study of transition in compressible boundary layers by means of direct numerical simulation (DNS) provides information not available from the commonly used linear and nonlinear stability theories. We want to study flows with both strong shocks and boundary layers, but, unfortunately, most shock capturing schemes are very dissipative in the boundary layer. We have previously presented a fully implicit finite volume method, and significant progress was made in improving the efficiency of a fully implicit method without using the approximate factorization method of Beam and Warming (1978). The finite volume method, however, is only second order accurate, and it was felt that higher order accuracy is necessary in order for success in direct numerical simulation of transition. The construction of an implicit and time accurate fourth order scheme is discussed. Author

N92-30065*# Stanford Univ., CA. Center for Turbulence Research.
EFFECT OF WALLS ON THE SUPERSONIC REACTING MIXING LAYER
D. S. SHIN and J. H. FERZIGER *In its* Annual Research Briefs, 1991 p 309-330 Dec. 1991
Avail: CASI HC A03/MF A04

Most stability analyses of supersonic mixing layers have considered unconfined shear layers. However, the supersonic mixing layers in ramjet combustors and most experiments are confined by solid walls. To include the effect of chemical reactions, the authors consider a reacting mixing layer in a channel. The chemistry model is a finite rate single step irreversible reaction with Arrhenius kinetics. All flow variables are nondimensionalized by their fast-stream values. The effects of heat release, Mach number, frequency, wavenumber, thickness of shear layer, as well as distance between walls and direction of wave propagation are considered. H.A.

N92-30082*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
BEARING SERVICING TOOL Patent Application
REX A. BOYCE, inventor (to NASA) 31 Oct. 1991 18 p
(NASA-CASE-MSC-21881-1; NAS 1.71:MSC-21881-1; US-PATENT-APPL-SN-785637) Avail: CASI HC A03/MF A01

A tool for removing and/or replacing bearings in situ is presented which comprises 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, the respective ends of the brace are correspondingly configured. An elongate guide member integral with the brace has two parts, each projecting endwise from a respective end of the brace. A pressure plate is alternatively removably mountable on either part of the guide member for longitudinal movement therealong, and has first and second ends of different configurations adapted to engage first and second ends respectively 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. NASA

N92-30099*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
APPARATUS FOR ELEVATED TEMPERATURE COMPRESSION OR TENSION TESTING OF SPECIMENS Patent Application
THOMAS S. GATES, inventor (to NASA) 12 May 1992 8 p
(NASA-CASE-LAR-14775-1; NAS 1.71:LAR-14775-1; US-PATENT-APPL-SN-881912) Avail: CASI HC A02/MF A01

In order to support materials selection for the next generation supersonic civilian passenger transport aircraft, a testing apparatus was developed to evaluate certain materials under conditions of high load and elevated temperature. In order to elevate the temperature of the material during standard tension and compression testing the test specimen is surrounded by a pair of supports which include internal heating means. These supports also prevent buckling of the specimen during compression testing. NASA

N92-30106*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THE 1991 INTERNATIONAL CONFERENCE ON AGING AIRCRAFT AND STRUCTURAL AIRWORTHINESS
CHARLES E. HARRIS, ed. Washington Jul. 1992 470 p
Conference held in Washington, DC, 19-21 Nov. 1991; sponsored by NASA, Washington and FAA
(Contract RTOP 538-02-10-01)
(NASA-CP-3160; L-17094; NAS 1.55:3160) Avail: CASI HC A20/MF A04

Technical sessions of the conference included structural performance, nondestructive evaluation, maintenance and repair, international activities, and commuter airlines. Each session was organized to provide a well-rounded view of the subject from the industry, regulatory, and research perspective. Thirty-four presentations were given by the international technical community.

N92-30107*# Boeing Commercial Airplane Co., Seattle, WA. Structures Engineering Div.
STRUCTURAL INTEGRITY OF FUTURE AGING AIRPLANES
JACK F. MCGUIRE and ULF G. GORANSON *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 33-47 Jul. 1992
Avail: CASI HC A03/MF A04

A multitude of design considerations is involved in ensuring the structural integrity of Boeing jet transports that have common design concepts validated by extensive analyses, tests, and three decades of service. As airplanes approach their design service objectives, the incidences of fatigue and corrosion may become widespread. Continuing airworthiness of the aging jet fleet requires diligent performance from the manufacturer, the airlines, and airworthiness authorities. Aging fleet support includes timely development of supplemental structural inspection documents applicable to selected older airplanes, teardown inspections of high-time airframes retired from service, fatigue testing of older airframes, and structural surveys of more than 130 airplanes operated throughout the world. Lessons learned from these activities are incorporated in service bulletin recommendations, production line modifications, and design manual updates. An overview of traditional Boeing fleet support activities and the anticipated benefits for future generations of commercial airplanes based on the continuous design improvement process are presented. Author

N92-30109*# Boeing Commercial Airplane Co., Seattle, WA.
PERFORMANCE OF FUSELAGE PRESSURE STRUCTURE
JAMES R. MACLIN *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 67-74 Jul. 1992
Avail: CASI HC A02/MF A04

There are currently more than 1,000 Boeing airplanes around the world over 20 years old. That number is expected to double by the year 1995. With these statistics comes the reality that structural airworthiness will be in the forefront of aviation issues well into the next century. The results of previous and recent test programs Boeing has implemented to study the structural performance of older airplanes relative to pressurized fuselage sections are described. Included in testing were flat panels with multiple site damage (MSD), a full-scale 737 and 2 747s as well as panels representing a 737 and 777, and a generic aircraft in large pressure-test fixtures. Because damage is a normal part of aging, focus is on the degree to which structural integrity is maintained after failure or partial failure of any structural element, including multiple site damage (MSD), and multiple element damage (MED). Author

N92-30110*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FRACTURE MECHANICS RESEARCH AT NASA RELATED TO THE AGING COMMERCIAL TRANSPORT FLEET
JAMES C. NEWMAN, JR. and CHARLES E. HARRIS *In its* The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 75-91 Jul. 1992
Avail: CASI HC A03/MF A04

NASA is conducting the Airframe Structural Integrity Program in support of the aging commercial transport fleet. This interdisciplinary program is being worked in cooperation with the U.S. airframe manufacturers, airline operators, and the FAA. Advanced analysis methods are under development and an extensive testing program is under way to study fatigue crack growth and fracture in complex built-up shell structures. Innovative nondestructive examination technologies are also being developed to provide large area inspection capability to detect corrosion, disbonds, and cracks. Recent fracture mechanics results applicable to predicting the growth of cracks under monotonic and cyclic loading at rivets in fuselage lap-splice joints are reviewed. Author

N92-30111*# Harvard Univ., Cambridge, MA. Div. of Applied Sciences.
PRELIMINARY RESULTS ON THE FRACTURE ANALYSIS OF MULTI-SITE CRACKING OF LAP JOINTS IN AIRCRAFT SKINS
J. L. BEUTH, JR. and JOHN W. HUTCHINSON *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 93-110 Jul. 1992
Sponsored in part by FAA
(Contract NSF MSM-88-12779)
Avail: CASI HC A03/MF A04

Results of a fracture mechanics analysis relevant to fatigue crack growth at rivets in lap joints of aircraft skins are presented. Multi-site damage (MSD) is receiving increased attention within the context of problems of aging aircraft. Fracture analyses previously carried out include small-scale modeling of rivet/skin interactions, larger-scale two-dimensional models of lap joints similar to that developed here, and full scale three-dimensional models of large portions of the aircraft fuselage. Fatigue testing efforts have included flat coupon specimens, two-dimensional lap joint tests, and full scale tests on specimens designed to closely duplicate aircraft sections. Most of this work is documented in the proceedings of previous symposia on the aging aircraft problem. The effect MSD has on the ability of skin stiffeners to arrest the growth of long skin cracks is a particularly important topic that remains to be addressed. One of the most striking features of MSD observed in joints of some test sections and in the joints of some of the older aircraft fuselages is the relative uniformity of the fatigue cracks from rivet to rivet along an extended row of rivets. This regularity suggests that nucleation of the cracks must not be overly difficult. Moreover, it indicates that there is some mechanism which keeps longer cracks from running away from shorter ones, or, equivalently, a mechanism for shorter cracks to catch-up with longer cracks. This basic mechanism has not been identified, and one of the objectives of the work is to see to what extent the mechanism is revealed by a fracture analysis of the MSD cracks. Another related aim is to present accurate stress intensity factor variations with crack length which can be used to estimate fatigue crack growth lifetimes once cracks have been initiated. Results are presented which illustrate the influence of load shedding from rivets with long cracks to neighboring rivets with shorter cracks. Results are also included for the effect of residual stress due to the riveting process itself. Author

N92-30112*# Federal Aviation Administration, Cambridge, MA. National Transportation Systems Center.
CURRENT DOT RESEARCH ON THE EFFECT OF MULTIPLE SITE DAMAGE ON STRUCTURAL INTEGRITY
P. TONG (Hong Kong Univ. of Science and Technology, Kowloon.), KEMAL ARIN, DAVID Y. JEONG, R. GREIF, JOHN C. BREWER, STEPHAN N. BOBO, and SAM N. SAMPATH (Federal Aviation Administration, Atlantic City, NJ.) *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 111-157 Jul. 1992
Avail: CASI HC A03/MF A04

Multiple site damage (MSD) is a type of cracking that may be found in aging airplanes and which may adversely affect their continuing airworthiness. The Volpe National Transportation Systems Center has supported the Federal Aviation Administration Technical Center on structural integrity research for the past two and half years. The work has focused on understanding the behavior of MSD, detection of MSD during airframe inspection, and the avoidance of MSD in future designs. These three elements of the MSD problem are addressed and a summary of the completed work, the current status, and requirements for future research is provided. Author

N92-30113*# Federal Aviation Administration, Seattle, WA.
STATUS OF THE FAA FLIGHT LOADS MONITORING PROGRAM
TERENCE J. BARNES and THOMAS DEFIORE (Federal Aviation Administration, Atlantic City, NJ.) *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 159-185 Jul. 1992
Avail: CASI HC A03/MF A04

In support of the Federal Aviation Administration Aging Aircraft Research Program, the Agency has established a Flight Loads Data Collection Program for Commercial Aircraft. The objectives of this Program are as follows: (1) review existing data collected by other sources including but not limited to U.S., Foreign, Military, etc.; (2) collect current operational usage data from both large and small transport aircraft; and (3) develop criteria for future generations of transports. This paper presents the status of the various programs which are completed, underway or planned. The FAA will be collecting, storing, and analyzing the data which characterize typical commercial transport operations. The airframe manufacturers will handle the task of calculating the loads and stresses. Author

N92-30114*# Aeronautical Systems Div., Wright-Patterson AFB, OH.
DAMAGE TOLERANCE FOR COMMUTER AIRCRAFT
JOHN W. LINCOLN *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 187-201 Jul. 1992
Avail: CASI HC A03/MF A04

The damage tolerance experience in the United States Air Force with military aircraft and in the commercial world with large transport category aircraft indicates that a similar success could be achieved in commuter aircraft. The damage tolerance process is described for the purpose of defining the approach that could be used for these aircraft to ensure structural integrity. Results of some of the damage tolerance assessments for this class of aircraft are examined to illustrate the benefits derived from this approach. Recommendations are given for future damage tolerance assessment of existing commuter aircraft and on the incorporation of damage tolerance capability in new designs. Author

N92-30115*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DAMAGED STIFFENED SHELL RESEARCH AT NASA. LANGLEY RESEARCH CENTER
JAMES H. STARNES, JR. and VICKI O. BRITT *In its* The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 203-220 Jul. 1992
Avail: CASI HC A03/MF A04

The structural behavior of stiffened fuselage shells with local cracks is influenced by the local deformations and stress gradients near the cracks, and this behavior must be understood to predict fuselage structural integrity and residual strength. As a crack grows, the stiffness and internal load distributions in a stiffened shell change, affecting the local deformations and stress gradients near the crack. Transport fuselage shells are designed to support internal pressure and mechanical loads which cause a geometrically nonlinear response. Research is being conducted at NASA LaRC to develop and demonstrate a verified nonlinear stiffened shell analysis methodology for accurately predicting the global and local behavior of nonlinear stiffened fuselage shells with local cracks and with combined internal pressure and mechanical loads. The nonlinear structural analysis methodology being developed and planned at NASA LaRC for damaged stiffened fuselage shells and the experiments being planned to verify this analysis methodology are summarized in the present paper. Author

N92-30116*# Federal Aviation Administration, Atlantic City, NJ.
FEDERAL AVIATION ADMINISTRATION AGING AIRCRAFT NONDESTRUCTIVE INSPECTION RESEARCH PLAN
CHRIS C. SEHER *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 221-229 Jul. 1992
Avail: CASI HC A02/MF A04

This paper highlights the accomplishments and plans of the Federal Aviation Administration (FAA) for the development of improved nondestructive evaluation (NDE) equipment, procedures, and training. The role of NDE in aircraft safety and the need for improvement are discussed. The FAA program participants, and coordination of activities within the program and with relevant organizations outside the program are also described. Author

N92-30117*# Douglas Aircraft Co., Inc., Long Beach, CA.
INSPECTION OF AGING AIRCRAFT: A MANUFACTURER'S PERSPECTIVE
DONALD J. HAGEMAIER *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 231-247 Jul. 1992
Avail: CASI HC A03/MF A04

Douglas, in conjunction with operators and regulators, has established interrelated programs to identify and address issues regarding inspection of aging aircraft. These inspection programs consist of the following: Supplemental Inspection Documents; Corrosion Prevention and Control Documents; Repair Assessment Documents; and Service Bulletin Compliance Documents. In addition, airframe manufacturers perform extended airframe fatigue tests to deal with potential problems before they can develop in the fleet. Lastly, nondestructive inspection (NDI) plays a role in all these programs through the detection of cracks, corrosion, and disbonds. However, improved and more cost effective NDI methods are needed. Some methods such as magneto-optic imaging, electronic shearography, Diffractor-Sight, and multi-parameter eddy current testing appear viable for near-term improvements in NDI of aging aircraft. Author

N92-30118*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THERMAL QNDE DETECTION OF AIRFRAME DISBONDS
WILLIAM P. WINFREE *In its* The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 249-260 Jul. 1992
Avail: CASI HC A03/MF A04

Thermographic characterization of aircraft bonded lap joints offers a quick noncontacting technique to acquire information for structural integrity assessment. This paper discusses recent research to optimize the technique and determine the limits of its applicability. The temperature of the outer surface of the lap joint is increased by the application of heat flux from either flash or quartz lamp heaters. The time dependence of the surface temperature of the lap joint is imaged radiometrically. Measurements are presented for a range of specimens, ranging from samples fabricated with well characterized disbonds to actual aircraft. A technique for processing these images to enhance the contrast between bonded and disbonded regions of the lap joint is presented. Numerical models of the technique simulate the procedure. These simulations provide a cost efficient method for optimizing the technique by varying parameters such as the time for application of heat. These simulations facilitate the definition of parameters difficult to determine experimentally, such as the minimum air gap required for a disbond to be detected. Good agreement between measurements and these simulations is found. Author

N92-30119*# Iowa State Univ. of Science and Technology, Ames. Center for Aviation Systems Reliability.
NDE RESEARCH EFFORTS AT THE FAA CENTER FOR AVIATION SYSTEMS RELIABILITY
DONALD O. THOMPSON and LISA J. H. BRASCHE *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 261-265 Jul. 1992
(Contract W-7405-ENG-82)
Avail: CASI HC A01/MF A04

The Federal Aviation Administration-Center for Aviation Systems Reliability (FAA-CASR), a part of the Institute for Physical Research and Technology at Iowa State University, began operation in the

Fall of 1990 with funding from the FAA. The mission of the FAA-CASR is to develop quantitative nondestructive evaluation (NDE) methods for aircraft structures and materials including prototype instrumentation, software, techniques, and procedures and to develop and maintain comprehensive education and training programs in aviation specific inspection procedures and practices. To accomplish this mission, FAA-CASR brings together resources from universities, government, and industry to develop a comprehensive approach to problems specific to the aviation industry. The problem areas are targeted by the FAA, aviation manufacturers, the airline industry and other members of the aviation business community. This consortium approach ensures that the focus of the efforts is on relevant problems and also facilitates effective transfer of the results to industry. Author

N92-30120*# Sandia National Labs., Albuquerque, NM.
AGING AIRCRAFT NDI DEVELOPMENT AND DEMONSTRATION CENTER (AANC): AN OVERVIEW
PATRICK L. WALTER *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 267-273 Jul. 1992 Sponsored in part by FAA
Avail: CASI HC A02/MF A04

A major center with emphasis on validation of nondestructive inspection (NDI) techniques for aging aircraft, the Aging Aircraft NDI Development and Demonstration Center (AANC), has been funded by the FAA at Sandia National Laboratories. The Center has been assigned specific tasks in developing techniques for the nondestructive inspection of static engine parts, assessing inspection reliability (POD experiments), developing testbeds for NDI validation, maintaining a FAA library of characterized aircraft structural test specimens, and leasing a hangar to house a high flight cycle transport aircraft for use as a full scale test bed. Author

N92-30121*# Sacramento Air Logistics Center, McClellan AFB, CA. Nondestructive Inspection Div.
NONDESTRUCTIVE INSPECTION PERSPECTIVES
DOUGLAS A. FROOM *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 275-278 Jul. 1992
Avail: CASI HC A01/MF A04

This paper presents ideas for consideration by those concerned with commercial aircraft nondestructive inspection (NDI). The perspective is that of an individual with a background in military aircraft NDI, and important differences are indicated between the commercial NDI and military NDI activities. In particular, it is significantly more expensive to implement some new NDI technology, and therefore, in-depth cost-benifit studies for commercial users are recommended. Author

N92-30132*# Civil Aviation Authority, Canberra (Australia).
AGING COMMUTER AEROPLANES: FATIGUE EVALUATION AND CONTROL METHODS
A. J. EMMERSON *In* NASA. Langley Research Center, The 1991 International Conference on Aging Aircraft and Structural Airworthiness p 367-378 Jul. 1992
Avail: CASI HC A03/MF A04

The loss of reliability in aircraft is caused by two broad classes of problems. There are those problems which are self evident and hazardous rather than catastrophic. These are the problem areas where characteristically there have been multiple overhauls, repairs, and replacements, and where aging really means the results of repair ineffectiveness that accumulates. The other class of the problem is the insidious and potentially catastrophic class. It includes the progressive deterioration of items that are not maintained, and often cannot be maintained because the deterioration cannot be seen. It includes the loss of physical properties in adhesives and other organic compounds, corrosion, and the response of repeated loads. Dealt with here is a currently unnecessarily troublesome aspect of that response. Although we must remain concerned about those types of aircraft which have been certified under a design standard or operational rule which embodies the elementary fail-safe concept and which have not been subjected to a subsequent structural audit, the focus here is on types of aircraft for which fatigue and damage tolerance evaluation was not required as a condition of certification. Author

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GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

A92-46262* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
MICROBURST MODELLING AND SCALING
T. S. LUNDGREN, J. YAO (Minnesota, University, Minneapolis), and N. N. MANSOUR (NASA, Ames Research Center, Moffett Field, CA) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 239, June 1992, p. 461-488. Research supported by University of Minnesota. refs
(Contract NCA2-329)
Copyright

A microburst can be modeled by releasing a volume of fluid that is slightly heavier than the ambient fluid, allowing it to fall onto a horizontal surface. Vorticity develops on the sides of this parcel as it descends and causes it to roll up into a turbulent vortex ring which impinges on the ground. Such a model exhibits many of the features of naturally occurring microbursts which are a hazard to aviation. In this paper this model is achieved experimentally by releasing a volume of salt water into fresh water from a cylindrical dispenser. When care is taken with the release the spreading rate of the surface outflow is measurable and quite repeatable despite the fact that the flow is turbulent. An elementary numerical approximation to this model, based on inviscid vortex dynamics, has also been developed. A scaling law is proposed which allows experiments with different fluid densities to be compared with each other and with the numerical results. More importantly the scaling law makes it possible to compare the model results with real microbursts. Author

A92-46788
REMOTE MEASUREMENTS OF SUPERCOOLED INTEGRATED LIQUID WATER DURING WISP/FAA AIRCRAFT ICING PROGRAM
B. B. STANKOV, E. R. WESTWATER, J. B. SNIDER, and R. L. WEBER (NOAA, Environmental Research Laboratories, Boulder, CO) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 604-611. Previously cited in issue 06, p. 899, Accession no. A91-19247. refs
(Contract DTFA01-90-Z-02005)

A92-46803
ASSESSMENT OF ONE-DIMENSIONAL ICING FORECAST MODEL APPLIED TO STRATIFORM CLOUDS
ARNOLD TUNICK and HENRY RACHELE (U.S. Army, Atmospheric Sciences Laboratory, White Sands Missile Range, NM) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 703-706. Previously cited in issue 06, p. 899, Accession no. A91-19248. refs

N92-28689# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
ATMOSPHERIC TURBULENCE SPECTRA AND CORRELATION FUNCTIONS
R. NOBACK 13 Jun. 1989 73 p
(Contract OV/RLD-937/1)
(NLR-TP-89217-U; ETN-92-91523) Avail: CASI HC A04/MF A01

The derivation of one, two, and three dimensional spectra and correlation functions for isotropic (atmospheric) turbulence and the mutual relations were collected from various sources. Aircraft loads usually are determined using a one dimensional turbulence description. In some cases, a two or even three dimensional description might be preferable. Aircraft loads can then be determined using two dimensional spectra and cross spectra. These types of spectra are described, and an outline of methods to determine aircraft loads is given. ESA

N92-29148* National Aeronautics and Space Administration. Pasadena Office, CA.

MICROWAVE TEMPERATURE PROFILER FOR CLEAR AIR TURBULENCE PREDICTION Patent

BRUCE L. GARY, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 2 Jun. 1992 16 p Filed 27 Nov. 1990 Supersedes N91-23662 (29 - 15, p 2465) (NASA-CASE-NPO-18115-1-CU; US-PATENT-5,117,689; US-PATENT-APPL-SN-618790; US-PATENT-CLASS-73-178R; US-PATENT-CLASS-364-443; US-PATENT-CLASS-374-112; INT-PATENT-CLASS-G01C-21/00) Avail: US Patent and Trademark Office

A method is disclosed for determining Richardson Number, Ri, or its reciprocal, RRi, for clear air prediction using measured potential temperature and determining the vertical gradient of potential temperature, d(theta)/dz. Wind vector from the aircraft instrumentation versus potential temperature, dW/D(theta), is determined and multiplies by d(theta)/dz to obtain dW/dz. Richardson number or its reciprocal is then determined from the relationship Ri = K(d theta)/dz divided by (dW/dz squared) for use in detecting a trend toward a threshold value for the purpose of predicting clear air turbulence. Other equations for this basic relationship are disclosed together with the combination of other atmospheric observables using multiple regression techniques.

Official Gazette of the U.S. Patent and Trademark Office

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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.

A92-44909

LESSONS LEARNED ABOUT INFORMATION MANAGEMENT WITHIN THE PILOT'S ASSOCIATE PROGRAM

CAROL L. JUDGE (USAF, Wright Laboratory, Wright-Patterson AFB, OH) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 1. Columbus, OH, Ohio State University, 1991, p. 85-89. Research supported by DARPA. refs

This paper discusses the lessons learned about information management from work performed to support the Pilot's Associate (PA) program. Within PA information management deals with the flow of information to the pilot and his resultant control responses. It provides control configurations and display formatting that best support the tasks to be accomplished. It is seen that there is the need for the pilot to be able to question the electronic crew member to determine why it reached certain conclusions or made specific recommendations. R.E.P.

A92-44915

SPECIFICATION OF ADAPTIVE AIDING SYSTEMS - INFORMATION REQUIREMENTS FOR DESIGNERS

ROBERT C. ANDES, JR. and WILLIAM B. ROUSE (Search Technology, Inc., Norcross, GA) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 1. Columbus, OH, Ohio State University, 1991, p. 120-125. refs
(Contract F33615-88-C-3612)

Designer's decision making in specifying adaptive aiding systems is considered. A study of design decisions 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 were substantial variations among designers in terms of both decisions made and information used to make the decisions. The implications of these results are considered for types of research studies whose results would be valued by designers. The specific problems facing engineering designers of adaptive aiding systems for advanced aircraft are also addressed. Empirical results of the study and design rules elicited from subjects are presented in terms of a possible belief structure of designers that is used during design. Author

A92-44982

PUTTING THE CONTROL BACK IN AIR TRAFFIC CONTROL - AN ENHANCED UNIVERSAL DEVELOPMENT SIMULATION SYSTEM

LYNNE NICHOLS (Custom Simulation Solutions Corp., Hurst, TX) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 1. Columbus, OH, Ohio State University, 1991, p. 544-549. refs
(Contract DTFA-02-90-C-90583)

A review is presented of the Universal Development Simulation System (UDSS) which will give air traffic controllers real 3D pictures of an aircraft's location. This system will provide controllers and pilots instant maps detailing buildings, towers and runways, radio beacons, both high and low altitude airways and all other necessary information to land at an airport. UDSS employs computer simulation's power to let users plan air traffic improvements such as traffic increases on existing runways, construction of new runways, and the remapping of airways for both of these improvements. R.E.P.

A92-45002

SAFETY VS. ECONOMY, SYSTEM-THEORETIC APPROACH TO THE PROBLEM ANALYSIS

JANUSZ M. MORAWSKI (Academy of Physical Education, Gdansk, Poland) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 679-684. Research supported by LOT Polish Airlines. refs

The multilevel, hierarchical structure of an airline company calls for the use of safety factors-related analyses that are consonant with system-theoretic considerations. While pilots see safety as a directly evident and explicit affair, managers have a more economic appreciation of safety hazards. It is presently shown that such competing perspectives can be reconciled through adherence to the 'scales conformity rule', which requires that information be conveyed at various organizational levels in language appropriate to the scale of operations of those for whom it is intended. O.C.

A92-45064

KNOWLEDGE-SENSITIVE TASK MANIPULATION - ACQUIRING KNOWLEDGE FROM PILOTS FLYING A MOTION-BASED FLIGHT SIMULATOR

JOHN R. BLOOMFIELD (Honeywell Systems and Research Center, Minneapolis; Hamline University, Saint Paul, MN), VALERIE L. SHALIN (New York, State University, Buffalo), and WILLIAM H. CORWIN (Honeywell Systems and Research Center, Minneapolis, MN) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 1068-1073. refs

The domain expert is a major source of knowledge for the designers and developers of automation aids, expert systems, and human-machine interface systems. The process of acquiring knowledge from experts has been highly time-intensive and the resultant knowledge base is often incomplete. An approach to knowledge acquisition that is designed to lead to a more rapid acquisition of information, and to produce a more complete and detailed knowledge base is developed. This approach involves the manipulation of the conditions under which an expert performs. This approach was tested using as the present domain experts four commercial airline pilot training instructors. Their ability to access cockpit instruments while they were flying a Phase II certified, six-degree-of-freedom, motion-based MD-80 flight simulator was varied. The instructors were available for only two hours each. However, using the present knowledge-sensitive task-manipulation approach for a total of eight hours in the simulator environment, large amounts of substantive, detailed knowledge were obtained. Author

A92-45454
MANUAL CONTROL OF VEHICLES WITH TIME-VARYING DYNAMICS
NORIHIRO GOTO (Kyushu University, Fukuoka, Japan) and HIROYUKI MATSUMOTO (Toshiba Co., Komukai Works, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 863-869. refs
(SAE PAPER 912078) Copyright

An experiment was conducted to seek the models of the human pilot controlling a vehicle with time-varying dynamics manually. In the experiment the human pilot controlled basic first-order linear time-varying controlled elements in a compensatory closed-loop fashion for step and random inputs. The analysis of the experimental data has found that for the step input case the human pilot can be modeled as a stationary proportional-plus-integral controller, whereas for the random input case a stationary model with constant coefficients cannot describe the pilot's control behavior sufficiently well. A nonstationary time series analysis suggests that the human pilot's control behavior for the random input case is also time-varying; adapting his characteristics to the changing controlled element dynamics in such a manner that the error and output spectral characteristics do not make appreciable changes with respect to time. Author

A92-45456
A DESIGN OF STRONGLY STABILIZING CONTROLLER
MASAYUKI SUZUKI, SHOHEI NIWA, and SHIN OKAZAWA (Nagoya University, Japan) IN: International Pacific Air and Space Technology Conference and Aircraft Symposium, 29th, Gifu, Japan, Oct. 7-11, 1991, Proceedings. Warrendale, PA, Society of Automotive Engineers, Inc., 1991, p. 883-889. refs
(SAE PAPER 912081) Copyright

A new convenient method for the design of strongly stabilizing controllers is presented. The method is derived by applying the quadratic stabilization method which is developed for the robust stabilization of uncertain systems. Some examples illustrating the design method's effectiveness are adduced. C.A.B.

A92-45489*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
FUTURE DIRECTIONS IN COMPUTING AND CFD
F. R. BAILEY and HORST D. SIMON (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 149-160. refs
(Contract NAS2-12961)
(AIAA PAPER 92-2734) Copyright

In recent years CFD on massively parallel machines has become a reality. This paper summarizes some recent trends both in high performance computing, and in CFD using parallel machines. The long term computational requirements for accomplishing some of the large scale problems in computational aerosciences, and current hardware and architecture trends are discussed. Performance results obtained from the implementation of some CFD applications on the Connection Machine CM-2 and the Intel iPSC/860 at NASA Ames Research Center are presented. It is argued that only massively parallel machines will be able to meet these grand challenge requirements. Author

A92-45492#
THE DESIGN OF A SYSTEM OF CODES FOR INDUSTRIAL CALCULATIONS OF FLOWS AROUND AIRCRAFT AND OTHER COMPLEX AERODYNAMIC CONFIGURATIONS
J. W. BOERSTOEL, S. P. SPEKREIJSE (National Aerospace Laboratory, Amsterdam, Netherlands), and P. L. VITAGLIANO (Alenia Aeronautica, Pomigliano d'Arco, Italy) IN: AIAA Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992, Technical Papers. Pt. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1992, p. 181-191. Research supported by Netherlands Agency for Aerospace Programs. refs
(AIAA PAPER 92-2619) Copyright

For industrial calculations of 3D flows around transport aircraft, a system of CFD codes for flow calculations is developed. This system includes codes for aerodynamic geometry modeling in block-decomposition work, multiblock grid generation, Euler and Navier-Stokes flow calculations, and flow visualization. The codes are tuned to each other. Two examples of this tuning are discussed. Analytic representations for geometric shapes of aerodynamic curves and surfaces are presented that may be used for several tasks in CFD work (geometric modeling of block faces and edges, analytic surface representation in grid generators aerodynamic modeling of surface, refacing of aerodynamic configuration surfaces). Multiblock grid generation is simplified by allowing grid lines to be only C0-continuous over block faces. Block-coupling algorithms for the flow solvers are discussed, that prevent accuracy loss due tc the nonsmoothness of the grid over block faces. Author

A92-45589#
A FAST, IMPLICIT UNSTRUCTURED-MESH EULER METHOD
JOHN C. VASSBERG (Southern California, University, Los Angeles, CA) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 16 p. refs
(AIAA PAPER 92-2693) Copyright

An efficient, time-accurate, unstructured-mesh Euler method is presented. The method is based on an implicit system of equations which is unconditionally stable; each time advance of the implicit problem is solved in an efficient manner with a modified multigrid scheme. The present method introduces an automated approach for defining the sequence of unstructured meshes required for the multigrid algorithm. Other techniques which increase computer throughput for unstructured-mesh problems are also discussed. An NACA 0012, steady-state, grid-adapted solution is provided to illustrate the convergence properties of the multigrid scheme. An unsteady solution about an NACA 64A010 airfoil, pitching in the flutter regime, is included and compared with test data. Author

A92-46629
THE METHOD OF DETERMINANT EQUATIONS IN THE APPLIED THEORY OF OPTIMAL SYSTEMS - SYSTEMS WITH 'RIGID' CONSTRAINTS AND WITH FIXED BOUNDARY CONDITIONS [METOD DETERMINANTNYKH URAVNENII V PRIKLADNOI TEORII OPTIMAL'NYKH SISTEM - SISTEMY S 'ZHESTKIMI' OGRANICHENIIAMI I S ZAKREPLENNYMI KRAEVYMI USLOVIIAMI]
S. O. SIMONIAN (Erevanskii Politekhnicheskii Institut, Yerevan, Armenia) Elektronnoe Modelirovanie (ISSN 0204-3572), vol. 14, May-June 1992, p. 9-14. In Russian. refs
Copyright

A method is proposed for the solution of the Feldbaum problem in linear problems of optimal speed of response in the case of real eigenvalues of the matrix of the system of main variables. The problem of oscillations around the center of gravity of an autopiloted aircraft is considered as an example. L.M.

A92-46748
LINEAR QUADRATIC MINIMAX CONTROLLERS
LAURENT E. GHAOUI, ALAIN CARRIER, and ARTHUR E. BRYSON, JR. (Stanford University, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 4, July-Aug. 1992, p. 953-961. refs
Copyright

Minimax methods are proposed for the analysis and design of controllers for the best controls with the worst initial conditions, worst parameter changes with specified quadratic norms, and worst disturbances with specified integral-square norms. The worst initial conditions are the only forcing functions; disturbances are regarded as an added set of feedback controls whose magnitudes are limited by negative weights in the performance index. The minimax value of the performance index is easily calculated as the maximum eigenvalue of a steady-state Liapunov or Riccati matrix. There is a lower bound on the disturbance weights in the performance index; at this bound, the controller design is identical to the H-infinity controller design. There is also an upper bound on the norm of the parameter changes; at this value, the closed-loop system goes unstable, and the corresponding parameter change vector is almost the same as the corresponding vector obtained by 'real mu' analysis, the only difference being the use of a quadratic norm instead of an infinity norm. Author

A92-46762
TWO VARIATIONS OF CERTAINTY CONTROL
SALVATORE ALFANO (U.S. Air Force Academy, Colorado Springs, CO) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, no. 4, July-Aug. 1992, p. 1040-1043. refs

Two variations of certainty control were investigated in order to determine their ability to minimize lateral velocity changes of a hypervelocity orbital vehicle in a head-on, 10-deg out-of-plane intercept. The first variation used a control effectiveness ratio to regulate thrusting times, whereas the second variation changed the spherical constraint function to an ellipsoidal one. Neither variation simultaneously reduced maneuvering cost and miss distance compared with the original formulation of certainty control. This indicates that the original formulation effectively uses the state deviations to minimize maneuvering coasts while maintaining a high level of accuracy. The ellipsoidal variation demonstrated a tradeoff in accuracy to reduce maneuvering costs, a choice to be made based on mission constraints. L.M.

A92-46817 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
WIND-TUNNEL COMPRESSOR STALL MONITORING USING NEURAL NETWORKS
CHING F. LO and G. Z. SHI (Tennessee, University, Tullahoma) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 736-738. Research supported by USAF and University of Tennessee-Calspan Center for Space Transportation and Applied Research. Previously cited in issue 18, p. 3181, Accession no. A91-44266. refs
(Contract NAG2-596; NAGW-1195)
Copyright

A92-47035
NUMERICAL GRID GENERATION IN COMPUTATIONAL FLUID DYNAMICS AND RELATED FIELDS; PROCEEDINGS OF THE 3RD INTERNATIONAL CONFERENCE, UNIVERSIDAD POLITECNICA DE CATALUNA, BARCELONA, SPAIN, JUNE 3-7, 1991
A. S. ARCILLA, ED., J. HAEUSER, ED. (ESTEC, Noordwijk, Netherlands), P. R. EISEMAN, ED. (Columbia University, New York; Program Development Corp., White Plains, NY), and J. F. THOMPSON, ED. (NSF, Engineering Research Center for Computational Field Simulation, Mississippi State, MS) Conference sponsored by CICYT, Instituto Nacional de Tecnica Aeroespacial of Spain, CEC, et al. Amsterdam and New York, North-Holland, 1991, 1011 p. For individual items see A92-47036 to A92-47097. (ISBN 0-444-88948-5) Copyright

Various papers on numerical grid generation in CFD and related fields are presented. The general topics addressed are: adaptive structured and unstructured grid generation, aerospace applications, internal flow configuration, general applications, interactive grid generation, structured and unstructured grid generation, grid quality, hydrodynamic applications, grids of mixed structure, and surface grid generation. C.D.

A92-47043
ANISOTROPIC CONTROL OF MESH GENERATION BASED UPON A VORONOI TYPE METHOD
M. G. VALLET (INRIA, Le Chesnay; Dassault Aviation, Saint-Cloud, France), F. HECHT (INRIA, Le Chesnay, France), and B. MANTEL (Dassault Aviation, Saint-Cloud, France) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 93-103. refs
Copyright

An automatic mesh generator whose data is the solution of a previous computation is proposed. A directional error estimator leads to the definition of a control space including some anisotropic information, or equivalently a Riemannian metric for mesh regeneration. The mesh fineness is controlled by creating points and its stretch by swapping edges. The obtained meshes are adapted to the given solution and can be constituted on stretch elements. Author

A92-47050
ADAPTIVE PARALLEL MESHES WITH COMPLEX GEOMETRY
ROY WILLIAMS (California Institute of Technology, Pasadena) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 201-213. refs
Copyright

The automatic creation and adaptive refinement of an unstructured mesh within a complex geometry such as the space surrounding an airplane are discussed. This may be formulated as two distinct parts; a nonparallel part requiring global knowledge which automatically creates a coarse compatible mesh, and a parallel local refinement algorithm, which refines the mesh until simulation can begin, then adaptively refines it according to the progress of the simulation. Background-mesh methods, sequential and parallel, offer some promise if good numerical algorithms are available. Sequential advancing front methods combined with the parallel Rivara refinement algorithm are a good choice. Author

A92-47051* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
GRIDDING STRATEGIES AND ASSOCIATED RESULTS FOR WINGED ENTRY VEHICLES
K. J. WEILMUENSTER, R. E. SMITH, and E. L. EVERTON (NASA, Langley Research Center, Hampton, VA) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 217-228. refs
Copyright

Two volume grid strategies based on similar software are presented for a geometrically complex entry vehicle. It is shown that quick relatively simple grid generation techniques can be used to construct computational grids about entry vehicles with nontrivial geometric complexity. Particular attention is given to both single- and dual-block grid topologies for a lifting body and solution generated on each grid. Results indicate that the grid topology can have an effect on the nature of the solution. O.G.

A92-47053
AN UNSTRUCTURED MESH GENERATION ALGORITHM FOR THREE-DIMENSIONAL AERONAUTICAL CONFIGURATIONS
LUCA FORMAGGIA (Alenia Aeronautics, Turin, Italy) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 249-260. refs
Copyright

An unstructured 3D mesh generation strategy aimed at solving compressible flows around aeronautical configurations is presented. The proposed algorithm is based on a front advancing technique. Nodes and elements of the mesh are generated at the same time in accordance to a predefined mesh density distribution. It is concluded that unstructured grid-based methodologies are capable of providing a useful tool for complex 3D aerodynamical analysis. O.G.

A92-47055* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

GRID GENERATION AND COMPRESSIBLE FLOW COMPUTATIONS ABOUT A HIGH-SPEED CIVIL TRANSPORT CONFIGURATION

J. S. ABOLHASSANI, J. E. STEWART, N. FARR (Computer Sciences Corp., Hampton, VA), R. E. SMITH, P. W. KERR, and E. L. EVERTON (NASA, Langley Research Center, Hampton, VA) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 273-285. refs

Copyright

Techniques and software are discussed for generating grids about a high-speed civil transport configuration. The configuration is defined by a computer-aided design system in wing, fuselage, tail and engine-nacelle components. Grid topology and the surfaces outlining the blocks of the topology are computed with interactive software. The volume grid is computed using software based on transfinite interpolation and Lagrangian blending functions. Several volume grids for inviscid and viscous flow have been generated using this system of codes. Demonstration flowfields around this vehicle are described. Author

A92-47066

INTERACTIVE GENERATION OF STRUCTURED/UNSTRUCTURED SURFACE MESHES USING ADAPTIVITY

Y. LAUZE, R. CAMARERO, and H. YANG (Ecole Polytechnique, Montreal, Canada) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 491-502. Research supported by Canadair Group Bombardier, Inc., and Centre de Recherche Informatique de Montreal. refs

Copyright

An adaptive meshing procedure for unstructured grids has been developed which is based on objective mesh functions, namely, grid density and grid elongation functions. Kriegging techniques are used to specify and evaluate the grid functions. The proposed procedure iteratively refines or coarsens the grid locally based on the value of the objective mesh function. The initial mesh is generated by a transfinite interpolation. The convergence to a final surface grid that matches the required characteristics is based on triangular subdivision, node relaxation, node reconnection and degeneration control. This procedure has been implemented in an integrated computer software package for a case of a wing-fuselage configuration. O.G.

A92-47069

SIMPLE DIAGNOSIS FOR THE QUALITY OF GENERATED GRID SYSTEMS

SUSUMU SHIRAYAMA (Institute of Computational Fluid Dynamics, Tokyo, Japan) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 547-555. refs

Copyright

A simple diagnosis is proposed for the quality of a grid system in a flow solver based on generalized curvilinear coordinates. It is shown that an efficient improvement of the grid system is accomplished by using this diagnosis. The diagnosis consists of three parts: searching a model equation which has a characteristic feature of the Navier-Stokes equations, solving the model equation effectively, and identifying the region to be improved. One grid system modification cycle is complete with this diagnosis in a few minutes using a scalar computer with a speed of about 5 MFLOPS. C.D.

A92-47078

PATCH-INDEPENDENT STRUCTURED MULTIBLOCK GRIDS FOR CFD COMPUTATIONS

JOSE M. DE LA VIUDA (Construcciones Aeronauticas, S.A., Division de Proyectos, Getafe, Spain), JEAN DIET (Aerospatiale, Division Engins Tactiques, Chatillon, France), and GILBERT RANOUX (Control Data France, Paris) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 703-715. refs

Copyright

The process of generating a patch-independent structured multiblock grid starting from a CAD surface definition is described. The grid topology and parameters are first defined within the available CAD system, and the grid generator and previously extracted data are then used to generate the body-fitted grid. Some examples are shown. C.D.

A92-47081

GENERATION OF EFFICIENT MULTIBLOCK GRIDS FOR NAVIER-STOKES COMPUTATIONS

TORSTEN BERGLIND and PETER ELIASSON (Aeronautical Research Institute of Sweden, Bromma) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 769-780. refs

Copyright

The aim of this work is to develop a general purpose system that converts a previously generated multiblock Euler grid to a multiblock Navier-Stokes grid. The basic concept is first to displace the surface grids at the configuration in the normal direction a distance that corresponds to the thickness of the boundary layer. Grid points in previously generated blocks are adjusted to these new boundaries by transfinite interpolation. New blocks are inserted in the void between each displaced grid surface and the original grid surface. The out-of-surface grid lines will thereby become almost orthogonal to the configuration surface. The use of O-O topology is ideal to resolve the boundary layer, since grid points are added only in the vicinity of the solid walls. An example of generation of a Navier-Stokes grid around the new Swedish fighter aircraft JAS 39 Gripen is demonstrated. Author

A92-47083

A GEOMETRY-INTEGRATED APPROACH TO MULTIBLOCK GRID GENERATION

KEVIN L. SMIT and T. Y. SU (Boeing Commercial Airplane Group, Seattle, WA) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 795-803. refs

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CFD is widely used to obtain detailed descriptions of the flowfields around aircraft. This paper describes an approach to multiblock grid generation in CFD in which geometry continuity is maintained and the required grid generation capability is produced using the Aero Grid and Paneling System (AGPS). The process is geometrically accurate throughout, with grid points representing the geometrical surface being extracted directly from the original surface lofts. The approach reduces or eliminates development and purchase costs because the AGPS source code is not modified. A playback feature of the approach allows jobs to be repeated. Engineering time is saved for the inexperienced user, for the first-time configuration, and for the aircraft design cycle. C.D.

A92-47089

THE CONSTRUCTION, APPLICATION AND INTERPRETATION OF THREE-DIMENSIONAL HYBRID MESHES

J. A. SHAW, J. M. GEORGALA, A. J. PEACE, and P. N. CHILDS (Aircraft Research Association, Ltd., Bedford, England) IN: Numerical grid generation in computational fluid dynamics and related fields; Proceedings of the 3rd International Conference, Barcelona, Spain, June 3-7, 1991. Amsterdam and New York, North-Holland, 1991, p. 887-898. Research supported by Ministry of Defence Procurement Executive. refs
Copyright

The hybrid structured-unstructured approach to mesh generation, whereby regions of regularly ordered hexahedral elements are combined with irregularly arranged tetrahedral volumes, offers the potential of attaining a harmonious balance between mesh quality, efficiency and flexibility. In this paper, techniques developed for the generation, use and graphical analysis of such hybrid meshes are discussed. The structured regions of mesh are constructed using the multiblock approach, while the unstructured regions are defined using the Delaunay algorithm. These regions of alternative mesh type are interfaced using an explicitly defined layer of tetrahedral and pentahedral elements. Examples of the application of the hybrid grid approach are shown for both civil and military aircraft. Particular emphasis on the interpretation of hybrid meshes is given to the creation of, and interpolation of data onto, planes through the grid and the visualization of all mesh elements within a given region. Author

A92-47534
DOUBLE DENSITY RECORDING ACQUISITION AND PLAYBACK
PAUL ROTH (Datatape, Inc., Pasadena, CA) IN: ITC/USA/'91; Proceedings of the International Telemetering Conference, Las Vegas, NV, Nov. 4-7, 1991. Research Triangle Park, NC, Instrument Society of America, 1991, p. 433-448.
Copyright

This paper discusses signal performance of longitudinal Double Density acquisition recordings made on flight recorders and reproduced on a single laboratory ground station recorder. It includes comparisons with standard bandwidth recording signal performance. Author

A92-47535
INTERNATIONALIZATION OF TELEMETRY SYSTEMS
WILLIAM ANDERSON (Loral Data Systems, Sarasota, FL) IN: ITC/USA/'91; Proceedings of the International Telemetering Conference, Las Vegas, NV, Nov. 4-7, 1991. Research Triangle Park, NC, Instrument Society of America, 1991, p. 449-454. refs
Copyright

The importance of providing local language user interfaces on telemetry systems is emphasized. Attention is then given to two basic approaches to converting systems to a foreign language interface: localization and internationalization. The discussion covers character sets, user-defined characters, input method, collating sequence, date and time, numeric formats, monetary symbols, terminals and printrs, standards, and implementation. V.L.

A92-47537
NEW BOEING FLIGHT TEST DATA ACQUISITION SYSTEMS
LEE H. ECCLES and LAWRENCE A. MALCHODI (Boeing Commercial Airplane Group, Seattle, WA) IN: ITC/USA/'91; Proceedings of the International Telemetering Conference, Las Vegas, NV, Nov. 4-7, 1991. Research Triangle Park, NC, Instrument Society of America, 1991, p. 463-469.
Copyright

Two new data acquisition systems are described. One of these systems will be used to investigate problems on aircraft which are being flown by the airlines in normal airline service. The second system is intended for use as the data acquisition system during the certification of the new 777 airplane. The two systems will differ in physical size, capacity, and the recorder being used. They are expected to use as much of the same hardware and software as possible. This paper discusses the design of both systems. Author

A92-48220
AN EXPLANATION-BASED-LEARNING APPROACH TO KNOWLEDGE COMPILATION - A PILOT'S ASSOCIATE APPLICATION
KEITH R. LEVI (Maharishi International University, Fairfield, IA), DAVID L. PERSCHBACHER (Alliant TechSystems, Inc., Minneapolis, MN), MARK A. HOFFMAN (ISX Corp., Westlake Village, CA), CHRISTOPHER A. MILLER, BARRY B. DRUHAN (Honeywell Systems and Research Center, Minneapolis, MN), and VALERIE L. SHALIN (New York, State University, Buffalo) IEEE Expert (ISSN 0885-9000), vol. 7, no. 3, June 1992, p. 44-51. refs
(Contract F33615-88-C-1739)
Copyright

The application of explanation-based learning as part of a larger knowledge compilation system for automating the development and maintenance of associate knowledge bases is addressed. Knowledge compilation restructures an existing system or knowledge base to increase usability, efficiency and consistency. Attention is given to the Pilot's Associate system, a coordinated suite of five expert systems that help the pilot of an advanced tactical fighter aircraft. R.E.P.

A92-48440
A HIGH PERFORMANCE GENERAL PURPOSE PROCESSING ELEMENT FOR AVIONIC APPLICATIONS
MARK S. RUSSELL, JAMES C. HANSEN (Unisys Electronic and Information Systems Group, Eagan, MN), and LAWRENCE J. MERBOTH (AT&T Bell Laboratories, Whippany, NJ) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 153-159.
Copyright

The Unisys/AT&T General Purpose Processing Element (GPPE) module is described. The GPPE, which is based upon next-generation reduced instruction set computer (RISC) microprocessor technology, combines the 32-b instruction set architecture (ISA) and 33-MHz operation. Using a commercial ISA and open architecture results in the most cost-effective, full-featured, militarized design available on a single-width SEM-E module. Other GPPE features include a multilayer data security mechanism and extensive features to protect classified data. The 6 Mbytes of SRAM and 512 kbytes of EEPROM available on the GPPE are consistent with large RISC addressing spaces and real-time operating system requirements. Support of the Joint Integrated Avionics Working Group two-level maintenance concepts is provided. I.E.

A92-48447
GLOBAL MEMORY IN THE PAVE PACE ARCHITECTURE
KENNETH R. LEEPER (Boeing Defense and Space Group, Seattle, WA) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 221-226. refs
Copyright

The Boeing Company is involved in independent research and development activity targeted at studying the partitioning and system control protocols of the Pave Pace architecture. One aspect of the system being investigated is the use of data coupling, involving the implementation of a globally accessible memory called the system virtual memory (SVM) for each computational bus in the system. The use of this SVM would have a dramatic impact on system control protocols, fault tolerance, and software partitioning in the resulting system design. The SVM described here is a version formalized from the Air-to-Air Attack Management contract. Specific topics include a conception description of the SVM; a summary of its operation and intended use; and its impact on system control protocols, fault tolerance and failure recovery, and software partitioning. I.E.

A92-48485
SYSTEMS SIMULATION OF AN ADVANCED AVIONICS COMSEC UNIT
LILLY BONDIE and BRIAN DEITRICH (Motorola, Inc., Government Electronics Group, Scottsdale, AZ) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 1. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 480-484.

The authors discuss JAID (JIAWG/AACU Interoperability Demonstration), the simulation of the AACU (Advanced Avionics COMSEC Unit) in an integrated avionics system. The AACU is the next generation of avionics COMSEC (communications security) devices. The simulation model of the AACU involves doing a gate-level model of the AACU bus interface hardware and a behavioral model of the functionality of the rest of the AACU. The AACU functionality demonstrated by the behavioral model involves emulating custom LSI and several microprocessors which perform the black box COMSEC functionality of the AACU. The behavioral model emulates the correct timing, state transition, and COMSEC functionality of the AACU. Issues involved in writing a behavorial model for a mixed-mode (behavioral and gate-level) simulation are emphasized here. I.E.

A92-48489
APPLYING ADVANCED DIGITAL SIMULATION TECHNIQUES IN DESIGNING FAULT TOLERANT SYSTEMS
VINCENT P. CALANDRA (Protocol, Mt. Olive, NJ) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 508-514. Research supported by USAF. refs
Copyright

Protocol, a services organization that is providing simulation solutions for the development of digital systems, is discussed. By leveraging the latest in design simulation technology, Protocol has addressed the problems associated with integrating today's most complex systems. The author describes the capabilities developed by Protocol, and how they can be applied to the development of complex fault-tolerant systems. It is noted that the methodologies and techniques developed and applied by Protocol have proven that anomalies in system designs can be located and corrected early in the development process through the use of gate level system simulation (GLSS). Protocol's concurrent hardware and software enabler (CHASE) provides the ability to debug software running on gate-level models of system hardware, thereby providing a software/hardware integration environment prior to fabrication. GLSS and CHASE together provide powerful capabilities needed by today's fault tolerant system designer. I.E.

A92-48502
AVIONICS SOFTWARE REUSABILITY OBSERVATIONS AND RECOMMENDATIONS
BRIAN J. SHELBURNE (Wittenberg University, Springfield, OH) and MARC J. PITARYS (USAF, Wright Laboratory, Wright-Patterson AFB, OH) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 614-619. refs
(Contract F49620-88-C-0053)

Attention is given to the Common Ada Missile Packages (CAMPs), a large collection of generic real-time embedded missile software that allows users to implement many applications, such as navigation routines, Kalman filters, and mathematical operations. In addition to a library of Åreusable' software, a parts engineering system (PES) was developed under the CAMP program. The use of CAMP for avionics software applications was investigated. It was found that CAMP in its current state was not suitable for avionics applications. The attempts to create avionics software with CAMP led to an abundance of observations concerning the writing and use of reusable software for avionics applications. The results of the avionics software reuse research are described. The authors also identify some of the errors found in the CAMP software and list recommendations that need to be adopted if widescale application of reusable software is to be a success. I.E.

A92-48506
A NEW DEVELOPMENT IN EMBEDDED COMPUTER PERFORMANCE MEASUREMENT
DIANE KOHALMI, JOHN NEWPORT (U.S. Navy, Naval Avionics Center, Indianapolis, IN), DIANE PAUL, CHUCK ROARK, and DAVID G. STRUBLE (Texas Instruments, Inc., Defense Systems and Electronics Group, Dallas) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 633-639.

The authors report on the results of Phase I of the Advanced Avionics Technology Demonstration (AATD) Embedded Computer Performance Measurement (ECPM) program being performed by Texas Instruments (TI) for the Naval Avionics Center (NAC). During Phase I of the AATD program, novel techniques were developed to measure spare processing throughput and I/O for use in comparing different embedded computer systems and to measure spare processing throughput and spare I/O percentages in support of US government standards such as TADSTAND D, which defines Navy policy requirements for computer reserves. TI used its MIL-STD-1750A based Mission Display Processor (MDP), developed for the YF-22 ATF DEM/VAL program, as the initial target computing system for this effort. The cornerstone of the benchmark is a NAC developed navigation program which was hosted on a VAX and retargeted by TI to its MDP. I.E.

A92-48513
EXPERT AVIONICS CODE MODIFICATION
JAMES S. WILLIAMSON (USAF, Wright Laboratory, Wright-Patterson AFB, OH) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 677-680. refs

A description is given of the Expert Avionics Code Modification (EACM) system, a software environment and a collection of embedded tools which function together to provide a capability for post-development support for avionics software written in the Ada programming language. The EACM system includes four main tools: Connectivity Analyzer (CA), Code Performance Anomaly Detector (CPAD), Shuffler, and Rippler (Side-Effect Analyzer). The purpose of this Ada avionics maintenance/enhancement system is to reduce the amount of resources (i.e., time, cost, and manpower) required to maintain software for processors utilized in avionics applications. Anticipated benefits of the EACM system include increased and easier program understanding, leading to a lower learning curve for new project members; fewer maintenance-generated Åbugs'; and more expedient and less costly enhancements. I.E.

A92-48515
VERIFICATION AND VALIDATION OF F-15 AND S/MTD UNIQUE SOFTWARE
F. L. TUTTLE and R. L. KISSLINGER (McDonnell Aircraft Co., Saint Louis, MO) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 690-697.

Four separate operational flight programs (OFPs) were developed by five vendors, using seven computer languages, and were integrated for use in the STOL (short takeoff and landing)/Maneuver Technology Demonstrator (S/MTD). The verification and validation (V & V) process used was very successful, as evidenced by the fact that very few problems have been encountered during the test program, and no flights were delayed as a result of software anomalies. The authors provide an overview of the V & V approach used by MCAIR and its suppliers. The approach is not a management breakthrough; rather, it is the application of well-known, but often neglected, principles of engineering management, particularly attention to detail. Emphasis is placed on the V & V of the flight critical software for the flight controllers. I.E.

A92-48518
PARTITIONED SOFTWARE SUPPORT CONCEPT FOR MODULAR EMBEDDED COMPUTER SOFTWARE
RICHARD E. NEESE, A. S. BRANTLEY, and MARC J. PITARYS (USAF, Wright Laboratory, Wright-Patterson AFB, OH) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 709-716. refs
(Contract F33615-88-C-1713)
The authors describe research directed at defining a partitioned software support concept for modular embedded computer software (ECS) for distributed, fault-tolerant avionics ECS architectures. In particular, they describe the research, model definition, and prototype development for a preliminary modular ECS partitioned software support concept. It is noted that new approaches in this area must emphasize modifications of behavioral rather than static aspects of mission profile components. The foundation is a software information representation scheme which handles the convoluted mappings between mission scripts, operational flight program software components, and processing hardware elements. It must cater to both the operating command (e.g., TAC) and the supporting command (AFLC) perspectives and provide automated application generators which expedite definition and implementation of mission scripts. I.E.

A92-48520
A NEURAL NETWORK BASED POSTATTACK DAMAGE ASSESSMENT SYSTEM
PAUL WANG and LIONEL MENEGOZZI (ITT Avionics, Nutley, NJ) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 724-729. refs
Copyright
Key elements of an automated damage assessment (ADA) will include ground-based sensors to survey and measure postattack damages, communication networks to link sensors, a survival recovery center (SRC), a runway repair team (or robots) for rapid response, and advanced signal processors to perform the search and optimization processes for the 'best' airbase recovery plan. To meet the USAF ADA requirements, ITT Avionics has proposed the development of a hybrid signal processor. The system will consist of algorithmic processors and neural networks. To improve DA performance, key DA functions are implemented by neural networks. Due to the intrinsic nature of distributed processing power, the neural network not only provides the high throughput required for DA but it also achieves fault tolerance and graceful degradation, which are extremely important for the Rapid Runway Repair program. I.E.

A92-48527
IDENTIFYING DESIGN REQUIREMENTS USING INTEGRATED ANALYSIS STRUCTURES
DANIEL E. SNYDER (Research Designs, Inc., Beavercreek, OH), MICHAEL D. MCNEESE (USAF, Armstrong Laboratory, Wright-Patterson AFB, OH), and BRIAN S. ZAFF (Logicon Technical Services, Inc., Dayton, OH) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 786-792. refs
Copyright
The authors present some of the analytical and design foundations for an integrated analysis structure for knowledge acquisition and design. Concept maps, IDEF (integrated computer-aided manufacturing definition), and storyboards are combined into an integrated structure for knowledge representation, called cognitive maps, and a hypermedia-based analytical framework is established using graphical spreadsheets. The authors describe the preliminary results of a project to define this hypermedia environment and integrated software. I.E.

A92-48557
THE APPLICATION OF MULTIMEDIA EXPERT SYSTEMS TO THE DEPOT LEVEL MAINTENANCE ENVIRONMENT
BRIAN FORD and IRA GORDON (AIL Systems, Inc., Melville, NY) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 1038-1041.
Copyright
The authors assert that depot level bench maintenance and repair can be significantly improved through the use of integrated multimedia expert systems. These integrated systems take advantage of advances in computer interface technology to provide the technician with text, still and full-motion graphics, animation, and sound. The authors present some of their experiences in developing this type of system to provide technical support for depot level maintenance. Specifically, the authors participated in the development of an expert system that is used by bench technicians to isolate and repair faults in analog shop replaceable units (SRUs) used in the avionic subsystem of a military aircraft. The SRU Test and Diagnostics Expert System was developed to perform fault isolation and troubleshooting using standard bench equipment, such as an oscilloscope, digital voltmeter and an SRU specific test set. I.E.

A92-48565
AIRCRAFT ROUTE OPTIMIZATION USING ADAPTIVE SIMULATED ANNEALING
KEITH KASTELLA (Unisys Corp., Electronic and Information Systems Group, Eagan, MN) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 1123-1129. refs
Copyright
It is demonstrated that simulated annealing (SA) is a viable optimization method for use in route optimization for aircraft flying in tactical attack roles at low altitude deep in enemy territory. It is found that adaptive control of the temperature based on a heuristic measure of equilibrium greatly reduces the algorithm's sensitivity to the cooling rate while giving a 5- to 10-fold speed-up with no adverse impact on the quality of the solutions produced. These results scale nearly linearly with problem size. I.E.

A92-48569
DEVELOPING INTELLIGENT AUTOMATIC TEST EQUIPMENT
WILLIAM R. SIMPSON and JOHN W. SHEPPARD (Arinc Research Corp., Annapolis, MD) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 1206-1213. refs
Copyright
The authors discuss internal research of the past 10 years which led to the evolution of several maintenance tools and an architecture for intelligent ATE (automatic test equipment). Specifically, the objectives of the research program, some of its results, and its current applications are reviewed. A demonstration intelligent ATE system consisting of a Racal-Dana VXI, instruments-on-a-board automatic test unit for an AV8B power supply is described, and the capabilities of this system and its implications for more generic ATE architectures are discussed. I.E.

A92-48794#
BUWICE - AN INTERACTIVE ICING PROGRAM APPLIED TO ENGINE INLETS
SCOTT EBERHARDT, BYOUNGSOO KIM, HONAM OK, WEI-LIN LI, DAVE TAFLIN (Washington, University, Seattle), and BAHMAN NAMDAR (Boeing Commercial Airplane Group, Seattle, WA) AIAA,

SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 9 p. refs
(AIAA PAPER 92-3179) Copyright

BUWICE is a user friendly, X-Window based software package written for ice accretion predictions on airfoils and axisymmetric engine inlets. The purpose of this paper is to demonstrate an application of a graphical user interface (GUI) that makes a complicated engineering application user friendly and to show its application to generic engine inlets. The GUI allows the user to control the flow of the program via pull-down menus, dialog boxes and push bottons. The code modules required in an icing prediction include a Navier-Stokes flow solver, an icing trajectory analysis code, an icing thermodynamics module, and, finally, an icing accretion module. Despite the complexity of each module, BUWICE retains the simplicity of a PC or MacIntosh application with its look-and-feel interface. The details of the program are discussed and several validation runs are demonstrated. Some specific, detailed data obtained from the code cannot be presented here due to the proprietary nature of the results. Author

A92-48802#
DYNAMIC TURBINE ENGINE COMPRESSOR CODE (DYNTECC) - THEORY AND CAPABILITIES
A. A. HALE and M. W. DAVIS (Sverdrup Technology, Inc., Arnold AFB, TN) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 12 p. Research supported by USAF. refs
(AIAA PAPER 92-3190)

The capabilities of DYNTECC, a one-dimensional stage-by-stage axial compression mathematical model, are reviewed. The code uses a finite difference technique to simultaneously solve the mass, momentum, and energy equations with turbomachinery source terms (e.g., mass bleed, blade forces, and shaft work); the source terms are determined from a complete set of stage characteristics. DYNTECC has the capability to analyze the post-stall behavior as well as predict the onset of system instability. The analysis capabilities of DYNTECC are illustrated for various applications. V.L.

A92-48903#
DERIVATION OF ABCD SYSTEM MATRICES FROM NONLINEAR DYNAMIC SIMULATION OF JET ENGINES
NANAHISA SUGIYAMA (National Aerospace Laboratory, Chofu, Japan) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 9 p. refs
(AIAA PAPER 92-3319) Copyright

A method is presented for deriving a linearized plant model in the form of ABCD system matrices from a nonlinear dynamic simulation. To illustrate the capabilities of the software developed here, ABCD matrices of a two-spool turbofan engine are obtained and compared against actual engine data. The sensitivity to perturbation and the formula used, the linearity of state derivatives, and model uncertainty are discussed. In the example, reasonable results are obtained with 2-percent perturbation and a three-point Lagrange formula. V.L.

A92-48910#
EXPERT SYSTEMS FOR THE TROUBLE-SHOOTING AND THE DIAGNOSTICS OF ENGINES
GIOVANNI TORELLA (Accademia Aeronautica, Pozzuoli, Italy) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 13 p. refs
(AIAA PAPER 92-3327) Copyright

A study was conducted to assess the possibility of developing expert systems for the trouble-shooting and diagnostics of both reciprocating and gas turbine engines. It is shown that the necessary information for constructing knowledge bases can be obtained from overhaul manuals or direct experience accumulated during the engine service life. For diagnostics, suitable knowledge bases can be built using engine simulation codes. Expert systems can be created using both procedural and declarative languages, with emphasis on full interaction with the user. Applications of expert systems for the trouble-shooting and diagnostics of engines are discussed. V.L.

N92-28245# Naval Postgraduate School, Monterey, CA.
NPSNET: FLIGHT SIMULATION DYNAMIC MODELING USING QUATERNIONS M.S. Thesis
JOSEPH M. COOKE Mar. 1992 62 p
(AD-A247484) Avail: CASI HC A04/MF A01

The Naval Postgraduate School (NPS) has actively explored the design and implementation of networked, realtime, three-dimensional battlefield simulations on low cost, commercially available graphics workstations. The most recent system, NPSNET, has improved in functionality to such an extent, that it is considered a low cost version of the Defense Advanced Research Project Agency's (DARPA) SIMNET system. In order to reach that level, it was necessary to economize in certain areas of the code so that real-time performance occurred at an acceptable level. One of those areas was in aircraft dynamics. However, with 'off-the-shelf' computers becoming faster and cheaper, real-time and realistic dynamics are no longer an expensive option. The realistic behavior can now be enhanced through the incorporation of an aerodynamic model. To accomplish this task, a prototype flight simulator was built that is capable of simulating numerous types of aircraft simultaneously within a virtual world. Beside being easily incorporated into NPSNET, such a simulator will also provide the base functionality for the creation of a general purpose aerodynamic simulator that is particularly useful to aerodynamic students for graphically analyzing differing aircraft's stability and control characteristics. This system is designed for use on a Silicon Graphics workstation and uses the GL libraries. GRA

N92-28581# Technische Univ., Delft (Netherlands). Faculty of Aerospace Engineering.
INVERSE CONTROL PROBLEMS: MATHEMATICAL PRELIMINARIES, SYSTEM THEORETICAL APPROACHES, AND THEIR APPLICATIONS TO AIRCRAFT DYNAMICS
E. S. L. H. WIRYOHADIATMOJO Oct. 1991 160 p
(LR-665; ETN-92-91403) Avail: CASI HC A08/MF A02

The concept of inverse control problems in multivariable systems is to determine the characteristics of unknown inputs when the characteristics of outputs are known a priori or prescribed. An attempt to provide systematically the necessary mathematical models to describe such problems is reported. By adopting the system theoretical approach, system inverses are constructed using transfer function and state space methods to study the behavior of the dynamics of such systems. The unknown inputs are found to be the outputs of these inverses. Additionally necessary and sufficient conditions for a class of reproducible outputs and for system invertibility are derived. ESA

N92-28635# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
HYPERBOLIC GRID GENERATION WITH BEM SOURCE TERMS
M. H. L. HOUNJET 9 Oct. 1990 14 p Presented at the International Association for Boundary Element Methods, Rome, Italy, 15-19 Oct. 1990
(Contract NIVR-01904-N)
(NLR-TP-90334-U; ETN-92-91448) Avail: CASI HC A03/MF A01

A method for the generation of O type grids about transverse cross sections of transport type aircraft is presented. The method combined a hyperbolic grid generation scheme with source terms obtained with a Boundary Element Method (BEM) in such a way that O type grids around fairly complex shapes with concavities can be generated easily. The component of the method, a boundary element method, a method to generate grids with a boundary element method, and the hyperbolic grid generation scheme are described, and applications are shown. ESA

N92-29188# Mei Associates, Inc., Lexington, MA.
DESIGN SPECIFICATIONS FOR THE ADVANCED INSTRUCTIONAL DESIGN ADVISOR (AIDA), VOLUME 2 Final Report, Aug. 1989 - Jul. 1991

ALBERT E. HICKEY, J. MICHAEL SPECTOR, and DANIEL J. MURAIDA Jan. 1992 132 p
(Contract F33615-88-C-0003)
(AD-A248202; AL-TR-1991-0085-VOL-2) Avail: CASI HC A07/MF A02

This is the final report for the second phase effort or the Advanced Instructional Design Advisor (AIDA) project. An experimental system called XAIDA is described. The proposed XAIDA is intended to assist subject-matter experts in the design and development of computer-based instructional materials. The functional requirements for an automated and intelligent advisor that would be appropriate for Air Force technical development are presented, along with a system specification, automated instruction, instructional development, computer-based instruction, interactive technology, courseware design. At the request of the 857th Strategic Hospital Bioenvironmental Engineering Services the Armstrong Laboratory Occupational and Environmental Health Directorate (AL/OE) conducted a Hazardous Waste Technical Assistance Survey at Minot AFB on 24-28 Jun. 1991. The scope of this survey was to address hazardous waste management practices, to explore opportunities for waste minimization, and to determine waste streams. The survey team performed a shop-by-shop determination of hazardous waste streams and met with hazardous waste managers to discuss their waste programs. Recommendations include: (1) employ proven waste reduction techniques in 857 TRANS shops, 857 CES vehicle maintenance and equipment maintenance shops, and 5 FMS aircraft maintenance shops; and (2) install locking devices on each accumulation drum or tank at accumulation points. GRA

N92-29604# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
HYPERBOLIC GRID GENERATION CONTROL BY PANEL METHODS
M. H. L. HOUNJET 15 Feb. 1991 17 p Presented at the 3rd International Conference on Numerical Grid Generation in Computational Fluid Dynamics and Related Fields, Barcelona, Spain, 3-7 Jun. 1991
(Contract NIVR-01904-N)
(NLR-TP-91061-U; ETN-92-91453) Avail: CASI HC A03/MF A01

A method for the generation of OH type grids about transport type aircraft is presented. The method combines a hyperbolic grid generation scheme with source terms obtained with a panel method in such a way that OH type grids around fairly complex shapes with concavities can be generated easily. The components of the method, a method to generate grids with a panel method and the hyperbolic grid generation scheme, are described and applications are shown. ESA

N92-30207*# Toledo Univ., OH.
USERS MANUAL FOR UPDATED COMPUTER CODE FOR AXIAL-FLOW COMPRESSOR CONCEPTUAL DESIGN Final Report
ARTHUR J. GLASSMAN Jul. 1992 23 p
(Contract NAG3-1165; RTOP 505-69-50)
(NASA-CR-189171; E-7003; NAS 1.26:189171) Avail: CASI HC A03/MF A01

An existing computer code that determines the flow path for an axial-flow compressor either for a given number of stages or for a given overall pressure ratio was modified for use in air-breathing engine conceptual design studies. This code uses a rapid approximate design methodology that is based on isentropic simple radial equilibrium. Calculations are performed at constant-span-fraction locations from tip to hub. Energy addition per stage is controlled by specifying the maximum allowable values for several aerodynamic design parameters. New modeling was introduced to the code to overcome perceived limitations. Specific changes included variable rather than constant tip radius, flow path inclination added to the continuity equation, input of mass flow rate directly rather than indirectly as inlet axial velocity, solution for the exact value of overall pressure ratio rather than for any value that met or exceeded it, and internal computation of efficiency rather than the use of input values. The modified code was shown to be capable of computing efficiencies that are compatible with those of five multistage compressors and one fan that were tested experimentally. This report serves as a users manual for the revised code, Compressor Spanline Analysis (CSPAN). The modeling modifications, including two internal loss correlations, are presented. Program input and output are described. A sample case for a multistage compressor is included. 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.

A92-45831* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HIGH-SPEED PROPELLER NOISE PREDICTION - A MULTIDISCIPLINARY APPROACH
MARK H. DUNN (Lockheed Engineering and Sciences Co., Hampton, VA) and F. FARASSAT (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 30, no. 7, July 1992, p. 1716-1723. Previously cited in issue 02, p. 228, Accession no. A91-12450. refs
Copyright

A92-45835* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RELATIONSHIP BETWEEN THE INSTABILITY WAVES AND NOISE OF HIGH-SPEED JETS
CHRISTOPHER K. W. TAM, PING CHEN (Florida State University, Tallahassee), and J. M. SEINER (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 30, no. 7, July 1992, p. 1747-1752. Previously cited in issue 06, p. 922, Accession no. A91-19328. refs
(Contract NAG1-421)
Copyright

A92-45876
INTERNATIONAL CONGRESS ON RECENT DEVELOPMENTS IN AIR- AND STRUCTURE-BORNE SOUND AND VIBRATION, AUBURN UNIVERSITY, AL, MAR. 6-8, 1990, PROCEEDINGS. VOLS. 1 & 2
MALCOLM J. CROCKER, ED. (Auburn University, AL) Congress sponsored by Auburn University, IUPAP, NSF, et al. Auburn, AL, Auburn University, 1990, p. Vol. 1, 510 p.; vol. 2, 477 p. For individual items see A92-45877 to A92-45934.
Copyright

Various papers on recent developments in air- and structure-borne sound and vibration are presented. The general topics addressed include: sound intensity, sound radiation and acoustic coupling, modal analysis and synthesis, acoustics, active vibration control, diagnostics and condition monitoring, finite element analysis, structural intensity and acoustical holography, passive vibration damping, boundary element methods, active noise and vibration control, material characterization and NDE, active noise and vibration control, sound radiation and scattering, statistical energy analysis, vibration and dynamics. C.D.

A92-45879
NEW METHODS TO DETERMINE THE TRANSMISSION LOSS OF PARTITIONS USING SOUND INTENSITY MEASUREMENTS
ZDENEK VALC (Zetor Co., Brno, Czechoslovakia) and MALCOLM J. CROCKER (Auburn University, AL) IN: International Congress on Recent Developments in Air- and Structure-Borne Sound and Vibration, Auburn, AL, Mar. 6-8, 1990, Proceedings. Vol. 1. Auburn, AL, Auburn University, 1990, p. 57-64. refs
Copyright

Some new approaches to determining sound transmission loss due to partitions are described. These approaches include: (1) the determination of the incident sound intensity with an intensity probe by placing highly absorbing material on the source side of the partition; (2) the determination of the incident sound intensity in the window of the source room using an intensity probe or alternatively, in the case of an aerospace structure, determining the intensity with the structural panel removed; and (3) the determination of the incident intensity from the surface-averaged sound pressure level in a reverberant source room. Preliminary measurements show that placing sound-absorbing material on the source side of the panel enables the incident intensity to be obtained accurately in the frequency range of about 700 to 10,000 Hz. C.D.

A92-45921
THE RELATIONSHIP BETWEEN MODE LOCALIZATION AND ENERGY TRANSMISSION PARAMETERS IN THE VIBRATION OF COUPLED STRUCTURES
JAMES A. MOORE and VENKATASAM ESWARA (Lowell, University, MA) IN: International Congress on Recent Developments in Air- and Structure-Borne Sound and Vibration, Auburn, AL, Mar. 6-8, 1990, Proceedings. Vol. 2. Auburn, AL, Auburn University, 1990, p. 787-792. refs
Copyright

Discontinuities in structures block vibratory energy transmission as characterized by a transmission coefficient and in an SEA model by the coupling loss factor. Weak coupling across a discontinuity results in 'local' structural modes of the entire system with the response localized on either side of the discontinuity. For simple 1-D string and beam systems, ratios of the modal response in local regions compare quantitatively with transmission coefficient values and possibly the SEA coupling loss factor. This result may aid in the initial selection of SEA subsystems. Estimates of response variance may be reduce if the SEA subsystems correspond to the regions of localized modal response. Transmission coefficient values at discontinuities in complex structures may serve to identify regions of localized response in selecting SEA subsystems. Author

A92-45929
SOLUTIONS OF ACOUSTIC FIELD PROBLEMS USING PARALLEL COMPUTERS
M. ZUBAIR, U. S. SHIRAHATTI, T. L. JACKSON, and C. E. GROSCH (Old Dominion University, Norfolk, VA) IN: International Congress on Recent Developments in Air- and Structure-Borne Sound and Vibration, Auburn, AL, Mar. 6-8, 1990, Proceedings. Vol. 2. Auburn, AL, Auburn University, 1990, p. 903-908. refs
Copyright

An effort is made to solve large scale acoustic field problems on such parallel computers as the DAP-510 and the NCUBE-7. After deriving both the mean flow equations for an inviscid moving medium and the acoustic fluctuations associated with them, Euler equations are solved by a compact four-step, fourth-order Runge-Kutta scheme, for efficiency and ease of implementation. O.C.

A92-46248
INTEGRATED OPTIC COMPONENTS FOR ADVANCED TURBINE ENGINE CONTROL SYSTEMS
S. M. EMO, T. R. KINNEY (Allied-Signal Aerospace Co., Bendix Engine Controls Div., South Bend, IN), and KA-KHA WONG (Allied-Signal, Inc., Morristown, NJ) IN: Integrated optics and optoelectronics II; Proceedings of the Meeting, San Jose, CA, Sept. 17-19, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1991, p. 266-276.
Copyright

The status of present optic technology in turbine engine control is highlighted, and future developments and trends are explored. Attention is given to a base engine control system configured with a primary and backup or standby control. Specific needs for integrated optic components in advanced turbine engine control systems are addressed. The optic harness and interconnect, as well as the electrooptic interface involving only coupling optic excitation and return signals are discussed. A number of 1:2 and 1:5 power splitters and combiners being fabricated using the ion-exchange technology on glass substrates are shown. The devices are potentially useful for the combination of various optical signals from a number of sensor units, and in addition calibration signals could be added prior to signal processing. Integrated optic and electrooptic interfaces are expected to evolve into the engine control environment. A concept for a multilayer electrooptic module which contains a single or multiple optic layers within the printed wiring card is illustrated. C.A.B.

A92-46430
ENERGY ANALYSIS OF HIGH-SPEED FLIGHT SYSTEMS
P. CZYSZ (McDonnell Douglas Corp., Saint Louis, MO) and S. N. B. MURTHY (Purdue University, West Lafayette, IN) IN: High-speed flight propulsion systems. Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1991, p. 143-235. Research supported by McDonnell Douglas Corp. refs
Copyright

Methods of energy analysis applicable to high-speed flight propulsion systems are described and illustrated, and the interrelations in the analysis of the trajectory, energy utilization, and weights are delineated. Energy analysis is shown to have a central role in flight vehicle optimization. The geography of the launch and recovery site and the weight fractions are taken into consideration. A methodology for optimizing propulsion for a given flight vehicle system is outlined. C.D.

A92-46799* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NOISE OF TWO HIGH-SPEED MODEL COUNTER-ROTATION PROPELLERS AT TAKEOFF/APPROACH CONDITIONS
RICHARD P. WOODWARD (NASA, Lewis Research Center, Cleveland, OH) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 679-685. refs
Copyright

This paper presents acoustic results for two model counter-rotation propellers which were tested in the NASA Lewis 9- x 15-ft Anechoic Wind Tunnel. The propellers had a common forward rotor, but the diameter of the aft rotor of the second propeller was reduced in an effort to reduce its interaction with the forward rotor tip vortex. The propellers were tested at Mach 0.20, which is representative of takeoff/approach operation. Acoustic results are presented for these propellers which show the effect of rotor spacing, reduced aft rotor diameter, operation at angle-of-attack, blade loading, and blade number. Limited aerodynamic results are also presented to establish the propeller operating conditions. Author

A92-46809
SUPPRESSION OF FATIGUE-INDUCING CAVITY ACOUSTIC MODES IN TURBOFAN ENGINES
ROBERT H. BENNER (Rohr, Inc., Chula Vista, CA) Journal of Aircraft (ISSN 0021-8669), vol. 29, no. 4, July-Aug. 1992, p. 718-720. Previously cited in issue 02, p. 229, Accession no. A91-12457. refs
Copyright

A92-47028#
HYPERSONIC PLASMA PREDICTIONS AT NONZERO ANGLE OF ATTACK
M. OLMOS, S. F. SATERLIE, L. GLATT (TRW Space and Defense Sector, San Bernardino, CA), S. HOWARD, K. GOLDEN, T. HANRAHAN (XonTech, Los Angeles, CA), and J. KRIEBEL (USAF, Ballistic Missile Organization, Norton AFB, CA) AIAA, Plasmadynamics and Lasers Conference, 23rd, Nashville, TN, July 6-8, 1992. 7 p. refs
(Contract F04704-92-C-0006)
(AIAA PAPER 92-3027)

Under various conditions encountered by a hypersonic-cruise aircraft over the course of its trajectory, levels of ionization may be encountered which could degrade the performance of guidance sensors such as radar and satellite global positioning. An effort is presently made to furnish predictions for the nonequilibrium chemically-reacting ionized flows generated by a hypersonic vehicle at small angle of attack. A comparison of these predictions with flight data shows good agreement with the vehicle's windward side; the leeward side predictions are, however, excessive. An analysis of these results shows possible areas of improvement in computational methodology. O.C.

A92-48500
OPTICS IN AIRCRAFT ENGINES
JAMES VACHON and SUBHASH MALHOTRA (GE Aircraft Engines, Cincinnati, OH) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 2. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 585-590.
Copyright

The authors describe optical IR&D (independent research and development) programs designed to demonstrate and evaluate optical technologies for incorporation into next-generation military and commercial aircraft engines. Using a comprehensive demonstration program to validate this technology in an on-engine environment, problems encountered can be resolved early and risk can be minimized. In addition to specific activities related to the optics demonstration on the fighter engine, there are other optical programs underway, including a solenoid control system, a light off detection system, and an optical communication link. Research is also underway in simplifying opto-electronics and exploiting multiplexing to further reduce cost and weight. I.E.

A92-48597
BASIC EXPERIMENTS ON THE DIRECTIVITY OF THE SOUND RADIATION EMITTED BY A TURBOSHAFT ENGINE [EXPERIENCES DE BASE SUR LA DIRECTIVITE DU RAYONNEMENT SONORE EMIS PAR UN TURBOMOTEUR]
C. POLACSEK (ONERA, Chatillon, France) (Congres Francais d'Acoustique, 2nd, Arcachon, France, Apr. 14-16, 1992) ONERA, TP no. 1992-36, 1992, 5 p. In French. refs
(ONERA, TP NO. 1992-36)

Basic acoustic experiments have been performed in an anechoic chamber in order to analyze the influence of the geometry of a turboshaft engine air intake on sound propagation and radiation. Two air intake models have been studied. The compressor noise is simulated by a spinning mode synthesizer. Modal analysis and experimental directivities are compared to some calculations. Author

A92-48601
INFLUENCE OF GEOMETRICAL PARAMETERS ON HELICOPTER ROTOR HIGH SPEED IMPULSIVE NOISE
J. PRIEUR and C. POLACSEK (ONERA, Chatillon, France) (DGLR and AIAA, Aeroacoustics Conference, 14th, Aachen, Federal Republic of Germany, May 11-14, 1992) ONERA, TP no. 1992-40, 1992, 10 p. refs
(ONERA, TP NO. 1992-40)

The radiation of impulsive noise from helicopter rotors in high speed forward flight, as well as global performance, is largely influenced by blade geometry. A review of theoretical effort in this field and examples mainly taken from ONERA experimental wind tunnel studies are presented. The benefit in terms of noise reduction, provided by an advanced geometry, is assessed and compared to what is obtained by lowering the rotation speed. Wind tunnel acoustic studies also show that the designs of low noise blade geometries either for descent flight, or for high speed are not inevitably antithetical. Author

A92-48602
ACOUSTIC SPINNING-MODE ANALYSIS BY ITERATIVE THRESHOLD METHOD APPLIED TO A HELICOPTER TURBOSHAFT ENGINE
D. BLACODON (ONERA, Chatillon, France) (DGLR and AIAA, Aeroacoustics Conference, 14th, Aachen, Federal Republic of Germany, May 11-14, 1992) ONERA, TP no. 1992-41, 1992, 11 p. Research supported by Ministere de la Defense and Turbomeca Co. refs
(ONERA, TP NO. 1992-41)

Spinning-mode analysis methods are commonly used to study the space-structure of the acoustic field inside ducts. In some applications, the acoustic field is very noisy. The acoustic modes may then be overwhelmed by the spurious modes in the modal spectra. The problem may be solved by methods which greatly reduce the background noise. Four methods studied in a previous work are briefly reminded in this paper. The method which provides the best reduction of the background noise may be inaccurate in certain cases. Indeed, it does not correctly predict the amplitudes of all the acoustic spinning modes. An iterative threshold technique is proposed to eliminate this drawback. It is compared to the four other methods by numerical simulations and by tests in a nozzle of a Turbomeca TM333 turboshaft engine. Author

A92-48618
RESEARCH AND STUDIES ON QUIET HELICOPTERS [ETUDES ET RECHERCHES EN MATIERE D'HELICOPTERES SILENCIEUX]
HENRI-JAMES MARZE (Eurocopter France, Marignane) and SERGE LEWY (ONERA, Chatillon, France) (Entretiens Science et Defense, La Villette, France, May 12, 13, 1992) ONERA, TP no. 1992-59, 1992, 18 p. In French. Research supported by DRET and Service Technique des Programmes Aeronautiques. refs
(ONERA, TP NO. 1992-59)

Various issues associated with the search for quiet helicopters are presented and a midterm research program started in 1991 is described. The flight regimes to be investigated first are high-speed flight and approach, as the main rotor generates a very characteristic loud and impulsive noise at that time. The prediction methods, the techniques of noise reduction, and the goals to be achieved are reviewed. R.E.P.

N92-28292# Army Construction Engineering Research Lab., Champaign, IL.
OPERATIONAL NOISE DATA FOR OH-58D ARMY HELICOPTERS Final Report
L. J. BENSON, MICHEAL J. WHITE, and KEVIN J. MURPHY Jan. 1992 57 p
(AD-A246822; CERL-N-92/07) Avail: CASI HC A04/MF A01

The Army needs helicopter noise source emission data for use in the Installation Compatible Use Zone (ICUZ) program and for environmental assessments. This research gathered noise source emission data for the OH-58D helicopter. The data were normalized to 250 ft for use in noise maps. The data were also used to develop sound exposure level (SEL) versus distance curves for comparison with other helicopter data. The data show that the A-weighted maximum noise level increases with airspeed for level flight, but the A weighted SEL increases only slightly. The highest A-weighted maximum level was produced by the out-of-ground effect hover. Landings produce the largest A-weighted SEL. GRA

N92-28302# Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab.
PASSIVE ACOUSTIC RANGE ESTIMATION OF HELICOPTERS Final Report
REO OLSON and DANIEL H. CRESS Feb. 1992 80 p
(AD-A248033; WES/TR/EL-92-13) Avail: CASI HC A05/MF A01

A passive acoustic method is presented that determines the velocity of a moving helicopter and its range at the closest point of approach. This method requires only the use of a single microphone if the fundamental blade rotation frequency of the helicopter is known, or two spatially separated microphones if it is not. The blade rotation frequency is generally adequately known after the helicopter is correctly classified using acoustic signature characteristics other than those discussed herein. The range estimate is considered valid for ranges of a few hundred meters with the attendant assumptions that: (1) the helicopter is traveling in a straight line, (2) the helicopter is moving at a constant velocity, and (3) the main rotor of the helicopter has a stable revolution rate typical of present operational helicopters. The technique was successfully tested on an example helicopter. GRA

N92-28556*# McDonnell-Douglas Corp., Long Beach, CA.
EVALUATION OF OUTDOOR-TO-INDOOR RESPONSE TO MINIMIZED SONIC BOOMS
DAVID BROWN and LOUIS C. SUTHERLAND Jun. 1992 42 p
Presented at the First Annual High-Speed Research Workshop, Williamsburg, VA, 14-16 May 1991 *Prepared in cooperation with* Wyle Labs., Inc., El Segundo, CA
(Contract NAS1-19060; RTOP 537-03-21-03)
(NASA-CR-189643; NAS 1.26:189643; WYLE-TN-91-8) Avail: CASI HC A03/MF A01

Various studies were conducted by NASA and others on the practical limitations of sonic boom signature shaping/minimization for the High-Speed Civil Transport (HSCT) and on the effects of these shaped boom signatures on perceived loudness. This current effort is a further part of this research with emphasis on examining shaped boom signatures which are representative of the most recent investigations of practical limitations on sonic boom minimization, and on examining and comparing the expected response to these signatures when experienced indoors and outdoors. Author

N92-28695# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
EXPERIMENTAL VALIDATION OF A LINE-DUCT ACOUSTICS MODEL INCLUDING FLOW
E. R. RADEMAKER 25 Jun. 1990 14 p Presented at ASME Conference on Duct Acoustics, Dallas, TX, Nov. 1990
(Contract NIVR-01803-N)
(NLR-TP-90223-U; ETN-92-91541) Avail: CASI HC A03/MF A01

In the spinning mode synthesizer which was coupled to the flow nozzle of the small anechoic wind tunnel, an experimental program for the validation of a theoretical duct acoustics model was carried out. This model, LINDA, calculates the sound propagation in a cylindrical flow duct of finite length, which includes an acoustically lined section between two hard walled sections. Measurements of the circumferential and radial acoustic pressure distribution downstream and upstream of the lined sections, and of the radial distribution halfway of a lined section were made with flow at several frequencies and acoustic mode adjustments. From these measurements, quantities which characterize the net damping attained by the liners (the insertion loss and transmission loss) were derived. These values and the radial distribution of the transmitted field are compared with the theoretical results. The agreeement is good (plus or minus 1dB). ESA

N92-28909*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE DESIGN OF TEST-SECTION INSERTS FOR HIGHER SPEED AEROACOUSTIC TESTING IN THE AMES 80- BY 120-FOOT WIND TUNNEL
PAUL T. SODERMAN and LARRY E. OLSON Jan. 1992 13 p
Proposed for presentation at the DGLR/AIAA 14th Aeroacoustics Conference, Aachen, Germany, 11-14 May 1992
(Contract RTOP 505-59-52)
(NASA-TM-103915; A-92052; NAS 1.15:103915) Avail: CASI HC A03/MF A01

An engineering feasibility study was made of aeroacoustic inserts designed for large-scale acoustic research on aircraft models in the 80- by 120-Foot Wind Tunnel at NASA Ames Research Center. The goal was to find test-section modifications that would allow improved aeroacoustic testing at airspeeds equal to and above the current 100 knots limit. Results indicate that the required maximum airspeed drives the design of a particular insert. Using goals of 200, 150, and 100 knots airspeed, the analysis led to a 30 x 60 ft open-jet test section, a 40 x 80 ft open-jet test section, and a 70 x 110 ft closed test section with enhanced wall lining respectively. The open-jet inserts would be composed of a nozzle, collector, diffuser, and acoustic wedges incorporated in the existing 80 x 120 ft test section. The closed test section would be composed of approximately 5-ft acoustic wedges covered by a porous plate attached to the test-section walls of the existing 80 x 120. All designs would require a double row of acoustic vanes between the test section and fan drive to attenuate fan noise and, in the case of the open-jet designs, to control flow separation at the diffuser downstream end. The inserts would allow virtually anechoic acoustics studies of large helicopter models, jets, and V/STOL aircraft models in simulated flight. Model scale studies would be necessary to optimize the aerodynamic and acoustic performance of any of the designs. Successful development of acoustically transparent walls, though not strictly necessary to the project, would lead to a porous-wall test section that could be substituted for any of the open-jet designs, and thereby eliminate many aerodynamic and acoustic problems characteristic of open-jet shear layers. Author

N92-28923# United Kingdom Atomic Energy Authority, Harwell (England).
REPORT ON THE WORKSHOP ON ION IMPLANTATION AND ION BEAM ASSISTED DEPOSITION
G. DEARNALEY Mar. 1992 3 p Workshop held in Corpus Christi, TX, 9-11 Mar. 1992
(AD-A250561; R/D-6907-EE-06) Avail: CASI HC A01/MF A01

This workshop was organized by the Corpus Christi Army Depot (CCAD), the major helicopter repair base within AVSCOM. Previous meetings had revealed a strong interest throughout DoD in ion beam technology as a means of extending the service life of military systems by reducing wear, corrosion, fatigue, etc. The workshop opened with an account by Dr. Bruce Sartwell of the successful application of ion implantation to bearings and gears at NRL, and the checkered history of the MANTECH Project at Spire Corporation. Dr. James Hirvonen (AMTL) continued with a summary of successful applications to reduce wear in biomedical components, and he also described the processes of ion beam-assisted deposition (IBAD) for a variety of protective coatings, including diamond-like carbon (DLC). GRA

N92-29095# Department of the Navy, Washington, DC.
MULTI-CHANNEL FIBER OPTIC ROTARY JOINT FOR SINGLE-MODE FIBER Patent Application
GREGORY H. AMES, inventor (to Navy) 16 Sep. 1991 21 p
(AD-D015273; US-PATENT-APPL-SN-760635) Avail: CASI HC A03/MF A01

A fiber optic rotary joint device is described. The device includes a rotor connected to either an input or output fiber optic array and a stator connected to the remaining unconnected input or output fiber optic array. A prism is mounted within the rotor for derotating an image of the input array to allow coupling to the output array. A prism rotor and a gear system are provided for rotating the prism at half the speed of the rotor. Optical means are provided for two adjustment tiers (small angular adjustment and fine adjustment) of alignment of the light propagation path for each channel of the array. Mechanical structural features provide maintenance of accurate alignment of optical elements under rotation of the joint. Further mechanical structural features provide resiliency of the gear system to isolate its operation from maintenance of mechanical alignment of optical elements. GRA

N92-29201# Cambridge Univ. (England). Dept. of Engineering.
BOUNDARY LAYER INDUCED NOISE IN AIRCRAFT
W. R. GRAHAM May 1992 345 p
(ISSN 0309-7293)
(CUED/A-AERO/TR-18) Avail: CASI HC A15/MF A03

The aim of this research is to investigate ways of controlling boundary layer induced noise at the design stage, as the problem is much harder to treat after it has become apparent. In order to achieve this, it is essential to be able to model the noise generation process successfully, preferably in such a way that our physical understanding of the problem is enhanced, since without this understanding the formulation of general design guidelines is almost impossible. At present, although a large body of research germane to the problem exists, there is no such model, and the development of one is, thus, the first requirement of this work. Once the model is complete and validated, the question of noise limitation may be addressed. The reduction of the boundary layer induced noise problem in aircraft to an initial model problem, which may be formulated in general terms, and the subsequent further approximations that may be made to achieve a form simple enough to facilitate understanding of the results while retaining the necessary features of the problem are described. Author

N92-29997# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Abteilung Technische Akustik.

JET AIRCRAFT NOISE AT HIGH SUBSONIC FLIGHT MACH NUMBERS [DER LAERM VON STRAHLFLUGZEUGEN BEI HOHEN UNTERSCHALL-FLUGMACHZAHLEN]

JAN BOETTCHER and ULF MICHEL Aug. 1991 94 p In GEORGIAN
(ISSN 0939-2963)
(DLR-FB-91-28; ETN-92-91733) Avail: CASI HC A05/MF A01; DLR, Wissenschaftlisches Berichtswesen, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC

Acoustic overfly measurements are carried out and analyzed to identify the sound sources of the noise development by means of their spectral radiation properties. The extension of existing prediction schemes for the radiation mixing and the broadband shock noise is discussed on the basis of experimental results. Measure and calculation results were compared and a good agreement was found for the time profiles of noise levels, the frequency spectra, and the total sound pressure level as a function of emission angle. The prediction schema could be used to demonstrate the influence of operational parameters and quantify the noise production. It is shown that a decrease in flight Mach number and an increase of flight height cause an important noise reduction. ESA

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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.

A92-44994

THE DEVELOPMENT OF AN INTELLIGENT HUMAN FACTORS DATA BASE AS AN AID FOR THE INVESTIGATION OF AIRCRAFT ACCIDENTS

AMANDA J. W. FEGGETTER (Ministry of Defence, London, England) IN: International Symposium on Aviation Psychology, 6th, Columbus, OH, Apr. 29-May 2, 1991, Proceedings. Vol. 2. Columbus, OH, Ohio State University, 1991, p. 624-629. refs

A human factors data aid encompassing psychological, physiological, sociological, and ergonomic considerations has been developed for use in the investigation of aircraft accidents. This data base incorporates intelligence in the form of stored rules and prior knowledge, collectively constituting a comprehensive list of contributory factors; after covering a given incident in detail, the aid allows all relevant data to be organized in the form of a draft standardized report. The system also facilitates the reexamination of suspected causative factors. O.C.

A92-45581#

APPLIED AERODYNAMICS EDUCATION - DESIGN AND SCIENCE

CONRAD F. NEWBERRY (U.S. Naval Postgraduate School, Monterey, CA) AIAA, Applied Aerodynamics Conference, 10th, Palo Alto, CA, June 22-24, 1992. 10 p. refs
(AIAA PAPER 92-2662)

The paper defines design and its role in engineering science classes in general and in aerodynamics classes in particular. The need and purpose for design in the engineering curriculum is treated in some detail. ABET design requirements are discussed in terms of accreditation criteria and as suggestions generally for incorporating design into engineering science classes. Some attention is given to how design type problems can enhance the learning of theoretical aerodynamics. There is a detailed discussion of the seven (7) ABET defined facets of design as they might be implemented in a typical undergraduate aerodynamics class. It is concluded that a design component in a typical aerodynamics class in engineering science is not only necessary, it is desirable and can be achieved with a minimal impact upon the science content of the course. Author

A92-47628

MASSINFO - AN INTELLIGENT MASS PROPERTIES INFORMATION SYSTEM

STEVEN R. WELCH (Boeing Defense & Space Group, Military Airplanes Div., Seattle, WA) Weight Engineering (ISSN 0583-9270), vol. 51, no. 3, Spring 1992, p. 7-18.
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MassInfo is a Macintosh program that uses an intuitive interface and built-in intelligence features to keep track of component weights, cgs, inertia, material distribution, weight recording quality, etc., for all types of vehicles. It is capable of handling multiple vehicle effectivities using relational data structures, multiple users with various administrative privileges and preferences, and multiple coordinate systems having offsets and rotations. Hierarchical trees (functional code, drawing, work breakdown structure, and three others optionally defined by the user) can be used to report mass properties. Several common report formats (such as Mil-Std-1374 and Mil-Std-38310B) can be easily generated, as well as custom user reports. Import and export features allow data exchange with other database systems or workstation applications. The paper illustrates the program's features through a sample session. A.F.S.

A92-48555

USING DESIGN OF EXPERIMENTS TO IMPROVE PRODUCT AND PROCESS INTEGRITY

LLOYD CONDRA (Eldec Corp., Lynnwood, WA) and MICHELLE LINDSLEY (Washington, University, Seattle) IN: NAECON 91; Proceedings of the IEEE National Aerospace and Electronics Conference, Dayton, OH, May 20-24, 1991. Vol. 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1991, p. 1008-1011. refs
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The authors summarize the needs and benefits of DoE (design of experiments) in avionics markets, provide a brief discussion of DoE methods, and present a formalism for using DoE in reliability determination and assurance. DoE is being used to produce dramatic improvements in the following areas of avionics manufacturing: process optimization/improvement; product design/improvement; new process development; capital equipment acquisition; quick response to RFPs; and improved communication. It is concluded that DoE is an efficient way to systematically obtain knowledge, and is therefore a valuable tool in an industry in which short cycle times, low costs, and high reliability must be demonstrated. I.E.

A92-49117#

ENGINE AIRCRAFT SYSTEMS INTEGRATION COURSE

PAUL J. HESS (GE Aircraft Engines, Cincinnati, OH) AIAA, SAE, ASME, and ASEE, Joint Propulsion Conference and Exhibit, 28th, Nashville, TN, July 6-8, 1992. 5 p. refs
(AIAA PAPER 92-3762) Copyright

An account is given of a course of study encompassing the numerous considerations involved in aircraft gas turbine system definition within an aerothermodynamic framework; these considerations range over engine cycle type, air flowpath design, control integration, inlet and exhaust integration, acoustics, survivability, reliability, and mechanical subsystems. The integration of these factors is stressed. The systems approach is employed throughout. Over the years of the course's use, student suggestions have led to a relative deemphasis of the design-related aspects of the subject matter. O.C.

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SPACE SCIENCES

Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.

A92-46595
STABILITY AND INHERENT PRECISION OF TWO METHODS FOR SOLVING MOTION AND ABLATION EQUATIONS FOR FIREBALL-FORMING BODIES IN THE EARTH ATMOSPHERE [USTOICHIVOST' I VNUTRENNIAIA TOCHNOST' DVUKH METODOV RESHENIIA URAVNENII DVIZHENIIA I ABLIATSII BOLIDOOBRAZUIUSHCHIKH TEL V ATMOSFERE ZEMLI]
V. V. KALENICHENKO (Astronomicheskaia Observatoriia, Kiev, Ukraine) Kinematika i Fizika Nebesnykh Tel (ISSN 0233-7665), vol. 8, no. 3, May-June 1992, p. 69-77. In Russian. refs
Copyright

The stability of two methods for solving motion and ablation equations for a fireball-forming body in the earth atmosphere is investigated; the solution's inherent precision is estimated on the basis of the Prairie network catalog. The ratio of the initial and terminal velocities of a fireball on the visible trajectory is shown to be a reliable criterion of the fireball's fitness for determining the physical characteristics of its cosmic body. For the Prairie network, the solution of the motion and ablation equations of a fireball-forming body is stable for those fireballs whose ratio of initial to terminal velocities exceeds 1.7. P.D.

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GENERAL

A92-46201
EMERGING TECHNOLOGY IN THE SOVIET UNION: SELECTED PAPERS WITH ANALYSIS
Falls Church, VA, Delphic Associates, Inc., 1990, 315 p. For individual items see A92-46202 to A92-46204.
(ISBN 1-55831-117-1) Copyright

Various papers on emerging Soviet technology are presented. The topics addressed are: economic considerations of emerging technology; aviation, motor, and space designs; new materials and components for IR lasers; electroslag technology for smelting high quality metals from scrap and for preparing ingots with differential properties; computer design and application in the USSR; advances in tribology: slideway design and unloading systems; analysis of emerging Soviet technology. C.D.

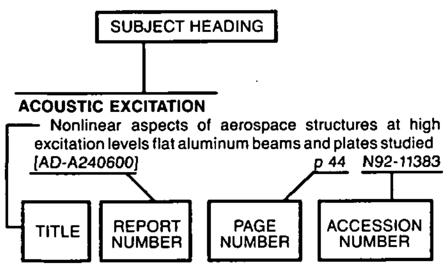
N92-28344*# National Aeronautics and Space Administration, Washington, DC.
NASA ENGINEERS AND THE AGE OF APOLLO
SYLVIA DOUGHTY FRIES 1992 232 p
(NASA-SP-4104; NAS 1.21:4104; LC-90-39761; ISBN-0-16-036174-5) Avail: CASI HC A11/MF A03

A historical account of NASA's Apollo era engineers is presented. This book is based on interviews that were conducted with fifty-one 'typical' engineers. Author

N92-29218# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.). Hauptabteilung Planung
DLR RESEARCH REPORTS AND COMMUNICATIONS Annual List, 1990 [JAHRESVERZEICHNIS 1990. DLR-FORSCHUNGSBERICHTE UND DLR-MITTEILUNGEN]
W. WOLKE Jul. 1991 41 p In GERMAN
(ISSN 0939-2971)
(ETN-92-91391) Avail: CASI HC A03/MF A01

Abstracts on the following are presented: flight mechanics, dynamics of flight systems, flight medicine, air traffic, flow mechanics, aerodynamics, propulsion, chemical propulsion, structural mechanics, aeroelasticity, materials, space simulation, high frequency, optoelectronics, physics, thermodynamics, wind tunnels, applied data technique, and data processing. ESA

Typical Subject Index Listing



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PERSONAL AUTHOR INDEX

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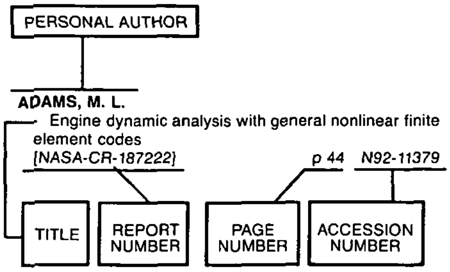

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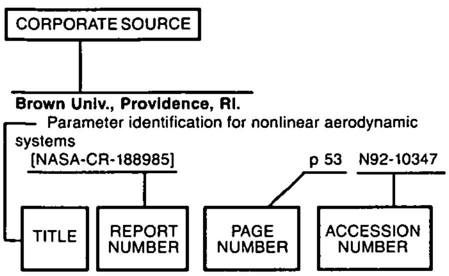

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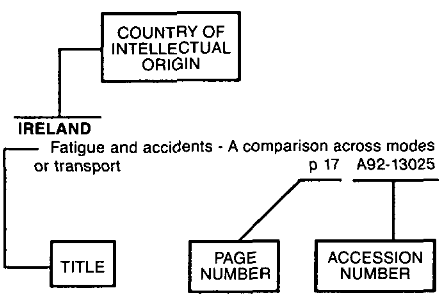

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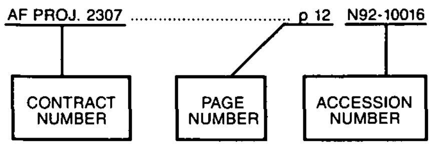

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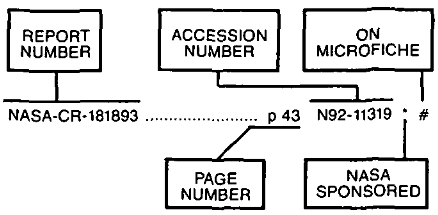

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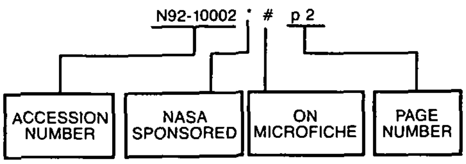

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